



UvA-DARE (Digital Academic Repository)

Populations crossing habitat boundaries in the face of environmental change

Chaparro Pedraza, P.C.

[Link to publication](#)

License
Other

Citation for published version (APA):
Chaparro Pedraza, P. C. (2019). *Populations crossing habitat boundaries in the face of environmental change*.

General rights

It is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), other than for strictly personal, individual use, unless the work is under an open content license (like Creative Commons).

Disclaimer/Complaints regulations

If you believe that digital publication of certain material infringes any of your rights or (privacy) interests, please let the Library know, stating your reasons. In case of a legitimate complaint, the Library will make the material inaccessible and/or remove it from the website. Please Ask the Library: <https://uba.uva.nl/en/contact>, or a letter to: Library of the University of Amsterdam, Secretariat, Singel 425, 1012 WP Amsterdam, The Netherlands. You will be contacted as soon as possible.

Bibliography

- Abrahams, M., and A. Sutterlin. 1999. The foraging and antipredator behaviour of growth-enhanced transgenic Atlantic salmon. *Animal Behaviour* 58:933–942.
- Alexander, R. M. 1998. When is migration worthwhile for animals that walk, swim or fly? *Journal of Avian Biology* pages 387–394.
- Alford, R. A., and H. R. N. 1988. Effects of larval growth history on anuran metamorphosis. *The American Naturalist* 131:91–106.
- Allendorf, F. W., and J. J. Hard. 2009. Human-induced evolution caused by unnatural selection through harvest of wild animals. *Proceedings of the National Academy of Sciences* 106:9987–9994.
- Arendt, J. D. 2009. Influence of sprint speed and body size on predator avoidance in New Mexican spadefoot toads (*Spea multiplicata*). *Oecologia* 159:455–461.
- ASFB. 2010. Annual review. Tech. rep.
- Auer, S. K., J. D. Arendt, R. Chandramouli, and D. N. Reznick. 2010. Juvenile compensatory growth has negative consequences for reproduction in Trinidadian guppies (*Poecilia reticulata*). *Ecology Letters* 13:998–1007.
- Beachy, C. K., T. H. Surges, and M. Reyes. 1999. Effects of developmental and growth history on metamorphosis in the gray treefrog, *Hyla versicolor* (Amphibia, Anura). *Journal of Experimental Zoology* 283:522–530.
- Bechtel, W., and R. C. Richardson. 1993. *Discovering Complexity Decomposition and Localization as Strategies in Scientific Research*. Princeton.
- Bellard, C., C. Bertelsmeier, P. Leadley, W. Thuiller, and F. Courchamp. 2012. Impacts of climate change on the future of biodiversity. *Ecology letters* 15:365–377.
- Bley, P., and J. Moring. 1988. Freshwater and ocean survival of Atlantic salmon and steelhead: A synopsis. Tech. rep.
- Bolchoun, L., B. Drossel, and K. T. Allhoff. 2017. Spatial topologies affect local food web structure and diversity in evolutionary metacommunities. *Scientific reports* 7:1818.
- Bone, E., and A. Farres. 2001. Trends and rates of microevolution in plants. *Genetica* 112:165–182.

