

Elizabeth L. Brainerd (she/her)
 Robert P. Brown Professor of Biology
 Department of Ecology, Evolution, and Organismal Biology
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Research Interests

Vertebrate morphology, biomechanics, physiology, and evolution; biomedical imaging

Education

Harvard University, Cambridge, Massachusetts:

Ph.D., 1991 Department of Organismic and Evolutionary Biology
 Advisor: Karel F. Liem

A.B., 1985 *Magna cum laude*, with Highest Honors in Biology

Academic Appointments

2020-Present	Robert P. Brown Professor of Biology, Department of Ecology, Evolution, and Organismal Biology, Brown University
2005-2020	Professor of Biology and Medical Science, Department of Ecology & Evolutionary Biology, Brown University
2010-2014	Director of Graduate Studies, Department of Ecology & Evolutionary Biology, Brown University
2006-2014	Vice Chair, Department of Ecology & Evolutionary Biology, Brown University
2002-2005	Director, Interdepartmental Program in Organismic and Evolutionary Biology, University of Massachusetts Amherst
1994-2005	Assistant and Associate Professor, Department of Biology, University of Massachusetts Amherst

Honors

2023	Bidder Prize Lecture, Society for Experimental Biology
2021	Joseph S. Nelson Lifetime Achievement Award in Ichthyology
2020	Appointed Robert P. Brown Professor of Biology
2020	Fellow, American Association for Anatomy
2019	Distinguished Research Achievement Award, Brown University
2018	Gilliam Fellowship Mentor, Howard Hughes Medical Institute

- 2017 Keynote Address, American Society of Biomechanics
- 2016 Elected President, Society for Integrative and Comparative Biology
- 2015 Dean’s Award for Excellence in Graduate Mentoring
- 2013 Elected President, International Society of Vertebrate Morphology
- 2010 Keynote Address, American Physiological Society
- 2004 Fellow, American Association for the Advancement of Science
- 1999 CAREER Award, National Science Foundation
- 1996 Lilly Teaching Fellowship, University of Massachusetts Amherst
- 1990 Junior Fellowship, Harvard University Society of Fellows
- 1986 NSF Graduate Research Fellowship
- 1985 Hoopes Prize for Undergraduate Research, Harvard University

Grant Support

- 2023-2024 NIH Subaward from Rhode Island Hospital, "Development of the Human Motion Analysis Data Portal" (1-year supplement to "Multi-Model Tracking of In Vivo Skeletal Structures and Implants."). Brown PI with RIH PI Trey Crisco. (\$205,322)
- 2023-2025 National Science Foundation, Sustaining Biological Infrastructure, "Updating technical components to sustain XMAPortal and ZMAPortal for the comparative biomechanics research community." Sole PI. (\$264,144).
- 2020-2025 National Science Foundation, “Major Research Instrumentation: Development of microXROMM for high-resolution X-ray motion imaging of small animals.” PI with co-PI Matthew Fuxjager. (\$1,307,504)
- 2020-2023 National Science Foundation, “Broadening participation of underrepresented groups in STEM through the virtual components of the 2021 Annual Meeting of the Society for Integrative and Comparative Biology.” PI with Co-PI Judy Kimberly. (\$27,781)
- 2017-2023 National Science Foundation, Advances in Biological Informatics. “ABI Sustaining: Maintenance of the XMA/ZMAPortal video data management systems and XMALab video motion analysis software for the comparative biomechanics community” (\$339,872). Sole PI.
- 2018-2022 NSF Graduate Research Fellowship funding for my doctoral students: Yordano Jimenez, Elska Kaczmarek, Jeremy J. Lomax, Hannah Weller (\$552,000 total).

- 2018-2022 HHMI James H. Gilliam Fellowship for Advanced Study (\$150,000). Awarded to Jeremy J. Lomax (doctoral student) and mentor E.L. Brainerd.
- 2017-2022 National Science Foundation, Integrative Organismal Systems. “Determining the source of muscle power for suction feeding in ray-finned fishes” (\$608,095). PI with co-PI Ariel Camp.
- 2016-2018 National Science Foundation, Environmental Biology. “Experimental miniaturization of guppy offspring” (\$17,197). Doctoral Dissertation Improvement Grant with doctoral student Terry Dial.
- 2013-2017 National Science Foundation, Advances in Biological Informatics. “ABI Development: Integrated X-Ray Motion Analysis Software and Video Data Management for the Comparative Biomechanics Community” (\$906,192). PI with co-PIs Steve Gatesy and David Baier.
- 2011-2015 National Science Foundation, Integrative Organismal Systems. “Rib Kinematics and Intercostal Muscle Function in Amniotes” (\$495,911). Sole PI.
- 2010-2014 National Science Foundation, Molecular and Cellular Biosciences. "Collaborative Research: QSTORM: Switchable Quantum Dots and Adaptive Optics for Super-Resolution Imaging" (Brown Budget: \$223,411 including REU supplements). Sole PI of Brown component of a collaborative project with three other institutions.
- 2009-2015 National Science Foundation, Integrative Organismal Systems. “RCN: A Research Coordination Network for X-ray Motion Analysis” (\$510,061 including REU and RET Supplements). PI with co-PI David Lee.
- 2007-2011 William M. Keck Foundation grant to design and build a dynamic 3-D skeletal imaging system (\$1.8 M). PI with seven other Brown faculty as co-PIs.
- 2006-2010 National Science Foundation, Instrument Development for Biological Research Program. “Hardware and Software Development for 3D Visualization of Rapid Skeletal Motion in Vertebrate Animals” (\$345,486). PI with co-PI Steve Gatesy.
- 2006-2007 Research Seed Fund Grant, Office of the Vice President for Research, Brown University (\$100,000). PI with seven other Brown faculty as co-PIs.
- 2003-2008 National Science Foundation, Ecological and Evolutionary Physiology Program. “Biomechanics of segmented axial musculature in salamanders and fishes” (\$382,400). Sole PI.
- 2003-2005 National Science Foundation, DDIG. “Kinematics, neural control, and evolution of the head retraction startle response in elongate anamniote

