

Andrew J Irwin

Department of Mathematics & Statistics, Dalhousie University, Halifax, NS, Canada, B3H 4R2
a.irwin@dal.ca • 506 364 5747 (cell) • www.mmab.ca • mathstat.dal.ca

Research Interests

Computational, mathematical and statistical models in biological oceanography, Biogeography and species habitat models, Macroecology, Models of growth and photosynthesis in algae, Biogeochemistry of the oceans, Applied transcriptomics and genomics, Theoretical ecology and evolution, Population genetics, Evolution of altruism.

Academic Appointments

Professor, Department of Mathematics and Statistics, Dalhousie University (2018–)
Adjunct Professor, Department of Mathematics and Computer Science, Mount Allison University (2018–2021)
Professor, Department of Mathematics and Computer Science, Mount Allison University (2016–2018)
Head, Department of Mathematics and Computer Science, Mount Allison University (2010–16, 2017 January–June)
Distinguished visiting fellow, State Key Lab for Marine Environmental Science, Xiamen University, Xiamen, China (2015 January)
Visiting Researcher, Program in Atmospheres, Oceans, and Climate; Earth, Atmosphere, and Planetary Science, Massachusetts Institute of Technology (2011–12)
Associate professor, Department of Mathematics and Computer Science, Mount Allison University (2010–2016)
Assistant professor, Department of Mathematics and Computer Science, Mount Allison University (2004–2010)
Assistant professor, Ecology and Evolutionary Biology, Graduate Center, City University of New York (2003–2004)
Assistant professor, Biology department, College of Staten Island, City University of New York (2003–2004)
NSERC Post-doctoral associate, Institute of Marine and Coastal Sciences, Rutgers University (2001–2003)
Post-doctoral associate, Dept. of Ecology, Evolution and Natural Resources, Rutgers University (2000–2001)

Education

Ph D, Queen's University, Kingston, Canada, Mathematics (2000) Advisor: Peter D Taylor, Mathematics, Biology, and Education.
B Ed, University of Manitoba, Mathematics and Chemistry (1995)
M Sc, University of British Columbia, Applied Mathematics (1993). Advisor: Bernie D Shizgal, Chemistry.
B Sc, University of Toronto, Chemical Physics and Mathematics (1991) Advisor: Simon J Fraser, Chemical Physics Theory Group

Awards

Distinguished service award, Canadian Association of University Teachers (2018)
Prix Nicole-Raymond Award, Federation of New Brunswick Faculty Associations (2018)

Refereed Publications (HQP in bold)

1. **JD Liefer, A Garg, MH Fyfe**, AJ Irwin, **I Benner**, CM Brown, MJ Follows, AW Omta, ZV Finkel (2019) The Macromolecular Basis of Phytoplankton C:N:P Under Nitrogen Starvation. *Front. Microbiol.* 10: 763. 10.3389/fmicb.2019.00763
2. **L Bretherton**, M Kamalanathan, J Genzer, J Hillhouse, S Setta, Y Liang, CM Brown, C Xu, J Sweet, U Passow, ZV Finkel, AJ Irwin, PH Santschi, A Quigg (2019) Response of natural phytoplankton communities exposed to crude oil and chemical dispersants during a mesocosm experiment. *Aquatic Toxicology* **206**: 43-53. GOMRI news story. 10.1016/j.aquatox.2018.11.004
3. ZV Finkel, AJ Irwin (2019) Phytoplankton. In *Encyclopaedia of Astrobiology*. In press.
4. **Y Liang, J Koester, J Liefer**, AJ Irwin, ZV Finkel (2019) Molecular mechanisms of temperature acclimation and adaptation in marine diatoms. *ISME J.* in press. 10.1038/s41396-019-0441-9
5. **N McGinty**, AD Barton, NR Record, ZV Finkel, AJ Irwin (2018) Traits structure copepod niches in the North Atlantic and Southern Ocean. *Mar. Ecol. Prog. Ser.* **601**: 109-126. 10.3354/meps12660