- Boulton, A. M., and G. A. Polis. 1999. Phenology and life history of the desert spider, *Diguetia mojavea* (Araneae, Diguetidae). *Journal of Arachnology* pages 513–521.
- Bowerman, T. E., A. Pinson-Dumm, C. A. Peery, and C. C. Caudill. 2017. Reproductive energy expenditure and changes in body morphology for a population of Chinook salmon *Oncorhynchus tshawytscha* with a long distance migration. *Journal of Fish Biology* pages 1–20.
- Carpenter, S. R., J. J. Cole, M. L. Pace, R. Batt, W. A. Brock, T. J. Cline, J. Coloso, J. R. Hodgson, J. F. Kitchell, D. A. Seekell, L. Smith, and B. C. Weidel. 2014. Early warnings of regime shifts: a whole-ecosystem experiment. *Science* 332:1079–1082.
- Caswell, H. 1983. Phenotypic plasticity in life-history traits: demographic effects and evolutionary consequences. *American Zoologist* 23:35–46.
- Caudill, C. C., W. R. Daigle, M. L. Keefer, C. T. Boggs, M. A. Jepson, B. J. Burke, R. W. Zabel, T. C. Bjornn, and C. A. Peery. 2007. Slow dam passage in adult Columbia River salmonids associated with unsuccessful migration: delayed negative effects of passage obstacles or condition-dependent mortality? *Canadian Journal of Fisheries and Aquatic Sciences* 64:979–995.
- Chevin, L. M., R. Lande, and G. M. Mace. 2010. Adaptation, plasticity, and extinction in a changing environment: Towards a predictive theory. *PLoS Biology* 8:e1000357.
- Claessen, D., and U. Dieckmann. 2002. Ontogenetic niche shifts and evolutionary branching in size structured populations. *Evolutionary Ecology Research* 4:189–217.
- Clark, J. S., D. M. Bell, M. H. Hersh, M. C. Kwit, E. Moran, C. Salk, A. Stine, D. Valle, and K. Zhu. 2011. Individual-scale variation, species-scale differences: inference needed to understand diversity. *Ecology Letters* 14:1273–1287.
- Cocheret de La Morinière, E., B. Pollux, I. Nagelkerken, and G. Velde. 2002. Post-settlement life cycle migration patterns and habitat preference of coral reef fish that use seagrass and mangrove habitats as nurseries. *Estuarine, coastal and shelf science* .
- Cornulier, T., N. G. Yoccoz, V. Bretagnolle, J. E. Brommer, A. Butet, F. Ecke, D. A. Elston, E. Framstad, H. Henttonen, B. Hornfeldt, O. Huitu, C. Imholt, R. A. Ims, J. Jacob, B. Jedrzejewska, A. Millon, S. J. Petty, H. Pietiainen, E. Tkadlec, K. Zub, and X. Lambin. 2013. Europe-wide dampening of population cycles in keystone herbivores. *Science* 340:63–66.
- Cortez, M. H. 2011. Comparing the qualitatively different effects rapidly evolving and rapidly induced defences have on predator–prey interactions. *Ecology Letters* 14:202–209.
- Crain, C. M., K. Kroeker, and B. S. Halpern. 2008. Interactive and cumulative effects of multiple human stressors in marine systems. *Ecology Letters* 11:1304–1315.
- Craver, C. F. 2007. *Explaining the brain: Mechanisms and the mosaic unity of neuroscience*. Oxford University Press.
- Crossin, G. T., S. G. Hinch, A. P. Farrell, D. A. Higgs, A. G. Lotto, J. D. Oakes, and M. C. Healey. 2004. Energetics and morphology of sockeye salmon: Effects of upriver migratory distance and elevation. *Journal of Fish Biology* 65:788–810.
- Darwin, C. 1859. *On the origin of species*. John Murray.

- Dawson, T. P., S. T. Jackson, J. I. House, I. C. Prentice, and G. M. Mace. 2011. Beyond predictions: biodiversity conservation in a changing climate. *Science* 332:53–58.
- de Roos, A. 2018. PSPManalysis: A package for numerical analysis of physiologically structured population models.
- de Roos, A. M. 1988. Numerical methods for structured population models: The Escalator Boxcar Train. *Numerical Methods for Partial Differential Equations* 4:173–195.
- . 1997. A gentle introduction to physiologically structured population models. Pages 119–204 in *Structured-population models in marine, terrestrial, and freshwater systems*. Springer.
- de Roos, A. M., and L. Persson. 2002. Size-dependent life-history traits promote catastrophic collapses of top predators. *Proceedings of the National Academy of Sciences* 99:12907–12912.
- . 2003. Competition in size-structured populations: mechanisms inducing cohort formation and population cycles. *Theoretical population biology* 63:1–16.
- . 2013. *Population and community ecology of ontogenetic development*. Princeton University Press.
- de Roos, A. M., T. Schellekens, T. van Kooten, K. van de Wolfshaar, D. Claessen, and L. Persson. 2007. Food-dependent growth leads to overcompensation in stage-specific biomass when mortality increases: the influence of maturation versus reproduction regulation. *The American Naturalist* 170:E59–E76.
- Dercole, F., F. Della Rossa, and P. Landi. 2016. The transition from evolutionary stability to branching: A catastrophic evolutionary shift. *Scientific Reports* 6:26310.
- Dercole, F., R. Ferriere, and S. Rinaldi. 2002. Ecological bistability and evolutionary reversals under asymmetrical competition. *Evolution* 56:1081–1090.
- Dieckmann, U., and R. Law. 1996. The dynamical theory of coevolution: a derivation from stochastic ecological processes. *Journal of mathematical biology* 34:579–612.
- Diehl, S., and P. Eklov. 1995. Effects of piscivore-mediated habitat use on resources, diet, and growth of perch. *Ecology* 76:1712–1726.
- Dodson, J. J., J. Laroche, and F. Lecomte. 2009. Contrasting evolutionary pathways of anadromy in euteleostean fishes. *American Fisheries Society Symposium* 69:63–77.
- Doebeli, M., and G. D. G. Ruxton. 1997. Evolution of Dispersal Rates in Metapopulation Models: Branching and Cyclic Dynamics in Phenotype Space. *Evolution* 51:1730–1741.
- Doucett, R., R. Booth, G. Power, and R. McKinley. 1999. Effects of the spawning migration on the nutritional status of anadromous Atlantic salmon (*Salmo salar*): insights from stable-isotope analysis. *Canadian Journal of Fisheries and Aquatic Sciences* 56:2172–2180.
- Doughty, C. E., J. Roman, S. Faurby, A. Wolf, A. Haque, E. S. Bakker, Y. Malhi, J. B. Dunning, and J.-C. Svenning. 2016. Global nutrient transport in a world of giants. *Proceedings of the National Academy of Sciences* 113:868–873.
- Durinx, M., J. A. J. (Hans) Metz, and G. Meszéna. 2008. Adaptive dynamics for physiologically structured population models. *Journal of Mathematical Biology* 56:673–742.
- Dwyer, J. M., and D. C. Laughlin. 2017. Constraints on trait combinations explain climatic drivers of biodiversity: the importance of trait covariance in community assembly. *Ecology Letters* 20:872–882.