- vertebrates” (\$10,100). Doctoral Dissertation Improvement Grant with Andrea B. Ward.
- 1999-2005 National Science Foundation, Ecological and Evolutionary Physiology Program. “CAREER: Lung ventilation in lizards and the evolution of amniote respiratory mechanisms” (\$350,000). Sole PI.
- 1999-2003 National Science Foundation, Undergraduate Mentoring in Environmental Biology. “UMEB: Preparing Students for Careers in Environmental Biology, a Massachusetts Partnership.” (\$256,754; E. Brainerd, PI and Executive Director; B. Jakob, F. Juanes and S. Prattis, Co-PIs and Co-Directors).
- 1998-1999 National Science Foundation, DDIG. “Functional morphology, ontogeny, and evolution of a new hard tissue, trabecular cartilage” (\$5005). Doctoral Dissertation Improvement Grant with Adam Summers.
- 1997-1998 National Science Foundation, POWRE Program. “How to circumvent a mechanical constraint: gular pump breathing during locomotion in monitor lizards” (\$49,776). Sole PI.
- 1995-1999 National Science Foundation, Ecological and Evolutionary Physiology Program. “Exhalation Mechanics and the Evolution of Aspiration Breathing in Tetrapods” (\$152,500). Sole PI.

PUBLICATIONS

Edited volume

Dial, K.P., Shubin, N., Brainerd, E.L. eds. 2015. *Great Transformations in Vertebrate Evolution*. University of Chicago Press: Chicago.

Peer-reviewed publications

Mayerl, C.J., Capano, J.G., MME, N.V.M., Weller, H.I., Kaczmarek, E.B., Chadam, M., Blob, R.W., Brainerd, E.L. and Wyneken, J., 2024. Turtle Girdles: Comparing the Relationships Between Environment and Behavior on Forelimb Function in Loggerhead Sea Turtles (*Caretta caretta*) and River Cooters (*Pseudemys concinna*). *Journal of morphology*, 285(12), p.e70007.

Kaczmarek, E.B. and Brainerd, E.L., 2024. Buoyancy control and air breathing in royal knifefish (*Chitala blanci*) and a new hypothesis for the early evolution of vertebrate air-breathing behaviors. *The Anatomical Record*.

Jimenez, Y.E., Parsons, J.W. and Brainerd, E.L., 2023. Epaxial and hypaxial co-contraction: a mechanism for modulating strike pressure and accuracy during suction feeding in channel catfish. *Journal of Experimental Biology*, 226(4), p.jeb244714.

- Li*, E.Y., Kaczmarek*, E.B., Olsen, A.M., Brainerd, E.L. and Camp, A.L., 2022. Royal knifefish generate powerful suction feeding through large neurocranial elevation and high epaxial muscle power. *Journal of Experimental Biology*, 225(11), p.jeb244294. *co-first authors.
- Kaczmarek, E.B., Gartner, S.M., Westneat, M.W. and Brainerd, E.L., 2022. Air breathing and suction feeding kinematics in the West African lungfish, *Protopterus annectens*. *Integrative and Comparative Biology*, 62:865–877, <https://doi.org/10.1093/icb/icac109>.
- Scott, B.R., Brainerd, E.L. and Wilga, C.A., 2022. Long-axis rotation of jaws of bamboo sharks (*Chiloscyllium plagiosum*) during suction feeding. *Integrative Organismal Biology*, 4(1), p.obac024.
- Capano, J.G., Boback, S.M., Weller, H.I., Cieri, R.L., Zwemer, C.F. and Brainerd, E.L., 2022. Modular lung ventilation in Boa constrictor. *Journal of Experimental Biology*, 225(6), p.jeb243119.
- Weller, H. I., López-Fernández, H., McMahan, C. D., & Brainerd, E. L., 2022. Relaxed feeding constraints facilitate the evolution of mouthbrooding in neotropical cichlids. *The American Naturalist*, 199(6), pp.E197-E210.
- Camp, A.L. and Brainerd, E.L., 2022. A new conceptual framework for the musculoskeletal biomechanics and physiology of ray-finned fishes. *Journal of Experimental Biology*, jeb.243376. doi:10.1242/jeb.243376
- Jimenez, Y.E. and Brainerd, E.L., 2021. Motor control in the epaxial musculature of bluegill sunfish in feeding and locomotion. *Journal of Experimental Biology*, 224(21), jeb242903. doi:10.1242/jeb.242903
- Jimenez, Y.E., Marsh, R.L. and Brainerd, E.L. 2021. A biomechanical paradox in fish: swimming and suction feeding produce orthogonal strain gradients in the axial musculature. *Scientific reports*, 11:1-9. 10.1038/s41598-021-88828-x
- Stover, K.K., Sleboda, D.A., Brainerd, E.L. and Roberts, T.J., 2021. Gastrocnemius muscle structural and functional changes associated with domestication in the Turkey. *Animals* 11:1850. <https://doi.org/10.3390/ani11071850>
- Weller, H.I., Olsen, A.M., Camp, A.L., Manafzadeh, A.R., Hernandez, L.P. and Brainerd, E. L. 2020. An XROMM study of food transport and swallowing in channel catfish. *Integrative Organismal Biology*, 2(1). 10.1093/iob/obaa018
- Olsen, A.M., Hernandez, L.P. and Brainerd, E.L., 2020. Multiple Degrees of Freedom in the Fish Skull and Their Relation to Hydraulic Transport of Prey in Channel Catfish. *Integrative Organismal Biology*, 2(1). 10.1093/iob/obaa031

