

WU-JUNG LEE

*Research Associate
Applied Physics Laboratory
University of Washington*

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EDUCATION**2013 Ph.D., MIT-WHOI Joint Program in Applied Ocean Science and Engineering**

Massachusetts Institute of Technology, Cambridge, MA, USA

Woods Hole Oceanographic Institution, Woods Hole, MA, USA

Advisors: Drs. Timothy Stanton, Andone Lavery, Peter Tyack

Thesis: Broadband and statistical characterization of echoes from random scatterers: application to acoustic scattering by marine organisms

2005 B.S. in engineering, Electrical Engineering

B.S., Life Science (with zoology focus) *double major

National Taiwan University, Taipei, Taiwan

2014 Methods in Computational Neuroscience, Marine Biological Laboratory, Woods Hole, MA, USA (Summer course)**RESEARCH INTERESTS**

I am interested in the use of sound – by both human and animals – to observe and understand the environment. My research spans two primary areas: acoustical oceanography, where I develop and apply active acoustic sensing techniques to infer properties of the ocean interior; and animal echolocation, where I combine experimental and computational approaches to understand the closed-loop sensorimotor feedback in echolocating bats and dolphins. In both areas, I focus on two fundamental aspects for achieving high confidence active acoustic sensing: 1) sampling – what can we do to collect better information? and 2) inference – how do we make reliable interpretation of echo information? Under these overarching themes, I am working to expand acoustic sensing capability for marine ecosystem monitoring at large temporal and spatial scales, and use echolocating animals as biological models to inspire adaptive sampling strategies in active acoustic context.

CURRENT AND PAST POSITIONS

2016 - present **Research Associate**, Applied Physics Laboratory, University of Washington

Supervisors: Drs. Dajun Tang, Sarah Webster and Eric Thorsos

Fall 2013 - **F. V. Hunt Postdoctoral Fellow**, Department of Psychological and Brain Sciences, Johns

2015 Hopkins University (lab relocated from University of Maryland in Spring 2014)

Advisor: Dr. Cynthia Moss

Spring 2013 **Postdoctoral Investigator**, Woods Hole Oceanographic Institution

Advisors: Drs. James Preisig and Andone Lavery

2007-2013 **Graduate student**, Woods Hole Oceanographic Institution

Advisors: Drs. Timothy Stanton and Andone Lavery (acoustic scattering)

Dr. Peter Tyack (marine mammal)

2005-2006 **Research Assistant**, Marine Mammal Research Project, Hawai'i Institute of Marine Biology

Advisor: Dr. Whitlow Au

2006 **Research Assistant**, Electrophysiology Laboratory, Marine Research Station, Institute of

Cellular and Organismic Biology, Academia Sinica, Taiwan

Advisor: Dr. Hong-Young Yan

2005 **Intern**, BioSonar Project, Acoustic Research Laboratory, Tropical Marine Science Institute,

National University of Singapore

Advisor: Dr. Matthias Hoffmann-Kuhnt

2004-2005 **Research Assistant**, Cetacean Laboratory, Institute of Ecology and Evolutionary Biology,

National Taiwan University

Advisor: Dr. Lien-Siang Chou

2003-2005 **Research Assistant**, Spatial Ecology Laboratory, Institute of Ecology and Evolutionary Biology, National Taiwan University
 Advisor: Dr. Pei-Fen Lee