- Ehrlén, J., and W. F. Morris. 2015. Predicting changes in the distribution and abundance of species under environmental change. *Ecology Letters* 18:303–314.
- Einum, S., E. B. Thorstad, and T. F. Naesje. 2002. Growth rate correlations across life-stages in female Atlantic salmon. *Journal of Fish Biology* 60:780–784.
- Eliason, E. J., T. D. Clark, M. J. Hague, L. M. Hanson, Z. S. Gallagher, K. M. Jeffries, M. K. Gale, D. A. Patterson, S. G. Hinch, and A. P. Farrell. 2011. Differences in thermal tolerance among sockeye salmon populations. *Science* 332:109–112.
- Ferguson, G. W., and S. F. Fox. 1984. Annual variation of survival advantage of large juvenile side-blotched lizards, *Uta stansburiana*: its causes and evolutionary significance. *Evolution* 38:342–349.
- Fidan, E. D., and M. Kaya. 2014. Effects of early feed restriction on some performance and reproductive parameters in japanese quail (*Coturnix coturnix japonica*). *International Journal of Poultry Science* 13:323.
- Food, and A. O. of the United Nations. Fisheries Department. 2016. The state of world fisheries and aquaculture. Food and Agriculture Organization of the United Nations.
- Friedland, K. D., J. C. MacLean, L. P. Hansen, A. J. Peyronnet, L. Karlsson, D. G. Reddin, N. Ó Maoiléidigh, and J. L. McCarthy. 2009. The recruitment of Atlantic salmon in Europe. *ICES Journal of Marine Science* 66:289–304.
- Froese, R., and D. Pauly. 2018. Fishbase.
- Fry, F. E. J. 1971. The effect of environmental factors on the physiology of fish. *Fish Physiology* 6:1–98.
- Gagliano, M., and M. I. McCormick. 2007. Compensating in the wild: Is flexible growth the key to early juvenile survival? *Oikos* 116:111–120.
- Geritz, S. A., G. Mesze, J. A. Metz, et al. 1998. Evolutionarily singular strategies and the adaptive growth and branching of the evolutionary tree. *Evolutionary ecology* 12:35–57.
- Gilbey, J., E. Cauwelier, C. S. Jones, a. McLay, L. R. Noble, and E. Verspoor. 2009. Size-dependent growth of individual Atlantic salmon *Salmo salar* alevins from hatch to first feeding. *Journal of Fish Biology* 75:2820–2831.
- Gilman, S. E., M. C. Urban, J. Tewksbury, G. W. Gilchrist, and R. D. Holt. 2010. A framework for community interactions under climate change. *Trends in Ecology and Evolution* 25:325–331.
- Glebe, B., and W. Leggett. 1981. Latitudinal differences in energy allocation and use during the freshwater migrations of american shad (*Alosa sapidissima*) and their life history consequences. *Canadian Journal of Fisheries and Aquatic Sciences* 38:806–820.
- Good, D. S. 1993. Evolution of behaviours in *Drosophila melanogaster* in high temperatures: Genetic and environmental effects. *Journal of Insect Physiology* 39:537–544.
- Grimm, V., and S. F. Railsback. 2012. Pattern-oriented modelling: a 'multi-scope' for predictive systems ecology. *Philosophical Transactions of the Royal Society B: Biological Sciences* 367:298–310.
- Guill, C., B. Drossel, W. Just, and E. Carmack. 2011. A three-species model explaining cyclic dominance of Pacific salmon. *Journal of Theoretical Biology* 276:16–21.