- Lomax, J. J., Martinson, T. F., Jimenez, Y. E. and Brainerd, E. L. 2020. Bifunctional role of the sternohyoideus muscle during suction feeding in striped surfperch, *Embiotoca lateralis*. *Integrative Organismal Biology*, 2(1). doi: 0.1093/iob/obaa021
- Camp, A.L., Olsen, A.M., Hernandez, L.P. and Brainerd, E.L. 2020. Fishes can use axial muscles as anchors or motors for powerful suction feeding. *Journal of Experimental Biology* 223, jeb225649, doi: 10.1242/jeb.225649
- Bhullar, B.A.S., Manafzadeh, A.R., Miyamae, J.A., Hoffman, E.A., Brainerd, E.L., Musinsky, C. and Crompton, A.W., 2020. Reply to: Jaw roll and jaw yaw in early mammals. *Nature*, 582(7812), pp.E9-E12. 10.1038/s41586-020-2364-z
- Jimenez Y.E., Brainerd E.L. 2020. Dual function of epaxial musculature for swimming and suction feeding in largemouth bass. *Proceedings of the Royal Society B*, 287: 20192631. doi: 10.1098/rspb.2019.2631
- Cieri, R.L., Hatch, S.T., Capano, J.G. and Brainerd, E.L., 2020. Locomotor rib kinematics in two species of lizards and a new hypothesis for the evolution of aspiration breathing in amniotes. *Scientific Reports*, 10(1): 7739. doi: 10.1038/s41598-020-64140-y
- Mayerl, C.J., Capano, J.G., Moreno, A.A., Wyneken, J., Blob, R.W. and Brainerd, E.L., 2019. Pectoral and pelvic girdle rotations during walking and swimming in a semi-aquatic turtle: testing functional role and constraint. *Journal of Experimental Biology*, 222(24). doi:10.1242/jeb.212688
- Brocklehurst, R.J., Moritz, S., Codd, J., Sellers, W.I. and Brainerd, E.L., 2019. XROMM kinematics of ventilation in wild turkeys (*Meleagris gallopavo*). *Journal of Experimental Biology*, 222(23). doi:10.1242/jeb.209783
- van Meer, N.M., Weller, H.I., Manafzadeh, A.R., Kaczmarek, E.B., Scott, B., Gussekloo, S.W., Wilga, C.D., Brainerd, E.L. and Camp, A.L., 2019. Intra-oropharyngeal food transport and swallowing in white-spotted bamboo sharks. *Journal of Experimental Biology*, 222(22). doi:10.1242/jeb.201426
- Roberts, T.J., Eng, C.M., Sleboda, D.A., Holt, N.C., Brainerd, E.L., Stover, K.K., Marsh, R.L. and Azizi, E. 2019. The multi-scale, three-dimensional nature of skeletal muscle contraction. *Physiology*, 34(6), pp.402-408. doi:10.1152/physiol.00023.2019
- Laurence-Chasen, J.D., Ramsay, J.B. and Brainerd, E.L. 2019. Shearing overbite and asymmetrical jaw motions facilitate food breakdown in a freshwater stingray, *Potamotrygon motoro*. *Journal of Experimental Biology*, 222(13), p.jeb197681. doi:10.1242/jeb.197681
- Witzmann, F., Brainerd, E.L. and Konow, N. 2019. Eye movements in frogs and salamanders—testing the palatal buccal pump hypothesis. *Integrative Organismal Biology*. doi:10.1093/iob/obz011.

- Brainerd, E.L. and Camp, A.L. 2019. Functional Morphology of Vertebrate Feeding Systems: New Insights from XROMM and Fluoromicrometry. In *Feeding in Vertebrates* (pp. 21-44). Springer, Cham. doi: 10.1007/978-3-030-13739-7_2
- Olsen, A.M., Hernández, L.P., Camp, A.L. and Brainerd, E.L. 2019. Channel catfish use higher coordination to capture prey than to swallow. *Proceedings of the Royal Society B*, 286(1901), p.20190507.
- Bhullar, B.A.S., Manafzadeh, A.R., Miyamae, J.A., Hoffman, E.A., Brainerd, E.L., Musinsky, C. and Crompton, A.W. 2019. Rolling of the jaw is essential for mammalian chewing and tribosphenic molar function. *Nature*, 566: 528.
- Scott, B., Wilga, C.A. and Brainerd, E.L. 2019. Skeletal kinematics of the hyoid arch in the suction-feeding shark *Chiloscyllium plagiosum*. *Journal of Experimental Biology*, 222(5): p.jeb193573. doi:10.1242/jeb.193573
- Hoffmann, S.L., Donatelli, C.M., Leigh, S.C., Brainerd, E.L. and Porter, M.E. 2019. Three-dimensional movements of the pectoral fin during yaw turns in the Pacific spiny dogfish, *Squalus suckleyi*. *Biology open*, 8(1), p.bio037291. doi:10.1242/bio.037291
- Capano, J.G., Moritz, S., Cieri, R.L., Reveret, L. and Brainerd, E.L. 2019. Rib motions don't completely hinge on joint design: costal joint anatomy and ventilatory kinematics in a teiid lizard, *Salvator merianae*. *Integrative Organismal Biology*, 1(1), p.oby004. doi: 10.1093/iob/oby004
- Cieri, R.L., Moritz, S., Capano, J.G. and Brainerd, E.L. 2018. Breathing with floating ribs: XROMM analysis of lung ventilation in savannah monitor lizards. *Journal of Experimental Biology*, 221(22), doi:10.1242/jeb.189449.
- Jimenez, Y.E., Camp, A.L., Grindall, J.D. and Brainerd, E.L. 2018. Axial morphology and 3D neurocranial kinematics in suction-feeding fishes. *Biology Open*, 7(9), p.bio036335. doi:10.1242/bio.036335.
- Stover, K.K., Brainerd, E.L. and Roberts, T.J. 2018. Waddle and shuffle: gait alterations associated with domestication in turkeys. *Journal of Experimental Biology*, 221. doi:10.1242/jeb.180687
- Camp, A.L., Roberts, T.J. and Brainerd, E.L. 2018. Bluegill sunfish use high power outputs from axial muscles to generate powerful suction-feeding strikes. *Journal of Experimental Biology*, 221(11). doi: 10.1242/jeb.178160
- Sheehan, F.T., Brainerd, E.L., Troy, K.L., Shefelbine, S.J. and Ronsky, J.L. 2018. Advancing quantitative techniques to improve understanding of the skeletal structure-function relationship. *Journal of Neuroengineering and Rehabilitation*. 15(1), p. 25. doi: 10.1186/s12984-018-0368-9