PEER-REVIEWED PAPERS

- Lee, W.-J.**, Falk, B., Chiu, C., Krishnan, A., Arbour, J.A., and Moss, C.F. (2017) Tongue-driven sonar beam steering by a lingual-1 echolocating fruit bat. *PLoS Biology*, 15(12): e2003148.
- Lee, W.-J.** and Moss, C. F. (2016) Can the elongated hindwing tails of fluttering moths serve as false sonar targets to divert bat attacks? *Journal of the Acoustical Society of America*, 139(5): 2579-2588.
- Warnecke, M., **Lee, W.-J.**, Krishnan, A., Moss, C.F. (2016) Dynamic echo information guides flight in the big brown bat. *Frontiers in Behavioral Neuroscience*, 10:81. doi: 10.3389/fnbeh.2016.00081.
- Lee, W.-J.** and Stanton, T. K. (2016) Statistics of broadband echoes: application to acoustic estimates of numerical density of fish. *IEEE Journal of Oceanic Engineering*, 41(3): 709-723.
- Danilovich, S., Krishnan, A., **Lee, W.-J.**, Borrisov, I., Eitan, O., Kosa, G., Moss, C. F., and Yovel, Y. (2015) Bats regulate biosonar based on the availability of visual information. *Current Biology*, 25(23): R1124–R1125.
- Lee, W.-J.** and Stanton, T. K. (2014). Statistics of echoes from mixed assemblages of scatterers with different scattering amplitudes and numerical densities. *IEEE Journal of Oceanic Engineering*, 39(4): 740-754.
- Lee, W.-J.**, Lavery, A. C., and Stanton, T. K. (2012). Orientation dependence of broadband acoustic backscattering from live squid. *Journal of the Acoustical Society of America*, 131(6): 4461-4475.
- Au, W. W. L., Houser, D. S., Finneran, J. J., **Lee, W.-J.**, Talmadge, L. A., and Moore, P. W. (2010). The acoustic field on the forehead of echolocating Atlantic bottlenose dolphins (*Tursiops truncatus*). *Journal of the Acoustical Society of America*, 128(3), 1426-1434.
- Mooney, T. A., **Lee, W.-J.**, and Hanlon, R. T. (2010). Long-duration anesthetization of squid (*Doryteuthis pealeii*). *Marine and Freshwater Behaviour and Physiology*, 43(4), 297-303.

MANUSCRIPT UNDER REVISION AFTER REVIEW

- Stanton, T. K., **Lee, W.-J.**, and Baik, K. Sonar echo statistics associated with discrete scatterers: A tutorial on physics-based methods. *Manuscript under revision after review*.

MANUSCRIPTS IN PREPARATION

- Lee, W.-J.**, Tang, D., Thorsos, E. I., Stanton, T. K. Direct observation of diel, kilometer-scale fish movements around shallow water artificial reefs using a mid-frequency sonar. *In preparation; manuscript available upon request*.
- Lee, W.-J.**, Staneva, V., Herman, B., Aravkin, S. Data-driven decomposition of ocean observatory echosounder time series for ecological insights. *In preparation; manuscript available upon request*.
- Schechter, G., Krishnan, A., **Lee, W.-J.**, Garmon, J.A., Moss, C.F., and Yovel, Y. Visuomotor adaptation in an echolocating fruit bat. *In preparation; figures available upon request*.

REPORTS

- Lee, W.-J.** (2014). Searching by active sensing: how the bat catches the bug. Final project presentation for the Methods in Computational Neuroscience summer course. Marine Biological Laboratory, Woods Hole, MA.
- Lee, W.-J.** (2009). Target discrimination and classification using broadband acoustic techniques – Saanich Inlet: a case study. Final project report for the Marine Bioacoustics summer course. Friday Harbor Laboratories, University of Washington, Friday Harbor, WA, USA.

PRESS

- [Luna moth's long tail could confuse bat sonar through its twist](#). UW Today, August 15, 2016.
- [The Squid, the Whale, and the Grad Student – A young scientist deciphers meaning embedded in sonar signals](#). Oceanus Magazine, 2009.

INVITED TALKS

- Department of Electrical and Computer Engineering, Dalhousie University. April 6, 2017.
- Institute of Cellular and Organismic Biology, Academia Sinica, Taiwan. December 12, 2016.
- December, 2017

School of Earth and Ocean Sciences, University of Victoria, BC, Canada. September 13, 2016.

Applied Physics Laboratory, University of Washington, Seattle, WA. September 1, 2015.

Hatfield Marine Station, Oregon State University, Corvallis, OR. July 7, 2015.

Department of Mechanical Engineering, University of New Hampshire, Durham, NH. June 1, 2015.

Spring 2015 Meeting of the Acoustical Society of America, Pittsburgh, PA. May 18, 2015.

Endemic Species Research Institute, Council of Agriculture, Executive Yuan. Nantou, Taiwan. April 20, 2015.

Spring 2014 Meeting of the Acoustical Society of America, Providence, RI. May 5, 2015.

Department of Engineering Science and Ocean Engineering, National Taiwan University. May 1, 2013.

Institute of Oceanography, National Taiwan University, Taipei, Taiwan. January 12, 2012.

Institute of Oceanography, National Taiwan University, Taipei, Taiwan. January 6, 2010.