- Guttal, V., and C. Jayaprakash. 2008. Changing skewness: an early warning signal of regime shifts in ecosystems. *Ecology Letters* 11:450–460.
- Hairston, N. G., S. P. Ellner, M. A. Geber, T. Yoshida, and J. A. Fox. 2005. Rapid evolution and the convergence of ecological and evolutionary time. *Ecology Letters* 8:1114–1127.
- Hairston Jr, N., C. Holtmeier, W. Lampert, L. Weider, D. Post, J. Fischer, C. Caceres, J. Fox, and U. Gaedke. 2001. Natural selection for grazer resistance to toxic cyanobacteria: evolution of phenotypic plasticity? *Evolution* 55:2203–2214.
- Hampton, J. 2000. Natural mortality rates in tropical tunas: size really does matter. *Canadian Journal of Fisheries and Aquatic Sciences* 57:1002–1010.
- Hendry, A. P., T. J. Farrugia, and M. T. Kinnison. 2008. Human influences on rates of phenotypic change in wild animal populations. *Molecular Ecology* 17:20–29.
- Hendry, K., and D. Cragg-Hine. 2003. Ecology of the atlantic salmon. conserving natura 2000 rivers ecology series no. 7. English Nature, Peterborough .
- Hinch, S. G., and P. S. Rand. 2000. Optimal swimming speeds and forward-assisted propulsion: energy-conserving behaviours of upriver-migrating adult salmon. *Canadian Journal of Fisheries and Aquatic Sciences* 57:2470–2478.
- Hobson, K. A. 1999. Tracing origins and migration of wildlife using stable isotopes: a review. *Oecologia* 120:134–326.
- Hoegh-Guldberg, O., and J. F. Bruno. 2010. The impact of climate change on the world's marine ecosystem. *Science* 328:1523–1528.
- Hughes, N. F. 2004. The wave-drag hypothesis: an explanation for size-based lateral segregation during the upstream migration of salmonids. *Canadian Journal of Fisheries and Aquatic Sciences* 61:103–109.
- Hutchings, J. a., and M. E. B. Jones. 1998. Life history variation and growth rate thresholds for maturity in Atlantic salmon, *Salmo salar*. *Canadian Journal of Fisheries and Aquatic Sciences* 55:22–47.
- Hymes, D. 1985. Language, memory, and selective performance: Cultee's" salmon's myth" as twice told to boas. *The Journal of American Folklore* 98:391–434.
- ICOLD. 2017. World register of dams.
- Jager, T., B. T. Martin, and E. I. Zimmer. 2013. Debkiss or the quest for the simplest generic model of animal life history. *Journal of theoretical biology* 328:9–18.
- Johansen, S. J. S., M. Ekli, B. Stangnes, and M. Jobling. 2001. Weight gain and lipid deposition in Atlantic salmon, *Salmo salar*, during compensatory growth: Evidence for lipostatic regulation? *Aquaculture Research* 32:963–974.
- Jonsson, B., and N. Jonsson. 1993. Partial migration: niche shift versus sexual maturation in fishes. *Reviews in Fish Biology and Fisheries* 3:348–365.
- . 2009. A review of the likely effects of climate change on anadromous Atlantic salmon *Salmo salar* and brown trout *Salmo trutta*, with particular reference to water temperature and flow. *Journal of Fish Biology* 75:2381–2447.

- . 2017. Fecundity and water flow influence the dynamics of Atlantic salmon. *Ecology of Freshwater Fish* pages 1–6.
- Jonsson, N., and B. Jonsson. 2003. Energy allocation among developmental stages, age groups, and types of atlantic salmon (*Salmo salar*) spawners. *Canadian Journal of Fisheries and Aquatic Sciences* 60:506–516.
- . 2004. Size and age of maturity of Atlantic salmon correlate with the North Atlantic Oscillation Index (NAOI). *Journal of Fish Biology* pages 241–247.
- Jonsson, N., B. Jonsson, and L. P. Hansen. 1997. Changes in proximate composition and estimates of energetic costs during upstream migration and spawning in Atlantic salmon *Salmo salar*. *Journal of Animal Ecology* 66:425–436.
- . 1998. The relative role of density-dependent and density-independent survival in the life cycle of Atlantic salmon *Salmo salar*. *Journal of Animal Ecology* 67:751–762.
- Jutila, E., E. Jokikokko, and M. Julkunen. 2006. Long-term changes in the smolt size and age of Atlantic salmon, *Salmo salar* L., in a northern Baltic river related to parr density, growth opportunity and postsmolt survival. *Ecology of Freshwater Fish* 15:321–330.
- Karl, T. R., and K. E. Trenberth. 2003. Modern global climate change. *science* 302:1719–1723.
- Keller, G., and G. Ribi. 1993. Fish predation and offspring survival in the prosobranch snail *Viviparus ater*. *Oecologia* 93:493–500.
- Keren-Rotem, T., A. Bouskila, and E. Geffen. 2006. Ontogenetic habitat shift and risk of cannibalism in the common chameleon (*Chamaeleo chamaeleon*). *Behavioral Ecology and Sociobiology* 59:723–731.
- Kerlinger, F. N. 1966. *Foundations of behavioral research*. New York.
- Kimirei, I., I. Nagelkerken, M. Trommelen, P. Blankers, N. Van Hoytema, D. Hoeijmakers, C. Huijbers, Y. Mgaya, and A. Rypel. 2013. What drives ontogenetic niche shifts of fishes in coral reef ecosystems? *Ecosystems* 16:783–796.
- Kjørboe, T., and M. Sabatini. 1994. Reproductive and life cycle strategies in egg-carrying cyclopoid and free-spawning calanoid copepods. *Journal of Plankton Research* 16:1353–1366.
- Kleinteich, A., S. M. Wilder, and J. M. Schneider. 2015. Contributions of juvenile and adult diet to the lifetime reproductive success and lifespan of a spider. *Oikos* 124:130–138.
- Kooijman, S. A. L. M. 2010. *Dynamic energy budget theory for metabolic organisation*. Cambridge university press.
- Kooijman, S. A. L. M., and J. A. J. Metz. 1984. On the dynamics of chemically stressed populations: the deduction of population consequences from effects on individuals. *Ecotoxicology and environmental safety* 8:254–274.
- Koskela, J., J. Pirhonen, and M. Jobling. 1997. Feed intake, growth rate and body composition of juvenile Baltic salmon exposed to different constant temperatures. *Aquaculture international* 5:351–360.
- Krause, J., S. P. Loader, J. McDermott, and G. D. Ruxton. 1998. Refuge use by fish as a function of body length-related metabolic expenditure and predation risks. *Proceedings of the Royal Society B: Biological Sciences* 265:2373–2379.
- Lande, R. 1982. A quantitative genetic theory of life history evolution. *Ecology* 63:607–615.