- Stover, K.K., Weinreich, D.M., Roberts, T.J. and Brainerd, E.L. 2018. Patterns of musculoskeletal growth and dimensional changes associated with selection and developmental plasticity in domestic and wild strain turkeys. *Ecology and Evolution*, 2018: 1–11. doi: 10.1002/ece3.3881
- Olsen, A.M., Camp, A.L. and Brainerd, E.L. 2017. The opercular mouth-opening mechanism of largemouth bass functions as a 3D four-bar linkage with three degrees of freedom. *Journal of Experimental Biology*, 220: 4612-4623. doi: 10.1242/jeb.159079
- Dial, T.R., Reznick, D.N. and Brainerd, E.L. 2017. Heterochrony in the evolution of Trinidadian guppy offspring size: maturation along a uniform ontogenetic trajectory. *Proceedings of the Royal Society B: Biological Sciences*, 284:20171319.
- Brocklehurst, R. J., Moritz, S., Codd, J., Sellers, W. I. and Brainerd, E. L. 2017. Rib kinematics during lung ventilation in the American alligator (*Alligator mississippiensis*): an XROMM analysis. *Journal of Experimental Biology*, 220: 3181-3190. doi: 10.1242/jeb.156166
- Camp, A. L., Scott, B., Brainerd, E. L. and Wilga, C. D. 2017. Dual function of the pectoral girdle for feeding and locomotion in white-spotted bamboo sharks. *Proceedings of the Royal Society B: Biological Sciences*, 284: 20170847. doi: 10.1098/rspb.2017.0847.
- Brainerd, E.L., Blob, R.W., Hedrick, T.L., Creamer, A.T. and Müller, U.K. 2017. Data management rubric for video data in organismal biology. *Integrative and Comparative Biology*, 57:33-47. doi: 10.1093/icb/icx060.
- Dial, T. R., Hernandez, L. P. and Brainerd, E. L. 2017. Morphological and functional maturity of the oral jaws covary with offspring size in Trinidadian guppies. *Scientific Reports* 7, 5771. doi: 10.1038/s41598-017-06414-6.
- Childs, B., Pugliese, B., Carballo, C., Miranda, D., Brainerd, E. and Kirker-Head, C. 2017. Three-dimensional kinematics of the equine metacarpophalangeal joint using X-ray reconstruction of moving morphology-a pilot study. *Veterinary and Comparative Orthopaedics and Traumatology*. doi: 10.3415/VCOT-16-06-0095.
- Witzmann, F. and Brainerd, E.L. 2017. Modeling the physiology of the aquatic temnospondyl *Archegosaurus decheni* from the early Permian of Germany. *Fossil Record*, 20: 105–127. doi:10.5194/fr-20-105-2017.
- Knörlein, B.J., Baier, D.B., Gatesy, S.M., Laurence-Chasen, J.D. and Brainerd, E.L. 2016. Validation of XMALab software for marker-based XROMM. *Journal of Experimental Biology*, 219: 3701-3711. doi: 10.1242/jeb.145383.
- Camp, A.L., Astley, H.C., Horner, A.M., Roberts, T.J. and Brainerd, E.L. 2016. Fluoromicrometry: a method for measuring muscle length dynamics with biplanar videofluoroscopy. *Journal of Experimental Zoology, Part A*, 325: 399-408. doi:

10.1002/jez.2031.

Mayerl, C.J., Brainerd, E.L. and Blob, R.W. 2016. Pelvic girdle mobility of cryptodire and pleurodire turtles during walking and swimming. *Journal of Experimental Biology*, 219: 2650-2658. doi: 10.1242/jeb.141622.

Brainerd, E.L., Moritz, S. and Ritter, D.A. 2016. XROMM analysis of rib kinematics during lung ventilation in the green iguana, *Iguana iguana*. *Journal of Experimental Biology*, 219: 404-411. doi: 10.1242/jeb.127928.

Bonnan, M.F., Shulman, J., Varadharajan, R., Gilbert, C., Wilkes, M., Horner, A. and Brainerd, E.L. 2016. Forelimb kinematics of rats using XROMM, with implications for small eutherians and their fossil relatives. *PLoS ONE* 11(3): e0149377. doi: 10.1371/journal.pone.0149377.

Brainerd, E.L. 2015. Major transformations in vertebrate breathing mechanisms. In: *Great Transformations in Vertebrate Evolution*. Dial, K.P., Shubin, N., Brainerd, E.L. eds. University of Chicago Press: Chicago.

Camp, A.L., Roberts, T.J. and Brainerd, E.L. 2015. Swimming muscles power suction feeding in largemouth bass. *Proceedings of the National Academy of Sciences*, 112: 8690-8695. doi: 10.1073/pnas.1508055112.

Camp, A.L. and Brainerd, E.L. 2015. Reevaluating musculoskeletal linkages in suction-feeding fishes with X-Ray Reconstruction of Moving Morphology (XROMM). *Integrative and Comparative Biology*, 55: 1-12. doi: 10.1093/icb/icv034.

Menegaz, R.A., Baier, D.B., Metzger, K.A., Herring, S.W. and Brainerd, E.L. 2015. XROMM analysis of tooth occlusion and temporomandibular joint kinematics during feeding in juvenile miniature pigs. *Journal of Experimental Biology*, 218: 2573-2584. doi: 10.1242/jeb.119438.

Gidmark, N.J., Taylor, C., LoPresti, E. and Brainerd, E.L. 2015. Functional morphology of durophagy in black carp, *Mylopharyngodon piceus*. *Journal of Morphology*, 276: 1422-1432. doi: 10.1002/jmor.20430.

Dial, T.R., Reznick, D.N., Brainerd, E.L. 2015. Effects of neonatal size on maturity and escape performance in the Trinidadian guppy. *Functional Ecology*, 30: 943-952. doi: 10.1111/1365-2435.12565.