6. PA Ajani, **N McGinty**, ZV Finkel, AJ Irwin (2018) Phytoplankton realised niches track changing oceanic conditions at a long-term coastal station of Sydney Australia. *Frontiers in Marine Science*. 5: 285. 10.3389/fmars.2018.00285
7. **J Liefer**, **A Garg**, D Campbell, AJ Irwin, ZV Finkel (2018) Nitrogen starvation induces distinct photosynthetic responses and recovery dynamics in diatoms and prasinophytes. *PLOS One*. e0195705. 10.1371/journal.pone.0195705
8. AJ Irwin, ZV Finkel (2018) Phytoplankton functional types: a trait perspective. In Kirchman, Gasol eds., *Microbial Ecology of the Oceans*, 3rd edition. Wiley. bioRxiv preprint 10.1101/148312
9. **W Xiao**, X Liu, AJ Irwin, E Laws, L Wang, B Chen, Y Zeng, B Huang (2018) Climate warming and eutrophication combine to restructure phytoplankton communities. *Water Research*, **128**: 206-216.
10. **CM Mutshinda**, ZV Finkel, CE Widdicombe, AJ Irwin (2017) Phytoplankton traits from long-term oceanographic time-series. *Marine Ecology Progress Series* **576**: 11-25. 10.3354/meps12220 bioRxiv preprint 10.1101/148304
11. Schofield, N Waite, K Coleman, Z Finkel, M Montes Hugo, A Irwin, T Miles, N Couto, H Ducklow, A Kahl, G Saba, AF Carvalho (2017) Decadal variability in coastal phytoplankton community composition along a changing West Antarctic Peninsula. *Deep Sea Research I*, **124**: 42-54. 10.1016/j.dsr.2017.04.014
12. **C Fiset**, **J Liefer**, AJ Irwin, ZV Finkel (2017) Methodological biases in estimates of macroalgal macromolecular composition. *L&O Methods*. In press. 10.1002/lom3.10186
13. **AW Omta**, **D Talmy**, D Sher, ZV Finkel, AJ Irwin, MJ Follows (2017) Extracting phytoplankton physiological traits from batch and chemostat culture data. *Limnology & Oceanography Methods*. In press. 10.1002/lom3.10172
14. **AD Barton**, AJ Irwin, ZV Finkel, CA Stock (2016) Anthropogenic climate change drives shift and shuffle in North Atlantic phytoplankton communities. *Proc. Nat. Acad. Sci. USA* **113**: 2964-2969. 10.1073/pnas.1519080113
15. **CM Mutshinda**, ZV Finkel, CE Widdicombe, AJ Irwin (2016) Ecological equivalence of species within phytoplankton functional groups. *Functional Ecology* **30**: 1714-1722. 10.1111/1365-2435.12641
16. ZF Finkel, MJ Follows, AJ Irwin (2016) Size-scaling of macromolecules and chemical energy content in the eukaryotic microalgae. *J Plank. Res.* **38**: 1151-1162. 10.1093/plankt/fbw057
17. ZV Finkel, MJ Follows, **J Liefer**, **CM Brown**, **I Benner**, AJ Irwin (2016) Phylogenetic diversity in the macromolecular composition of microalgae. *PLoS ONE* **11**(5): e0155977. 10.1371/journal.pone.0155977
18. **EA Kerrigan**, AJ Irwin, ZV Finkel (2015) Community and population changes in diatom size structure in a subarctic lake over the last two centuries. *Peer J* **3**: e1074. 10.7717/peerj.1074
19. AJ Irwin, ZV Finkel, F Müller-Karger, L Troccoli Ghinaglia (2015) Reply to Brun: A fingerprint of evolution revealed by shifts in realized phytoplankton niches in natural populations. *Proc. Nat. Acad. Sci. USA*. **112**: E5255. 10.1073/pnas.1514396112
20. AJ Irwin, ZV Finkel, F Müller-Karger, L Troccoli Ghinaglia (2015) Phytoplankton adapt to changing ocean environments. *Proc. Nat. Acad. Sci. USA*. **112**: 5762-66. 10.1073/pnas.1414752112
21. D Tchernov, DF Gruber, AJ Irwin (2014) Isotopic fractionation of carbon in the coccolithophorid *Emiliania huxleyi*. *Mar. Ecol. Prog. Ser.*, **508**: 53-66. 10.3354/meps10840
22. **Y Wu**, DA Campbell, AJ Irwin, DJ Suggett, ZV Finkel (2014) Ocean acidification enhances the growth rate of larger diatoms. *Limnology and Oceanography*, **59**(3): 1027-34. 10.4319/lo.2014.59.3.1027
23. **CM Mutshinda**, ZV Finkel, AJ Irwin (2014) Identifying environmental drivers of species abundance using Bayesian variable selection. *Ecological Modelling*. **269**: 1-8. 10.1016/j.ecolmodel.2013.07.025
24. MJ Oliver, A Irwin, M Moline, W Fraser, D Patterson, O Schofield, J Kohut (2013) Adélie Penguin Foraging Behavior Affected by Local Tides. *PLoS One* **8**: e55163.
25. **CM Mutshinda**, L Troccoli-Ghinaglia, ZV Finkel, FE Müller-Karger, AJ Irwin (2013) Environmental control of the dominant phytoplankton in the Cariaco basin: a hierarchical Bayesian approach. *Marine Biology Research* **9**: 247-261.
26. **ME Cimino**, WR Fraser, AJ Irwin, MJ Oliver (2013) Satellite data identify decadal trends in the quality of Pygoscelis penguin chick-rearing habitat. *Global Change Biology* **19**: 136-148.
27. **SC Sharpe**, **JA Koester**, **M Loebel**, AM Cockshutt, DA Campbell, AJ Irwin, ZV Finkel (2012) Influence of cell size and DNA content on growth rate and photosystem II function in cryptic species of *Ditylum brighwellii*. *PLoS One* **7**: e52916.
28. AJ Irwin, **AM Nelles**, ZV Finkel (2012) Phytoplankton niches estimated from field data. *Limnology and Oceanography* **57**(3): 787-797.