CONFERENCE PRESENTATIONS

- Lee, W.-J.** (2017) I wonder how animals can do it so well: An ongoing detour to build better sonar, enabled by the Hunt fellowship. Presented at *the 174th Meeting of the Acoustical Society of America*, New Orleans, LA, USA, December 4-8, 2017.
- Lee, W.-J.**, Staneva, S., Herman, B., Aravkin, A. (2017) Data-driven decomposition of long-term echosounder time series from ocean observatories. Presented at *the 174th Meeting of the Acoustical Society of America*, New Orleans, LA, USA, December 4-8, 2017.
- Lee, W.-J.**, Yu, H.-Y., Au, W.W.L., Smith, A., Jen, I.-F., Yang, W.-C., Fan, Y.-C., Nachtigall, P.E., Chou, L.-S. (2016) Biosonar radiation field on the forehead of a Risso's dolphin during prey capture. Presented at *the 5th Joint Meeting of the Acoustical Society of America and the Acoustical Society of Japan*, Honolulu, HI, USA, November 28-December 2, 2016.
- Lee, W.-J.**, Tang, D., Thorsos, E.I., Stanton, T.K. (2016) Mid-frequency clutter and reverberation characteristics of fish in a shallow ocean waveguide. Presented at *the 5th Joint Meeting of the Acoustical Society of America and the Acoustical Society of Japan*, Honolulu, HI, USA, November 28-December 2, 2016.
- Lee, W.-J.**, Falk, B., Chiu, C., Krishnan, A., Moss, C. F. (2016) Asymmetric multi-frequency biosonar beam pattern of tongue-clicking bat, *Rousettus aegyptiacus*. Presented at *the 171th Meeting of the Acoustical Society of America*, Salt Lake City, UT, USA, May 23-27, 2016.
- Lee, W.-J.** and Stanton, T. K. (2016). Modeling and analyzing the statistics of sonar echoes from marine organisms. Presented at *the 2016 Ocean Sciences Meeting*, New Orleans, LA, USA, February 21-26, 2016.
- Lee, W.-J.** and Moss, C. F. (2015). Detection and tracking of fluttering moths by echolocating bats. Presented at *the 169th Meeting of the Acoustical Society of America*, Pittsburgh, PA, USA, May 18-22, 2015.
- Krishnan, A., **Lee, W.-J.**, and Moss, C. F. (2014). Use of multisensory information by flying bats. Presented at *the 2014 Annual meeting of the Society for Neuroscience*, Washington, D.C., USA, November 15-19, 2014.
- Lee, W.-J.**, Sändig, S., Denzinger, A., Schnitzler, H.-U., Horiuchi, T. K., and Moss, C. F. (2014). Reconstructing the acoustic scenes encountered by free-flying, foraging bats. Presented at *the 167th Meeting of the Acoustical Society of America*. Providence, RI, USA, May 5-9, 2014.
- Lee, W.-J.** and Stanton, T. K. (2014). Accounting for the non-Rayleigh echo statistics of individual elongated scatterers in an aggregation. Presented at *the 167th Meeting of the Acoustical Society of America*, Providence, RI, USA, May 5-9, 2014.
- Lee, W.-J.**, Stanton, T. K., and Lavery, A. C. (2012). Estimating numerical density of scatterers in monotype aggregations using the statistics of broadband echoes: applications to fish echoes. Presented at *the 164th Meeting of the Acoustical Society of America*, Kansas City, MO, USA, October 22-26, 2012.
- Ross, T., **Lee, W.-J.**, Keister, J. E., Lara-Lopez, A., and Greene, C. (2012). Broadband acoustics on the VENUS observatory in Saanich Inlet. Presented at *the 2012 Ocean Sciences Meeting*, Salt Lake City, UT, USA, February 20-24, 2012.
- Lavery, A. C., Geyer, W. R., Scully, M. E., Lawson, G. K., Wiebe, P. H., **Lee, W.-J.**, Stanton, T. K., and Fincke, J. R. (2012). Development of high-frequency broadband acoustic scattering techniques for imaging, classification, and quantification of stratified turbulence and zooplankton. Presented at *the 2012 Ocean Sciences Meeting*, Salt Lake City, UT, USA, February 20-24, 2012.
- Lee, W.-J.**, Sayigh, L. S., Jensen, F. J., and Tyack, P. L. (2011). Tonal whistles or burst pulses? Linking potential sound production mechanisms to the classification of toothed whale sounds. Presented at *the 19th Biennial Conference on the Biology of Marine Mammals*, Tampa, FL, USA, November 27-December 2, 2011.