Gidmark, N.J., Tarrant, J.C. and Brainerd, E.L. 2014. Convergence in morphology and masticatory function between the pharyngeal jaws of grass carp, *Ctenopharyngodon idella*, and oral jaws of amniote herbivores. *Journal of Experimental Biology*, 217: 1925-1932. doi: 10.1242/jeb.096248.

- Camp, A.L. and Brainerd, E.L. 2014. Role of axial muscles in powering mouth expansion during suction feeding in largemouth bass (*Micropterus salmoides*). *Journal of Experimental Biology*, 217: 1333-45. doi: 10.1242/jeb.095810.
- Nowroozi, B.N. and Brainerd, E.L. 2014. Importance of mechanics and kinematics in determining the stiffness contribution of the vertebral column during body-caudal-fin swimming in fishes. *Zoology (Jena)*, 117: 28-35. doi: 10.1016/j.zool.2013.10.003.
- Nowroozi, B. and Brainerd, E.L. 2013. X-ray motion analysis of the vertebral column during the startle response in striped bass, *Morone saxatilis*. *Journal of Experimental Biology*, 216: 2833-2842.
- Harper, C.J., Swartz, S.M. and Brainerd, E.L. 2013. Specialized bat tongue is a hemodynamic nectar mop. *Proceedings of the National Academy of Sciences*, 110: 8852-8857.
- Gidmark, N.J., Konow, N., LoPresti, E. and Brainerd, E.L. 2013. Bite force is limited by the force-length relationship of skeletal muscle in black carp, *Mylopharyngodon piceus*. *Biology Letters*, 9: 20121181.
- Gidmark, N.J., Staab, K.L., Hernandez, L.P. and Brainerd, E.L. 2012. Flexibility in starting posture drives flexibility in kinematic behavior of the kinethmoid-mediated premaxillary protrusion mechanism in a cyprinid fish, *Cyprinus carpio*. *Journal of Experimental Biology*, 215: 2262-2272.
- Nowroozi, B. and Brainerd, E.L. 2012. Regional variation in the mechanical properties of the vertebral column during lateral bending in *Morone saxatilis*. *Journal of the Royal Society Interface*, 9: 2667-2679.
- Cundall, D., Brainerd, E.L., Constantino, J., Deufel, A., Grapski, D. and Kley, N.J. 2012. Drinking in snakes: resolving a biomechanical puzzle. *Journal of Experimental Zoology*, 317A: 152-172.
- Nowroozi, B., Harper, C.J., De Kegel, B., Adriaens, D. and Brainerd, E.L. 2012. Regional variation in morphology of vertebral centra and intervertebral joints in striped bass, *Morone saxatilis*. *Journal of Morphology*, 273: 441-452.
- Miranda, D.L., Schwartz, J.B., Loomis, A.C., Brainerd, E.L., Fleming, B.C. and Crisco, J.J. 2011. Static and Dynamic Error of a Biplanar Videoradiography System Using Marker-Based and Markerless Tracking Techniques. *Journal of Biomechanical Engineering*, 133: 121002.
- Dawson, M.M., Metzger, K.A., Baier, D.B. and Brainerd, E.L. 2011. Kinematics of the quadrate bone during feeding in Mallard ducks. *Journal of Experimental Biology*, 214: 2036-2046.

- Gidmark, N.J., Strother, J.A., Horton, J.M., Summers, A.P. and Brainerd, E.L. 2011. Locomotory transition from water to sand and its effects on undulatory kinematics in sand lances (Ammodytidae). *Journal of Experimental Biology*, 214: 657-664.
- Brainerd, E.L., Baier, D.B., Gatesy, S.M., Hedrick, T.L., Metzger, K.A., Gilbert, S.L. and Crisco, J.J. 2010. X-ray Reconstruction of Moving Morphology (XROMM): precision, accuracy and applications in comparative biomechanics research. *Journal of Experimental Zoology*, 313A: 262-279. doi: 10.1002/jez.589.
- Miranda, D.L., Brainerd, E.L., Fleming, B.C. and Crisco, J.J. 2010. Accuracy and precision of 3-D skeletal motion capture technology. *Transactions of the 56th Annual Meeting of the Orthopaedic Research Society*. Paper 334.
- Nowroozi, B., Strother, J.A., Horton, J.M., Summers, A.P. and Brainerd, E.L. 2009. Whole-body lift and ground effect during pectoral fin locomotion in the northern spearnose poacher (*Agonopsis vulsa*). *Zoology*, 112(5): 393-402.
- Landberg, T., J.D. Mailhot and E.L. Brainerd. 2009. Lung ventilation during treadmill locomotion in a semi-aquatic turtle, *Trachemys scripta*. *Journal of Experimental Zoology*, 311A: 551-562.
- Azizi, E., Brainerd, E.L. and Roberts, T.J. 2008. Variable gearing in pennate muscles. *Proceedings of the National Academy of Sciences*, 105: 1745-1750.
- Keefe, D.M., O'Brien, T.M., Baier, D.B., Gatesy, S.M., Brainerd, E.L. and Laidlaw, D.H. 2008. Exploratory Visualization of Animal Kinematics Using Instantaneous Helical Axes. *Computer Graphics Forum*, 27(3): 863-870.
- Miranda, D.L., Rainbow, M.J., Brainerd, E.L. and Fleming, B.C. 2008. Tracking 3D kinematics of healthy and ACL-transected goat knee joints *in vivo*: a preliminary study. *Proceedings of the 34th Annual Northeast Bioengineering Conference*, pp. 170-171.
- Azizi, E. and Brainerd, E.L. 2007. Architectural gear ratio and muscle fiber strain homogeneity in segmented musculature. *Journal of Experimental Zoology*, 307A: 1-12.
- Ward, A.B. and Brainerd, E.L. 2007. Evolution of axial patterning in elongate fishes. *Biological Journal of the Linnean Society*, 90: 97-116.
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- Brainerd, E.L. 1994. The evolution of lung-gill bimodal breathing and the homology of vertebrate respiratory pumps. *American Zoologist*, 34: 289-299.
- Brainerd, E.L. 1994. Mechanical design of polypterid fish integument for energy storage during recoil aspiration. *Journal of Zoology* (London), 232: 7-19.