29. **HM van Tol**, AJ Irwin, ZV Finkel (2012) Macroevolutionary trends in silicoflagellate skeletal morphology: the costs and benefits of silicification. *Paleobiology*, **38**(3): 391-402.
30. Schofield, SM Glenn, MA Moline, M Oliver, A Irwin, Y Chao, M Arrott (2012) Ocean observatories and information: Building a global ocean observing network. In Earth System Monitoring. J Orcutt [ed], pp. 319-336. 10.1007/978-1-4614-5684-1_14
31. **ZP Mei**, ZV Finkel, AJ Irwin (2011) Modeling the allometry of growth and C:N stoichiometry of phytoplankton using a variable quota model. *Mar. Ecol. Prog. Ser.*, **434**: 29-43. 10.3354/meps09149
32. **BZ Chen**, AJ Irwin, ZV Finkel (2011) Biogeographic distribution of diversity and size-structure of organic-walled dinoflagellate cysts. *Mar. Ecol. Prog. Ser.* **425**: 35-45. 10.3354/meps08985
33. AS Quigg, ZV Finkel, AJ Irwin (2011) Testing the evolutionary inheritance of elemental stoichiometry in phytoplankton. *Proc. R. Soc. Lond. B.* **278**: 526-534. 10.1098/rspb.2010.1356
34. ZV Finkel, KA Matheson, KS Reagan, AJ Irwin (2010) Genotypic and phenotypic variation in diatom silicification under paleoceanographic conditions. *Geobiology*. 10.1111/j.1472-4669.2010.00250.x
35. AJ Irwin and MJ Oliver (2009) Are ocean deserts getting larger? *Geophysical Research Letters* **36**: L18609. 10.1029/2009GL039883
36. **ZP Mei**, ZV Finkel, AJ Irwin (2009) Light and nutrient availability affect the size-scaling of growth in phytoplankton. *J theor Biol*, **259**: 582-588. 10.1016/j.jtbi.2009.04.018
37. ZV Finkel, **C Jacob-Vaillancourt**, AJ Irwin, ED Reavie, JP Smol (2009) Environmental control of diatom community size structure varies across aquatic ecosystems. *Proc R Soc B*, **276**: 1627-1634. 10.1098/rspb.2008.1610 (cover)
38. AJ Irwin and ZV Finkel (2008) Mining a sea of data: deducing environmental controls of remote-sensed chlorophyll. *PLOS One* **3**(11): e3836. 10.1371/journal.pone.0003836.
39. MJ Oliver and AJ Irwin (2008) Objective ocean global biogeographic provinces. *Geophysical Research Letters*, **35**: L15601. 10.1029/2008GL034238.
40. **C Six**, ZV Finkel, AJ Irwin, DA Campbell (2007) Light variability illuminates niche-partitioning among oceanic picocyanobacteria. *PLOS One*, **2**(12): e1341. 10.1371/journal.pone.0001341.
41. ZV Finkel, **J Sebbo**, M Katz, AJ Irwin, O Schofield, S Feist-Burkhardt, J Young, P Falkowski (2007) A universal driver of macroevolutionary change in the size of phytoplankton over the Cenozoic. *Proceedings of the National Academy of Sciences USA*, **104**(51): 20416-20420. 10.1073/pnas.0709381104
42. I Berman-Frank, AS Quigg, ZV Finkel, AJ Irwin, L Haramaty (2007) Nitrogen-fixation strategies and Fe requirements in cyanobacteria *Limnology and Oceanography*. **52**(5): 2260-2269.
43. AJ Irwin, ZV Finkel, O Schofield and PG Falkowski (2006) Scaling-up from size-dependent physiology to the size structure of phytoplankton communities, *J Plank Res*, **28**: 459-471. 10.1093/plankt/fbi148
44. JA Raven, ZV Finkel, AJ Irwin (2005) Picophytoplankton: Bottom-up and top-down controls on ecology and evolution. *Vie et Milieu* **55**: 209-215.
45. T Shi, TS Bibby, L Jiang, AJ Irwin, PG Falkowski (2005) Constraints on protein interactions on evolution of photosynthetic genes in cyanobacteria. *Mol. Bio. & Evol.* **22**: 2179-2189.
46. C Dutech, VL Sork, AJ Irwin, PE Smouse, FW Davis (2005) Gene flow and fine-scale genetic structure in a wind pollinated tree species, *Quercus lobata* (Fagaceae), *Am. J. Bot.* **92**: 252-261.
47. Schofield, T Bergmann, M Oliver, AJ Irwin, G Kirkpatrick, WP Bissett, C Orrico and MA Moline (2004) Inverting inherent optical signatures in the nearshore coastal waters at the Long Term Ecosystem Observatory. *J. Geophys. Res.* **109**(C12): S04.
48. MJ Oliver, S Glenn, JT Kohut, AJ Irwin, OM Schofield, MA Moline and WP Bissett (2004) Bioinformatic Approaches for Objective Detection of Water Masses on Continental Shelves. *J Geophys. Res.*, **109**(C07): S04.
49. ZV Finkel, AJ Irwin, and O Schofield (2004) Resource Limitation Alters the 3/4 Size Scaling of Metabolic Rates in Phytoplankton. *Marine Ecology Progress Series*, **273**: 269-279.
50. A Quigg, ZV Finkel, AJ Irwin, Y Rosenthal, T-Y Ho, JR Reinfelder, O Schofield, FMM Morel and P Falkowski (2003) The evolutionary inheritance of elemental stoichiometry in marine phytoplankton. *Nature* **425**: 291-294.
51. AJ Irwin, J Hamrick, M-J Godt, and PE Smouse (2003) A multi-year estimate of the effective pollen donor pool for *Albizia julibrissin*. *Heredity* **90**: 187-194.
52. AJ Irwin and PD Taylor (2001) Evolution of altruism in stepping-stone populations with overlapping generations. *Theo. Pop. Biol.* **60**: 315-325.
53. ZV Finkel and AJ Irwin (2001) Light absorption by phytoplankton and the filter amplification correction: cell size and species effects. *J. Exp. Mar. Biol. & Ecol.* **259**: 51-61.