- Lande, R., and S. Shannon. 1996. The role of genetic variation in adaptation and population persistence in a changing environment. *Evolution* 50:434–437.
- Lane, J. E., L. E. B. Kruuk, A. Charmantier, J. O. Murie, and F. S. Dobson. 2012. Delayed phenology and reduced fitness associated with climate change in a wild hibernator. *Nature* 489:554–557.
- Lankau, R. A., and S. Y. Strauss. 2007. Multiple feedbacks maintain both genetic and species diversity in a plant community. *Science* 317:1561–1563.
- Lans, L., L. A. Greenberg, J. Karlsson, O. Calles, M. Schmitz, and E. Bergman. 2011. The effects of ration size on migration by hatchery-raised Atlantic salmon (*Salmo salar*) and brown trout (*Salmo trutta*). *Ecology of Freshwater Fish* 20:548–557.
- Lenders, H., T. Chamuleau, A. Hendriks, R. Lauwerier, R. Leuven, and W. Verberk. 2016. Historical rise of waterpower initiated the collapse of salmon stocks. *Scientific reports* 6:29269.
- Levin, S. A. 1998. Ecosystems and the biosphere as complex adaptive systems. *Ecosystems* 1:431–436.
- Levy, D. A., and C. C. Wood. 1992. Review of proposed mechanisms for sockeye salmon population cycles in the fraser river. *Bulletin of Mathematical Biology* 54:241–261.
- Lewontin, R. C. 1968. *Population biology and evolution*. Syracuse University Press, Syracuse, NY.
- . 2001. *The Triple Helix: Gene, Organism, and Environment*. Harvard University Press, Cambridge.
- Limburg, K. E., and J. R. Waldman. 2009. Dramatic declines in North Atlantic diadromous fishes. *BioScience* 59:955–965.
- MacFarlane, R. B. 2010. Energy dynamics and growth of Chinook salmon (*Oncorhynchus tshawytscha*) from the Central Valley of California during the estuarine phase and first ocean year. *Canadian Journal of Fisheries and Aquatic Sciences* 67:1549–1565.
- Martin, B., R. Heintz, E. Danner, and R. Nisbet. 2017. Integrating lipid storage into general representations of fish energetics. *Journal of Animal Ecology* 86:812–825.
- McCarthy, J. L., K. D. Friedland, and L. P. Hansen. 2008. Monthly indices of the post-smolt growth of Atlantic salmon from the Drammen River, Norway. *Journal of Fish Biology* 72:1572–1588.
- McCormick, S. D., L. P. Hansen, T. P. Quinn, and R. L. Saunders. 1998. Movement, migration, and smolting of atlantic salmon (*Salmo salar*). *Canadian Journal of Fisheries and Aquatic Sciences* 55:77–92.
- McGinnity, P., P. Prodöhl, A. Ferguson, R. Hynes, N. O. Maoiléidigh, N. Baker, D. Cotter, B. O’Hea, D. Cooke, G. Rogan, J. Taggart, and T. Cross. 2003. Fitness reduction and potential extinction of wild populations of Atlantic salmon, *Salmo salar*, as a result of interactions with escaped farm salmon. *Proceedings of the Royal Society B-Biological Sciences* 270:2443–50.
- Mellard, J. P., C. de Mazancourt, and M. Loreau. 2015. Evolutionary responses to environmental change: trophic interactions affect adaptation and persistence. *Proceedings of the Royal Society B: Biological Sciences* 282.
- Mesa, M., and C. Magie. 2006. Evaluation of energy expenditure in adult spring chinook salmon migrating upstream in the Columbia River basin: an assessment based on sequential proximate analysis. *River research and applications* 22:1085–1095.