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- Brainerd, E.L., Liem, K.F. and Samper, C.T. 1989. Air ventilation by recoil aspiration in polypterid fishes. *Science*, 246: 1593-1594.

Other publications (not peer-reviewed)

- Brainerd, E.L. 2005. Journal Club: Stickleback genetics and tetraodontiform fishes. *Nature*, 436: 1069.
- Brainerd, E.L. 2001. News and Views: Caught in the Crossflow. *Nature*, 412: 387-388.
- Brainerd, E.L. Physiology: Respiration. 2000. Chapter for the *Encyclopedia of Paleontology*, Ronald Singer, ed. Fitzroy Dearborn, Chicago, pp. 1019-1021.
- Brainerd, E.L. 1999. News and Views: Lickety Split. *Nature*, 401: 757.
- Brainerd, E.L. 1997. News and Views: Efficient fish not faint-hearted. *Nature*, 389: 229-230.
- Brainerd, E.L. 1989. Book review: Life's Devices by Steven Vogel. *Copeia*, 1989(3): 805-806.

Publications by lab members

It is my policy that my name does not necessarily appear on all publications from members of my lab group. The following papers include work done by one or more of my students or post-docs while they were part of my research group.

- Capano, J.G. 2020. Reaction forces and rib function during locomotion in snakes. *Integrative and Comparative Biology*, 60: 10.1093/icb/icaa033
- Olsen, A.M. 2019. A mobility-based classification of closed kinematic chains in biomechanics and implications for motor control. *Journal of Experimental Biology*, 222:195735
- Camp, A.L. 2019. What fish can teach us about the feeding functions of postcranial muscles and joints. *Integrative and Comparative Biology* **59**, 383-393.
- Laulicht, B., Gidmark, N.J., Tripathi, A. and Mathiowitz, E. 2011. Localized drug delivery from magnetic pills. *Proceeding of the National Academy of Sciences*, 108(6): 2252-2257.
- Azizi, E. and Horton, J.M. 2004. Patterns of axial and appendicular movements during aquatic walking in the salamander *Siren lacertina*. *Zoology*, 107: 111-120.
- Ward, A.B. and Azizi, M. 2004. Convergent evolution of the head retraction escape response in elongate fishes and amphibians. *Zoology*, 107: 205-217.

- Azizi, E. and Landberg, T. 2002. Effects of metamorphosis on the aquatic escape response of the two-lined salamander (*Eurycea bislineata*). *Journal of Experimental Biology*, 205: 841-849.
- Kley, N.J. 2002. Prey transport mechanisms in blindsnakes and the evolution of unilateral feeding systems in snakes. *American Zoologist*, 41: 1321-1337.
- Summers, A.P. and Ferry-Graham, L.A. 2001. Ventilatory modes and mechanics of the hedgehog skate (*Leucoraja erinacea*): testing the continuous flow model. *Journal of Experimental Biology*, 204: 1577-1587.
- Summers, A.P. 2000. Stiffening the stingray skeleton - an investigation of durophagy in myliobatid stingrays (Chondrichthyes, Batoidea, Myliobatidae). *Journal of Morphology*, 243: 113-126.
- O'Reilly, J.C., Summers, A.P. and Ritter, D.A. 2000. The evolution of the functional role of trunk muscles during locomotion in adult amphibians. *American Zoologist*, 40: 123-135.
- Leonard, J.B.K., Summers, A.P. and Koob, T.J. 1999. Routine and standard metabolic rate of embryonic little skate (*Raja erinacea*): the cost of active pumping. *Journal of Experimental Zoology*, 283: 13-18.
- Liem, K.F. and Summers, A.P. 1999. Gross anatomy and functional morphology of the muscles. In *The Biology of Elasmobranch Fishes*. Edited by Hammett, W. Johns Hopkins Press, Baltimore.
- Summers, A.P. and O'Reilly, J.C. 1997. A comparative study of locomotion in the caecilians *Dermophis mexicanus* and *Typhlonectes natans* (Amphibia: Gymnophiona). *Zoological Journal of the Linnean Society*, 121(1): 65-76.

TEACHING

Courses at Brown University

EEOB, Graduate Seminar, "Biological Imaging" Fall 2022.

Biology 1885, Human Anatomy and Biomechanics for undergraduate students, 2021, 2022, 2023

Biology 181/BIOL3644/MED2160, Human Anatomy for medical students, 2005-Present. Certificate of Exemplary Teaching, 2006, 2007, 2012, 2013, 2014, 2015, 2019.

EEB, Graduate Seminar, "General biomechanical principles of vertebrate feeding mechanisms." Fall 2012

EEB, Graduate Seminar, "Comparative Vertebrate Physiology: Systems Modeling and Simulation." Spring 2015

EEB, Graduate Seminar, "Professional Development Workshop" for 1st year graduate students, Fall 2010; Fall 2013; Fall 2014

EEB, Graduate Seminar, "Tree Thinking" with Steve Gatesy, Spring 2006

Teaching at Friday Harbor Labs, University of Washington

Guest Lecturer, Functional Morphology of Marine Fishes (summer course), 1994-Present

Course Leader, with Adam Summers, Functional Morphology of Marine Fishes, 2004

Research Mentor, 2 students, REU Program, Summer 2015

Guest Lecturer, FHL 305, Biology of Fishes, Fall 2015

Research Mentor, 2 students, FHL 470, Research in Marine Biology, Fall 2015

Courses at UMass Amherst

Biology 101, Introductory Biology (ecology, evolution, behavior and physiology)

Biology 105, Biology of Social Issues (general education course)

Biology 297a, Introductory Human Physiology

Biology 297h, Honors Introductory Human Physiology

Biology 567, Comparative Physiology with lab

Biology 521, Comparative Vertebrate Anatomy with lab

Biology HO3, Human Anatomy Seminar

Biology HO6, Functional Vertebrate Morphology Seminar

Biology HO2, Human Physiology Seminar

OEB 697, Evolutionary Developmental Biology (graduate seminar)

OEB 697, Microevolution and Macroevolution (graduate seminar)

OEB 897, Muscle Architecture and Biomechanics (graduate seminar)

Supervision of Undergraduate Research

To date I have supervised the independent research of more than 90 undergraduate students. I have received five REU supplements to my NSF grants, and I have published 15 papers with 19 undergraduate co-authors. My undergraduate students regularly present their work at regional, national and international meetings.