54. AJ Irwin and PD Taylor (2000) Evolution of dispersal in a stepping-stone population with overlapping generations. *Theo. Pop. Biol.* **58**: 321-328.
55. PD Taylor, AJ Irwin, and T Day (2000) Inclusive fitness in finite deme-structured and stepping-stone populations. *Selection.* **1**: 153-163.
56. PD Taylor and AJ Irwin (2000) Overlapping generations can promote altruistic behaviour. *Evolution* **54**: 1135-1141.
57. ZV Finkel and AJ Irwin (2000) Modelling size-dependent photosynthesis: light absorption and the allometric rule. *J. theor. Biol.* **204**: 361-369.
58. AJ Irwin and PD Taylor (2000) Heterozygous advantage and the evolution of female choice. *Evolutionary Ecology Research.* **2**: 119-128.
59. AJ Irwin and BD Shizgal (1995). A discrete velocity model for relaxation of anisotropic distribution functions, *Rarefied Gas Dynamics*, **19**: 654-651.
60. NC Kenkel and AJ Irwin (1994) Fractal analysis of dispersal, *Abstracta Botanica*, **18**(2), 79-84.
61. AJ Irwin, SJ Fraser, and R Kapral (1990) Stochastically induced coherence in bistable systems, *Phys. Rev. Lett.*, **64**, 2343-2346
62. AJ Irwin, SJ Fraser, and R Kapral (1990) *Phys. Rev. Lett.*, **65**, 3357.
63. AJ Irwin and SJ Fraser (1990) Cellular automaton model of chemical wave propagation on fractals, *J. Chem. Phys.*, **93**, 3471-3483.