- Metcalf, N., and J. Thorpe. 1990. Determinants of geographical variation in the age of seaward-migrating salmon, *Salmo salar*. *The Journal of Animal Ecology* pages 135–145.
- Michael, R. S. 2002. Problem statement, theory, and hypotheses.
- Millon, A., S. J. Petty, B. Little, O. Gimenez, T. Cornulier, and X. Lambin. 2014. Dampening prey cycle overrides the impact of climate change on predator population dynamics: a long-term demographic study on tawny owls. *Global Change Biology* 20:1770–1781.
- Miner, B. G., S. E. Sultan, S. G. Morgan, D. K. Padilla, and R. A. Relyea. 2005. Ecological consequences of phenotypic plasticity. *Trends in ecology & evolution* 20:685–692.
- Mittelbach, G. G., and C. W. Osenberg. 1993. Stage-structured interactions in bluegill: Consequences of adult resource variation. *Ecology* 74:2381–2394.
- Moore, J. K., W. Fu, F. Primeau, G. L. Britten, K. Lindsay, M. Long, S. C. Doney, N. Mahowald, F. Hoffman, and J. T. Randerson. 2018. Sustained climate warming drives declining marine biological productivity. *Science* 359:1139–1143.
- Myers, R. A., G. Mertz, J. M. Bridson, and M. J. Bradford. 1998. Simple dynamics underlie sockeye salmon (*Oncorhynchus nerka*) cycles. *Canadian Journal of Fisheries and Aquatic Sciences* 55:2355–2364.
- Nelson, W. A., and T. Yamanaka. 2013. Recurrent insect outbreaks caused by temperature-driven changes in system stability. *Science* 341:796–799.
- Nisbet, R. M., E. B. Muller, K. Lika, and S. A. L. M. Kooijman. 2000. From molecules to ecosystems through dynamic energy budget models. *Journal of Animal Ecology* 69:913–926.
- Norberg, J., M. C. Urban, M. Vellend, C. A. Klausmeier, and N. Loeuille. 2012. Eco-evolutionary responses of biodiversity to climate change. *Nature Climate Change* 2:747.
- Nordeng, H. 1983. Solution to the "Char Problem" based on Arctic Char (*Salvelinus alpinus*) in Norway. *Canadian Journal of Fisheries and Aquatic Sciences* 40:1372–1387.
- Ohgushi, T., O. Schmitz, and R. D. Holt. 2012. Trait-mediated indirect interactions: ecological and evolutionary perspectives. Cambridge University Press.
- Olsen, E. M., M. Heino, G. R. Lilly, M. J. Morgan, J. Brattey, B. Ernande, and U. Dieckmann. 2004. Maturation trends indicative of rapid evolution preceded the collapse of northern cod. *Nature* 428:932–935.
- Olsson, I. C., L. A. Greenberg, E. Bergman, and K. Wysujack. 2006. Environmentally induced migration: The importance of food. *Ecology Letters* 9:645–651.
- Ozgul, A., D. Z. Childs, M. K. Oli, K. B. Armitage, D. T. Blumstein, L. E. Olson, S. Tuljapurkar, and T. Coulson. 2010. Coupled dynamics of body mass and population growth in response to environmental change. *Nature* 466:482–485.
- Palkovacs, E. P., M. T. Kinnison, C. Correa, C. M. Dalton, and A. P. Hendry. 2012. Fates beyond traits: ecological consequences of human-induced trait change. *Evolutionary Applications* 5:183–191.
- Palumbi, S. R., and P. Mu. 2001. Humans as the world's greatest evolutionary force. *Science* 293:1786–1791.
- Parker, G. A., and J. M. Smith. 1990. Optimality theory in evolutionary biology. *Nature* 348:27.