- Lee, W.-J.** and Stanton, T. K. (2011). Statistics of echoes from mixed assemblages of scatterers with different scattering strengths and numerical densities. Presented at *the 162th Meeting of the Acoustical Society of America*, San Diego, CA, USA, October 31-November 4, 2011.
- Lee, W.-J.** and Stanton, T. K. (2010). Analysis of mixed assemblages of fish using the statistics of echoes from a single beam broadband echosounder. Presented at *the 2nd Pan-American/Iberian Meeting on Acoustics*, Cancun, Mexico, November 15-19, 2010.
- Lee, W.-J.**, Lavery, A. C., and Stanton, T. K. (2010). Interpretation of the compressed pulse output for broadband acoustic scattering from inhomogeneous weakly scattering objects. Presented at *the 2nd Pan-American/Iberian Meeting on Acoustics*, Cancun, Mexico, November 15-19, 2010.
- Lee, W.-J.**, Lavery, A. C., and Stanton, T. K. (2009). Broadband acoustic scattering from squid: implications for toothed-whale foraging. Presented at *the 5th Animal Sonar Symposium*, Kyoto, Japan, September 14-18, 2009.
- Lee, W.-J.**, Stanton, T. K., and Lavery, A. C. (2009). Broadband acoustic backscattering from live squid: Experiment and analysis. Presented at *the 157th Meeting of the Acoustical Society of America*, Portland, OR, USA, May 18-22 2009.
- Lee, W.-J.**, Yu, H.-Y., and Chou, L.-S. (2005). Vocalization repertoire of the three stranded rough-toothed dolphins (*Steno bredanensis*) in Danshui River, Taipei, Taiwan. Presented at *the 16th Biennial Conference on the Biology of Marine Mammals*, San Diego, CA, USA, December 12-16 2005.
- Lee, P.-F.**, **Lee, W.-J.**, Chen, Y.-A., Yeh, C.-C., and Chou, L.-S. (2005). Distribution of cetaceans in the waters off eastern Taiwan. Presented at *the 16th Biennial Conference on the Biology of Marine Mammals*, San Diego, CA, USA, December 12-16 2005.
- Lee, W.-J.**, Tsai, P.-Y., Chen, Y.-H., and Chou, L.-S. (2005). Exploration of the behavior and movement patterns of spinner dolphins in North Ilan waters. Presented at *the 8th Animal Behavior and Ecology Conference*, Taichung, Taiwan.

HONORS AND AWARDS

Fellowships, scholarships, and grants

- Data Science Incubator, eScience Institute, University of Washington (2017)
- Young Investigator Travel Grant, Acoustical Society of America (2016)
- SEED (Science & Engineering Enrichment & Development) Postdoctoral Fellowship, Applied Physics Laboratory, University of Washington (2016-2017)
- Frederick V. Hunt Postdoctoral Fellowship in Acoustics, the Acoustical Society of America (2014-2015)
- Ocean Life Institute Student Fellow, Woods Hole Oceanographic Institution (2011-2012)
- Innovative Technology Program Award, Woods Hole Oceanographic Institution (2010-2012)
- Ocean Life Institute Research Funds, Woods Hole Oceanographic Institution (2010-2012)
- Coastal Ocean Institute Student Research Award, Woods Hole Oceanographic Institution (2009)
- Taiwan Merit Scholarships, jointly supported by Taiwan's Ministry of Education, Council for Economic Planning and Development, and National Science Council in Taiwan (2007-2009)

Presentation awards

- Best student paper in Acoustical Oceanography, the 164th Meeting of the Acoustical Society of America, Kansas City, Missouri, USA (October 22-26, 2012)
- Best student paper in Underwater Acoustics, the 2nd Pan-American/Iberian Meeting on Acoustics, Cancun, Mexico (November 15-19, 2010)
- Awards for Outstanding Poster Presentations, the 5th Animal Sonar Symposium, Kyoto, Japan (September 14-18, 2009)
- Best student paper in Acoustical Oceanography, the 157th Meeting of the Acoustical Society of America, Portland, Oregon, USA (May 18-22, 2009)

INSTRUMENT AND SOFTWARE DEVELOPMENT

- Open-source Matlab tools for biosonar beam pattern reconstruction and animal call analysis. https://github.com/leewujung/beam pattern_processing. August 2015 – present.
- A scalable broadband ultrasonic microphone array for bat echolocation research (hardware and software). February – July, 2014.