Supervision of Graduate and Postdoctoral Research

Current Doctoral Students:

Rachel Fleming and Amy Rutter, Ecology, Evolution, and Organismal Biology
Department, Brown University

Former Postdoctoral Fellows:

Brown University: Kelsey Stilson, Corrine Avidan, Aaron Olsen, Kory Evans, Ariel Camp, Justin Schaefer, Rachel Menegaz, Sabine Moritz, Keith Metzger, David Baier

UMass Amherst: Rachel Simons, James O'Reilly

Former Doctoral Students:

Adam P. Summers, Ph.D. 1999, UMass Amherst, Organismic and Evolutionary Biology Program (OEB). After receiving his doctorate, Adam was awarded a Miller Postdoctoral Fellowship at Berkeley and is now Professor of Biology at the University of Washington.

Nathan J. Kley, Ph.D. 2001, UMass Amherst, OEB Graduate Program. After receiving his doctorate, Nate was awarded the John Caldwell Meeker Postdoctoral Fellowship at the Field Museum of Natural History and is now Associate Professor of Anatomical Sciences at Stony Brook University.

Andrea B. Ward, Ph.D. 2005, UMass Amherst, OEB Graduate Program. After receiving her doctorate, Andie moved to the University of Chicago to pursue postdoctoral work in molecular developmental mechanisms and is now Professor and Chair of Biology at Adelphi University.

Emanuel Azizi, Ph.D. 2005, UMass Amherst, OEB Graduate Program. After receiving his doctorate, Manny moved to Brown University to pursue postdoctoral work on muscle mechanics with Tom Roberts and is now Associate Professor of Ecology & Evolutionary Biology at UC Irvine.

Bryan N. Nowroozi, Ph.D. 2011, Brown University, Department of Ecology & Evolutionary Biology. Bryan was awarded a postdoctoral fellowship in the Center for Advanced Surgical and Interventional Technology, Department of Bioengineering at UCLA and now Senior Manager of R&D for Mimeo Labs, Inc., a medical device company in California.

Nick Gidmark, Ph.D. 2012, Brown University, Department of Ecology & Evolutionary Biology. Nick completed postdoctoral fellowships at the Friday Harbor Labs and University of Chicago, and now is an Associate Professor at Knox College.

Cally Harper, Ph.D. 2013, Brown University, Department of Ecology & Evolutionary Biology. Dr. Harper works in the field of environmental engineering.

Ariel Camp, Ph.D. 2015, Brown University, Department of Ecology & Evolutionary Biology. Ariel is currently a Tenure-track Fellow in the Department of Musculoskeletal & Ageing Science at the University of Liverpool.

Terry Dial, Ph.D. 2016, Brown University, Department of Ecology & Evolutionary Biology. Terry is currently Assistant Professor, Professional Practice at Utah State University, Moab.

Kristin Stover, Ph.D. 2017, Brown University, Department of Ecology & Evolutionary Biology. Kris is currently an Assistant Professor and Director of Undergraduate Anatomy Education at The Ohio State University College of Medicine.

Yordano Jimenez, Ph.D. 2021, Brown University, Department of Ecology & Evolutionary Biology. NSF Postdoctoral Research Fellow in Biology, working with Eric Tytell at Tufts University.

John Capano, Ph.D. 2021, Brown University, Department of Ecology & Evolutionary Biology. Associate, Magnolia Innovation.

Jeremy (JJ) Lomax, Ph.D. 2022, Brown University, Department of Ecology & Evolutionary Biology. Associate Scientist, Exponent.

Hannah Weller, Ph.D. 2023. Brown University, Department of Ecology & Evolutionary Biology. Postdoctoral Fellow, University of Helsinki

Elska Kaczmarek, Ph.D. 2023. Brown University, Department of Ecology & Evolutionary Biology. Postdoctoral Fellow, Northern Arizona University

Former Master of Science Students:

Wallace O. (Skip) Bennett, M.S. 2000, UMass Amherst, OEB Graduate Program. Skip received his MS degree in May 2000 and work from his MS thesis was published in the *Journal of Experimental Biology*. He now works as a high-school science teacher.

Kelly Druzisky, M.S. 2001, UMass Amherst, OEB Graduate Program. Kelly completed a MS thesis on buccal oscillation behavior in an aquatic turtle, and this work was published in *Zoology*. Kelly received her MBA from UMass Amherst in 2003 and now works as an accountant.

Robert Levine, M.S. 2003, UMass Amherst, OEB Graduate Program. Robb completed an MS thesis on eye retraction in frogs, which has been published in *Journal of Experimental Biology*. Robb is now a Physician's Assistant.

Tobias Landberg, M.S. 2004, UMass Amherst, OEB Graduate Program. Tobias went on to doctoral work at the University of Connecticut. He presented his master's thesis work on the ontogeny of aquatic escape in salamanders at SICB in January 2004, for which he won the D. Dwight Davis Prize for the best student paper in vertebrate morphology. Tobias is now an Assistant Professor at Arcadia College.

Nicole Danos, M.S. 2005, UMass Amherst, OEB Graduate Program. Nicole went on to doctoral work at Harvard with George Lauder. Nicole is now an Assistant Professor at University of San Diego.