- Parmesan, C. 2006. Ecological and Evolutionary Responses to Recent Climate Change. *Annual Review of Ecology, Evolution, and Systematics* 37:637–669.
- Påslaru, V. 2014. The mechanistic approach of the theory of island biogeography and its current relevance. *Studies in History and Philosophy of Science Part C: Studies in History and Philosophy of Biological and Biomedical Sciences* 45:22–33.
- Patel, S., and S. J. Schreiber. 2015. Evolutionarily Driven Shifts in Communities with Intraguild Predation. *The American Naturalist* 186:E98–E110.
- Pauly, D., V. Christensen, S. Guénette, T. J. Pitcher, U. R. Sumaila, C. J. Walters, R. Watson, and D. Zeller. 2002. Towards sustainability in world fisheries. *Nature* 418:689–695.
- Pecquerie, L., L. R. Johnson, S. A. L. M. Kooijman, and R. M. Nisbet. 2011. Analyzing variations in life-history traits of Pacific salmon in the context of Dynamic Energy Budget (DEB) theory. *Journal of Sea Research* 66:424–433.
- Pelletier, F., D. Garant, and A. P. Hendry. 2009. Eco-evolutionary dynamics. *Philosophical Transactions of the Royal Society B: Biological Sciences* 364:1483–1489.
- Persson, L., and A. M. de Roos. 2013. Symmetry breaking in ecological systems through different energy efficiencies of juveniles and adults. *Ecology* 94:1487–1498.
- Persson, L., and L. Greenberg. 1990. Juvenile Competitive Bottlenecks: the perch (*Perca fluviatilis*)-roach (*Rutilus rutilus*) interaction. *Ecology* 71:44–56.
- Persson, L., K. Leonardsson, a. M. de Roos, M. Gyllenberg, and B. Christensen. 1998. Ontogenetic scaling of foraging rates and the dynamics of a size-structured consumer-resource model. *Theoretical population biology* 54:270–293.
- Polis, G. A., M. E. Power, and G. R. Huxel. 2004. *Food webs at the landscape level*. University of Chicago Press.
- Pollux, B. J. A., and D. N. Reznick. 2011. Matrotrophy limits a female's ability to adaptively adjust offspring size and fecundity in fluctuating environments. *Functional Ecology* 25:747–756.
- Post, D. M., and E. P. Palkovacs. 2009. Eco-evolutionary feedbacks in community and ecosystem ecology: interactions between the ecological theatre and the evolutionary play. *Philosophical Transactions of the Royal Society of London B: Biological Sciences* 364:1629–1640.
- Potts, W., and P. Rudy. 1969. Water balance in the eggs of the Atlantic salmon *Salmo salar*. *Journal of experimental Biology* 50:223–237.
- Power, G. 1981. Stock characteristics and catches of Atlantic salmon (*Salmo Salar*) in Quebec, and Newfoundland and Labrador in relation to environmental variables. *Canadian Journal of Fisheries and Aquatic Sciences* 38:1601–1611.
- Rankin, D. J., and A. López-Sepulcre. 2005. Can adaptation lead to extinction? *Oikos* 111:616–619.
- Reznick, D., M. J. Butler IV, and H. Rodd. 2001. Life-history evolution in guppies. vii. the comparative ecology of high-and low-predation environments. *The American Naturalist* 157:126–140.
- Reznick, D. N., M. J. Butler IV, F. H. Rodd, and P. Ross. 1996. Life-history evolution in guppies (*Poecilia reticulata*) 6. Differential mortality as a mechanism for natural selection. *Evolution* 50:1651–1660.

- Rocha, J. C., G. Peterson, Ö. Bodin, and S. Levin. 2018. Cascading regime shifts within and across scales. *Science* 362:1379–1383.
- Rudolf, V. H. W., and J. Armstrong. 2008. Emergent impacts of cannibalism and size refuges in prey on intraguild predation systems. *Oecologia* 157:675–686.
- Sánchez-Hernández, J., A. D. Nunn, C. E. Adams, and P. A. Amundsen. 2018. Causes and consequences of ontogenetic dietary shifts: a global synthesis using fish models. *Biological Reviews* .
- Scheffer, M., J. Bascompte, W. A. Brock, V. Brovkin, S. R. Carpenter, V. Dakos, H. Held, E. H. Van Nes, M. Rietkerk, and G. Sugihara. 2009. Early-warning signals for critical transitions. *Nature* 461:53.
- Scheffer, M., S. Carpenter, J. A. Foley, C. Folke, and B. Walker. 2001. Catastrophic shifts in ecosystems. *Nature* 413:591–596.
- Scheffer, M., S. Hosper, M. Meijer, B. Moss, and E. Jeppesen. 1993. Alternative equilibria in shallow lakes. *Trends in Ecology & Evolution* 8:275–279.
- Schoener, T. W. 2011. The newest synthesis: understanding the interplay of evolutionary and ecological dynamics. *Science* 331:426–429.
- Schreiber, S., and V. H. Rudolf. 2008. Crossing habitat boundaries: coupling dynamics of ecosystems through complex life cycles. *Ecology letters* 11:576–587.
- Semlitsch, R. D. 1990. Effects of body size, sibship, and tail injury on the susceptibility of tadpoles to dragonfly predation. *Canadian Journal of Zoology* 68:1027–1030.
- Shearer, K., T. Åsgård, G. Andorsdóttir, and G. Aas. 1994. Whole body elemental and proximate composition of Atlantic salmon (*Salmo salar*) during the life cycle. *Journal of Fish Biology* 44:785–797.
- Sih, A., M. C. Ferrari, and D. J. Harris. 2011. Evolution and behavioural responses to human-induced rapid environmental change. *Evolutionary Applications* 4:367–387.
- Sinervo, B., and P. Doughty. 1996. Interactive effects of offspring size and timing of reproduction on offspring reproduction: experimental, maternal, and quantitative genetic aspects. *Evolution* 50:1314–1327.
- Singer, M. C., C. D. Thomas, and C. Parmesan. 1993. Rapid human-induced evolution of insect–host associations. *Nature* 366:681.
- Sogard, S. M. 1997. Size selective mortality in the juvenile stages of teleost fishes: a review. *Bulletin of Marine Science* 60:1129–1157.
- Steffen, W., R. A. Sanderson, P. D. Tyson, J. Jäger, P. A. Matson, B. Moore III, F. Oldfield, K. Richardson, H.-J. Schellnhuber, B. L. Turner, et al. 2006. *Global change and the earth system: a planet under pressure*. Springer Science & Business Media.
- Sutton, S. G., T. P. Bult, and R. L. Haedrich. 2000. Relationships among fat weight, body weight, water weight, and condition factors in wild Atlantic salmon parr.
- Taborsky, B. 2005. The influence of juvenile and adult environments on life-history trajectories. *Proceedings of the Royal Society B: Biological Sciences* 273:741–750.
- ten Brink, H., and A. M. de Roos. 2018. Large-amplitude consumer-resource cycles allow for the evolution of ontogenetic niche shifts in consumer life history. *Journal of Theoretical Biology* 457:237–248.