LABORATORY AND FIELD EXPERIENCE

Laboratory experiment

- Two-dimensional broadband beampattern of Egyptian fruit bat (*Rousettus aegyptiacus*), big brown bat (*Eptesicus fuscus*), Seba's short-tailed fruit bat (*Carollia perspicillata*), and Formosan Leaf-nosed bat (*Hipposideros armiger terasensis*). August-September, 2015
- Concurrent on-head radiation field and two-dimensional beampattern of Risso's dolphin (*Grampus griseus*). April-May, 2015. In collaboration with Dr. Whitlow Au at the Hawai'i Institute of Marine Biology and Dr. Wei-Cheng Yang at the National Chiayi University, Taiwan.
- Broadband acoustic scattering from fluttering moth prey of bats. June, 2014 and December-February, 2015.
- Broadband acoustic scattering from live squid. June-August, 2008.

Field experience

- VISIONS'17: Ocean Observatories Initiative (OOI) Cabled Array maintenance cruise. August 20-27, 2017.
- NOAA Northwest Fisheries Science Center 2017 hake acoustic-trawl survey. July 23-August 7, 2017
- Zooplankton patchiness and ecosystem dynamics at the shelf break, led by Dr. Gareth Lawson. September 21-30, 2010 and October 26-November 6, 2010.
- Broadband acoustic studies of fish in Georges Bank and the Gulf of Maine, led by Dr. Timothy Stanton. September 8-18, 2010.
- Active acoustic and net sampling of zooplankton in Saanich Inlet, British Columbia, Canada, led by Drs. John Horne, Julie Keister, and Charles Greene. July 30-31, 2009.
- Various day trips for at-sea instrument test near Cape Cod, MA. 2007-2012.
- Behavioral observation and visual survey of marine mammals in the waters off Taiwan. 2003-2006.

PROFESSIONAL ACTIVITIES

- Associate Editor for the Journal of the Acoustical Society of America Express Letters (JASA-EL)
- Subject Matter Expert (SME) for the Bio-acoustic sonar for the Ocean Observatories Initiative (OOI)
- Reviewer for:
 - Journal of the Acoustical Society of America
 - Limnology and Oceanography
 - Proceedings of the National Academy of Science
 - Scientific Reports
 - Fisheries Research
 - Frontiers in Behavioral Neuroscience
 - Acta Acustica united with Acustica
 - Animal Behaviour
 - PLOS ONE
 - Journal of Marine Science and Technology
- Member of the Technical Committees in Acoustical Oceanography (TCAO) and Animal Bioacoustics (TCAB), Acoustical Society of America
- Member of:
 - Acoustical Society of America
 - IEEE Oceanic Engineering Society, Signal Processing Society, Women in Engineering Society
- Member of the Woods Hole Oceanographic Institution Diversity Committee (2012-2013)

TEACHING, MENTORING, AND OUTREACH

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| 2017-present | Research mentor for undergraduate students in the Department of Electrical Engineering and Department of Physics, University of Washington, Seattle. |
| December 2016 | Guest lecturer for university-wide General Education Lectures, National Cheng Kung University, Taiwan |
| 2013-2015 | Research mentor for graduate and undergraduate students in the Department of Psychological and Brain Sciences, Johns Hopkins University, and the Neuroscience and Cognitive Science Program, University of Maryland |

- April 2013 **Co-organizer and lecturer** (acoustics and signal processing), Bioacoustics workshop, National Museum of Natural Science, Taichung, Taiwan
- April 2013 **Guest lecturer**, on women in science and engineering in Gender Equality Education, National Pingtung University of Education, Pingtung, Taiwan
- September 2011 **Presenter and panelist** in the Ocean Science Journalism workshop, Woods Hole Oceanographic Institution
- 2003-2006 **Trainer for marine mammal visual observer and stranding response**, Cetacean Lab, Institute of Ecology and Evolutionary Biology, National Taiwan University
- 2002 **Co-organizer**, National Taiwan University Summer Camp for Cetacean and the Ocean, for high school students, Hualien, Taiwan
- 2002 **Tutor** (mathematics and natural sciences) for elementary school and high school students in aboriginal Katipul Village, Taitung, Taiwan
- 2002-2006 **Lecturer** (marine mammal biology) for elementary school outreach program, Taiwan Cetacean Society
- July-August 2011 **Wildlife and geology interpreter** on dolphin-watching boats, Ilan, Taiwan
- 2000-2003 **Tutor** (mathematics and physics) for high school students