Recent International Working Groups and Workshops

- Using current phytoplankton communities to anticipate climate induced restructuring. *Ancient DNA from the Seafloor to Predict the Fate of Plankton in a Future Ocean: Challenges and Opportunities in Paleogenomics*. Harvard University. May 2018.
- Inferring niches and traits from *in situ* data. *Modeling marine microbial diversity*. NYC. Simons Foundation. May 2018.
- Statistical models of phytoplankton traits and the challenges of interpreting field data*. Bergen, Norway. FILAMO workshop on Obstacles in communication between field, lab, and modeling work. August 2017.
- Computational modeling of marine microbial systems*. NYC. Simons Foundation. New approaches to statistical modeling of plankton from species to communities. January 2017.
- Global Changes in Marine Plankton Diversity and Productivity*. Leipzig, Germany. A workshop funded by the Synthesis Centre of Biodiversity Science (sDiv) at the German Center for Integrative Biodiversity Research (iDiv). PIs: Aleksandra Lewandowska and Boris Worm. Nov. 29-Dec. 4 2015.
- Modeling Marine Microbes*. Sackville NB. Gordon and Betty Moore PI working group (participants from MIT, Haifa, ANU, Mount Allison). Meeting organizer. June 2015.
- Macromolecular pools: models and measurements*. Haifa, Israel. A planning meeting of the Follows, Sher and Finkel research groups. Sept. 8-11, 2013.
- Workshop on *Representation of phytoplankton physiology in marine ecosystem models*. Exeter, UK. Invited by James Clark, College of Life & Env. Sci., U. of Exeter. Dec. 13-14, 2012.
- Meeting of the Palmer Long Term Ecosystem Research Network working group*. Twin Bridges, Montana. At Polar Oceans Research. June 2012

Recent Research Presentations

- Quantifying plankton niches using observational data. Marine Biological Association, Plymouth UK. July 2019.
- Statistical analysis of the macromolecular determinants of growth rate, CBIOMES annual meeting, Simons Foundation Flatiron Institute, NYC, May 2019.
- Marine Microbial Macroecology, Statistics collaborative research group, AARMS, Dalhousie, May 2019.
- Parameter estimation for ordinary differential equations: Bayesian methods with Stan, CBIOMES workshop, MIT, Boston, January 2019.
- Predicting phytoplankton biomass in the Bay of Fundy, Harmful Algae Symposium, Bedford Institute of Oceanography, Dartmouth NS, January 2019.
- Modeling microbial ecology in a dynamic ocean. Mathematics & Statistics, Dalhousie University, September 2017 (invited).
- Using field data to reduce uncertainty in models of phytoplankton dynamics and biogeography. FILAMO workshop, Bergen, Norway. August 2017 (invited).