WU-JUNG LEE

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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

RESEARCH INTERESTS

I integrate interdisciplinary skills in acoustics, signal processing, and biology to develop both physics-based models and data-driven methods to better observe the rapidly-changing ocean using sound. My research focuses on two fundamental aspects of achieving high confidence acoustic sensing:

- Sampling – what can we do to collect better information?
- Inference – how do we make reliable interpretation of echo information?

Under these overarching themes, I am working to expand sonar sensing capability for marine ecosystem monitoring at large temporal and spatial scales. I also use echolocating animals as biological models to inspire adaptive sampling strategies in the context of acoustic sensing. I am an active contributor to open-source community-driven software tools, and am a strong advocate for reproducible research and best practices in ocean sciences and acoustics.

CURRENT AND PAST POSITIONS

2019–	**Senior Oceanographer, Principle Investigator**, Applied Physics Laboratory, University of Washington
2018–	**Faculty**, University of Washington Institute for Neuroengineering (UWIN)
2016–2018	**Research Associate (with Principle Investigator status)**, Applied Physics Laboratory, University of Washington Supervisors: Drs. Dajun Tang, Sarah Webster and Eric Thorsos
2013–2015	**F.V. Hunt Postdoctoral Fellow**, Department of Psychological and Brain Sciences, Johns Hopkins University (lab relocated from University of Maryland in Spring 2014) Advisor: Dr. Cynthia Moss
2007–2013	**Graduate student**, Woods Hole Oceanographic Institution Advisors: Drs. Timothy Stanton and Andone Lavery (acoustic scattering) Dr. Peter Tyack (marine mammal)
2007	**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
2005	**Intern**, BioSonar Project, Acoustic Research Laboratory, Tropical Marine Science Institute, National University of Singapore
2004–2005	**Research Assistant**, Cetacean Laboratory, Institute of Ecology and Evolutionary Biology, National Taiwan University
2003–2005	**Research Assistant**, Spatial Ecology Laboratory, Institute of Ecology and Evolutionary Biology, National Taiwan University

PEER-REVIEWED PAPERS

Lee, W.-J., Tang, D., Stanton, T. K, Thorsos, E. I. (2018) Macroscopic observations of diel fish movements around a shallow water artificial reef using a mid-frequency horizontal-looking sonar. *Journal of the Acoustical Society of America*, 144(3), 1424-1434.

Stanton, T. K., **Lee, W.-J.**, and Baik, K. (2018) Sonar echo statistics associated with discrete scatterers: A tutorial on physics-based methods. *Journal of the Acoustical Society of America*, *in press*.

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-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.

MANUSCRIPTS IN PREPARATION

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.*

Lee, W.-J., Yu, H.-Y., Au, W.W.L., Smith, A., Jen, I.-F., Yang,W.-C., Fan, Y.-C., Nachtigall, P.E., Chiou, L.-S. Modal changes of echolocation beamwidth by a foraging Risso's dolphin. *In preparation; figures 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

Fruit bat's locating clicks echo sophisticated radar. Reuters | Video – Technology, April 22, 2018.

Navigating with the tongue, the Egyptian fruit bat way! Research Matters, April 3, 2018.

Phased arrays & the Egyptian fruit bat. Lab Animal Magazine, February, 2018.

Fruit bat's echolocation may work like sophisticated surveillance sonar. UW Today, February 6, 2018.

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.
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 6, 2010; January 12, 2012.

SELECTED CONFERENCE PRESENTATIONS

Lee, W.-J. and Staneva, S. (2018) Exploring matrix and tensor factorization for discovering latent structures in large echosounder datasets. *The 176th Meeting of the Acoustical Society of America and the 2018 Acoustics Week in Canada*. Victoria, BC, Canada, November 5-9, 2018.

Lee, W.-J., Staneva, S., Herman, B., Aravkin, A. (2018) Data-driven decomposition of ocean observatory echosounder time series for ecological insights. *The 2018 Ocean Sciences Meeting*, Portland, OR, USA, February 11-16, 2018.