SERVICE AND PROFESSIONAL ACTIVITIES

Brown University Service

2008-present	Director, Keck XROMM Core Facility
2020	Co-Chair, EEB Departmental DIAP Committee
2017-present	Director of Postdoctoral Studies, Department of Ecology & Evolutionary Biology
2017-2020	Member, Committee on Medical Faculty Appointments
2010-present	Member, Research Computing Advisory Committee
2014	Member, Search Committee for CCV Executive Director
2006-2014	Vice Chair, Department of Ecology & Evolutionary Biology
2010-2014	Director of Graduate Studies, Department of Ecology & Evolutionary Biology
2010	Member, Search Committee for CCV Executive Director
2006-2007	Member, Conservation Biology Search Committee, EEB Department
2005-2006	Member, Plant Systematics Search Committee, EEB Department
2005-present	Chair, Space Committee, EEB Department
2006	Member, Dean of the College Search Committee
2006	Member, PLME Working Group
2006-2009	Member, Medical Curriculum Committee
2006-2009	Member, Medical Committee on Academic Standing
2006-2009	Member, Institutional Animal Care and Use Committee

University of Massachusetts Amherst Service

2002-2005	Director, Interdepartmental Program in Organismic and Evolutionary Biology (OEB)
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- 1999-2003 PI and Director, UMass Amherst Undergraduate Mentoring in Environmental Biology Program (an NSF-funded program designed to increase the participation of underrepresented minorities in the sciences)
- 2002-2003 Organizer, Special Seminar Series on 3D Imaging Techniques in the Life Sciences
- 2001-2002 Chair, *Ad Hoc* Committee for the Periodic Evaluation of the Dean of The College of Engineering
- 1999-2001 Associate Director, OEB Program (Chair, Admissions Committee; Member, Seminar Committee)
- 1999-2000 Chair, Vertebrate Morphology/Evolution Search Committee (Dr. Betsy Dumont hired)
- 1999-2000 Chair, OEB Darwin Fellows Search Committee (Dr. Barbara Whitlock hired)
- 1999-2000 Member, Biology Department Search Committee (Dr. Jeff Podos hired)
- 1997-present Member, Steering Committee, Massachusetts Museum of Natural History
- 1994-present Member, Steering Committee, OEB Program
- 1996-1999 Member, Biology Department Personnel Committee
- 1996-1997 Associate Director, OEB Program (20 months, 4/96–12/97)
- 1995-1997 Chair, Seminar Committee, OEB Program
- 1994-1997 Member, OEB Graduate Admissions Committee
- 1995-1997 Member, Biological Computing Resource Center Steering Committee
- 1997 Member, Biology Department Learning Goals Committee
- 1996 Member, Search Committee for position in Vertebrate Morphology/Evolution (Dr. Jin Meng hired)
- 1996 Member, Search Committee for Director of Biological Computing Resource Center (Dr. Steve Brewer hired)
- 1995 Co-founder, with William Bemis, Darwin Postdoctoral Fellows Program
- 1994-present Founder and organizer of the Fish Group, a monthly seminar series and discussion group for local scientists and students working on fishes. Expanded to Fish and Herp Group, 1997

Professional Service

- 2021-2023 Past President, Society for Integrative and Comparative Biology
- 2019-2021 President, Society for Integrative and Comparative Biology
- 2019-2022 Past President International Society of Vertebrate Morphology and Chair of the Scientific Program Committee for ICVM2023 in Cairns Australia

- 2018 Symposium organizer for joint American Association of Anatomists and International Society of Vertebrate Morphology symposium at EB2018, “From bats to whales: feeding shapes diversity in the mammalian skull.”
- 2017-2019 President Elect, Society for Integrative and Comparative Biology
- 2016-2019 President, International Society of Vertebrate Morphology
- 2013-2016 President Elect, International Society of Vertebrate Morphology
- 2012-2014 Member at Large, Executive Committee, Society for Integrative and Comparative Biology
- 2009-present Member, Editorial Board, *Journal of Experimental Biology*
- 2009-2011 Associate Editor, *Journal of Experimental Zoology, Part A*
- 2006 Local Committee Chair, Northeast Regional Meeting, Division of Vertebrate Morphology, Society for Integrative and Comparative Biology. Organized two-day conference at Brown for 70 participants.
- 2005-2007 Chair, Division of Vertebrate Morphology, Society for Integrative and Comparative Biology
- 2002-2004 Chair, Scientific Program Committee, 7th International Congress of Vertebrate Morphology
- 2001-2003 Chair, *Ad Hoc* Committee for Increasing Membership Diversity, Society for Integrative and Comparative Biology
- 2003-2006 Member, *Ad Hoc* Committee for Increasing Membership Diversity, Society for Integrative and Comparative Biology
- 2000-present Member, Executive Committee, International Society of Vertebrate Morphologists
- 2004-2007 Associate Editor, *Evolution*
- 2001-2014 Editorial Board Member, *Physiological and Biochemical Zoology*
- 1995-present Panel Member, National Science Foundation, Division of Integrative Organismal Systems (approximately one panel every two years)
- 1995-present *Ad Hoc* proposal review, National Science Foundation, Ecological & Evolutionary Physiology, Animal Behavior, Integrative Animal Biology, Geology & Paleontology, and International Programs
- 1996-1998 Associate Editor, *American Zoologist*

- 1999 Discussion group leader and reporter for three-day, NASA-sponsored workshop, "Microgravity's Effects on Biological Systems and Behavior: An Integrative Approach."
- 1997-1999 Committee Member, Student Support Committee, Society for Integrative and Comparative Biology
- 1998 Chair, Nominating Committee, Division of Vertebrate Morphology, Society for Integrative and Comparative Biology
- 1997 Local Committee Chair, Northeast Regional Meeting, Division of Vertebrate Morphology, Society for Integrative and Comparative Biology. Organized two-day conference at UMass for 70 participants.

Professional Associations

AAAS (Fellow)
American Association for Anatomy (Fellow)
American Physiological Society
American Society of Biomechanics
American Society of Ichthyologists and Herpetologists
International Society of Vertebrate Morphology
Sigma Xi
Society for Integrative and Comparative Biology
Society for Experimental Biology
Society of Vertebrate Paleontology