- Thompson, P. M., and J. C. Ollason. 2001. Lagged effects of ocean climate change on fulmar population dynamics. *Nature* 413:417–420.
- Thorpe, J. E., M. Mangel, N. B. Metcalfe, and F. a. Huntingford. 1998. Modelling the proximate basis of salmonid life-history variation, with application to Atlantic salmon, *Salmo salar* L. *Evolutionary Ecology* 12:581–599.
- Thorpe, J. E., M. S. Miles, and D. S. Keay. 1984. Developmental rate, fecundity and egg size in Atlantic Salmon, *Salmo Salar* L. *Aquaculture* 43:289–305.
- Thuiller, W., T. Münkemüller, S. Lavergne, D. Mouillot, N. Mouquet, K. Schifffers, and D. Gravel. 2013. A road map for integrating eco-evolutionary processes into biodiversity models. *Ecology Letters* 16:94–105.
- Tuomainen, U., and U. Candolin. 2011. Behavioural responses to human-induced environmental change. *Biological Reviews* 86:640–657.
- Urban, M. C., L. De Meester, M. Vellend, R. Stoks, and J. Vanoverbeke. 2012. A crucial step toward realism: responses to climate change from an evolving metacommunity perspective. *Evolutionary Applications* 5:154–167.
- Vagg, R., and H. Hepworth. 2006. Migratory species and climate change: Impacts of a changing environment on wild animals. Tech. rep., UNEO/CMS Secretariat.
- van Gils, J. A., S. Lisovski, T. Lok, W. Meissner, Ożarowska, J. de Fouw, M. Soloviev, T. Piersma, and M. Klaassen. 2016. Body shrinkage due to Arctic warming reduces red knot fitness in tropical wintering range. *Science* 352:819–821.
- Vasseur, D. A., P. Amarasekare, V. H. W. Rudolf, and J. M. Levine. 2011. Eco-Evolutionary dynamics enable coexistence via neighbor-dependent selection. *The American Naturalist* 178:E96–E109.
- Walsh, M. R., S. B. Munch, S. Chiba, and D. O. Conover. 2006. Maladaptive changes in multiple traits caused by fishing: Impediments to population recovery. *Ecology Letters* 9:142–148.
- Walters, A. W., T. Copeland, and D. A. Venditti. 2013. The density dilemma: limitations on juvenile production in threatened salmon populations. *Ecology of Freshwater fish* 22:508–519.
- Walther, G.-R. 2010. Community and ecosystem responses to recent climate change. *Philosophical Transactions of the Royal Society B: Biological Sciences* 365:2019–2024.
- WCD. 2000. Dams and Development: A new framework for decision-making. Tech. Rep. November.
- Werner, E. 1988. Size, scaling, and the evolution of complex life cycles. Pages 60–81 in *Size-structured populations*. Springer.
- Werner, E. E., and J. F. Gilliam. 1984. The ontogenetic niche and species interactions in size-structured populations. *Annual review of ecology and systematics* 15:393–425.
- Wilson, E. O. 2009. Island Biogeography in the 1960s. *The Theory of Island Biogeography Revisited* pages 1–12.
- Woodward, G., M. O. Gessner, P. S. Giller, V. Gulis, S. Hladyz, A. Lecerf, B. Malmqvist, B. G. McKie, S. D. Tiegs, H. Cariss, et al. 2007. Evolutionary responses to climate change. *Conservation Biology* 21:1353–1355.
- Woodward, J. 2005. *Making things happen: A theory of causal explanation*. Oxford university press.

- Wysujack, K., L. A. Greenberg, E. Bergman, and I. C. Olsson. 2009. The role of the environment in partial migration: Food availability affects the adoption of a migratory tactic in brown trout *Salmo trutta*. *Ecology of Freshwater Fish* 18:52–59.
- Yoshida, T., L. E. Jones, S. P. Ellner, G. F. Fussmann, and N. G. Hairston. 2003. Rapid evolution drives ecological dynamics in a predator–prey system. *Nature* 424:303–306.
- Zamiri, M. J. 1978. Effects of reduced food intake on reproduction in mice. *Australian Journal of Biological Sciences* 31:629–639.
- Zeller, M., and J. C. Koella. 2016. Effects of food variability on growth and reproduction of *Aedes aegypti*. *Ecology and Evolution* 6:552–559.