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. *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. *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. *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*. *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. *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. *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. *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. *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. *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. *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. *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. *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. *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. *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. *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. *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 strayed rough-toothed dolphins (*Steno bredanensis*) in Danshui River, Taipei, Taiwan. *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. *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. *The 8th Animal Behavior and Ecology Conference*, Taiwan.

GRANTS AND CONTRACTS

My research program has attracted funding from diverse funding sources, including the National Science Foundation, Office of Naval Research, and National Oceanic and Atmospheric Administration. I also lead the organization of the first Oceanhackweek via a contract with the Consortium of Ocean Leadership.

($ home institution component)

National Science Foundation, Division of Ocean Sciences, 2019-2020
Principal Investigator ($281,608)
"EAGER: Developing a temporally adaptive decomposition framework for analyzing long-term echosounder time series"
Collaborator: Valentina Staneva, University of Washington

Office of Naval Research, Ocean Acoustics, 2018-2021
Key Investigator ($403,000)
"MURI: Active sensing in echolocating humans and marine mammals"
Collaborators: Barbara C. Shinn-Cunningham, Carnegie Mellon University; Peter L. Tyack, University of St. Andrews; John B. Buck, University of Massachusetts, Dartmouth; Kenneth Shorter, University of Michigan

NOAA Fisheries, Advanced Sampling Technology Work Group, 2018-2019
Co-Principal Investigator ($84,193)
"Broadband acoustic species identification and enumeration using trans-dimensional Bayesian inversion"
Collaborators: Dezhang Chu, Northwest Fisheries Science Center; Stan Dosso, University of Victoria

Consortium of Ocean Leadership, 2018
Lead organizer ($109,265)
"Oceanhackweek 2018: A hands-on, community-driven workshop on ocean observatory data science"
Collaborators: Robert Fatland, Amanda Tan, Valentina Staneva, Friedrich Knuth, Landung Satiewan, Aaron Marburg, University of Washington

HONORS AND AWARDS

- SEED Postdoctoral Fellowship, Applied Physics Laboratory, University of Washington (2016-2017)
- Young Investigator Travel Grant, Acoustical Society of America (2016)
- Frederick V. Hunt Postdoctoral Fellowship in Acoustics, the Acoustical Society of America (2014-2015)
- Best student papers in Acoustical Oceanography (ASA 157th, 2009; ASA164th, 2012), Underwater Acoustics (ASA 160th, 2010)
- 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)
- Awards for Outstanding Poster Presentations, the 5th Animal Sonar Symposium, Kyoto, Japan (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)

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
  - Proceedings of the National Academy of Science
  - Limnology and Oceanography
  - 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)

INSTRUMENT AND SOFTWARE DEVELOPENT

- Echopype: an open-source package for echosounder data conversion and analysis in Python. https://github.com/OSOceanAcoustics/echopype. April 2017 – present.
- An open-source package for beampattern reconstruction and analysis in Matlab. https://github.com/leewujung/beampattern_processing. August 2015 – present.
- A scalable broadband ultrasonic microphone array for bat echolocation research (hardware and software). February – July, 2014.

LABORATORY AND FIELD EXPERIENCE

Field experience

- VISIONS'17; VISIONS'18: Ocean Observatories Initiative (OOI) Cabled Array maintenance cruise. August 20-27, 2017; July 19-August 5, 2018.
- 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.

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.

TEACHING, MENTORING, AND OUTREACH

2018 August	**Lead organizer** for Oceanhackweek 2018 at University of Washington, Seattle.
2018 February	**Lead organizer** for Cabled Array Hackweek at University of Washington, Seattle.
2018–present	**Co-organizer** for the Big Acoustic Data Analysis Working Group (BADAWG) at University of Washington, Seattle.
2017–present	**Research mentor** for undergraduate students in the Department of Electrical Engineering and Department of Physics, University of Washington, Seattle.
May 2018	**Guest lecturer** for Wildlife Sciences Seminar to non-science background undergraduate students, University of Washington
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