

William T. Gough, PhD

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EMPLOYMENT

- 10-2022 – Present University of Hawaii at Manoa (HIMB), Hawaii
Post-Doctoral Fellow
- Building capacity within Hawaii and the MMRP (Marine Mammal Research Program) for use of biologging technologies and analysis of accelerometry data.
 - Special focus on marine mammal species of interest to Navy such as the humpback whale, false killer whale, and Hawaiian monk seal.
 - Principal Investigator (Dr. Lars Bejder)

EDUCATION

- 08-2017 – 08-2022 Stanford University (Hopkins Marine Station), California
PhD., Biology
- Dissertation: Energetic Tradeoffs at Extreme Body Size. (Major Advisor: Dr. Jeremy Goldbogen)
- 08-2015 – 05-2017 West Chester University, Pennsylvania
M.S., Biology
- Thesis: Morphology and Compressive Stiffness of the Core Fibrous Layer of the Cetacean Tail Fluke. (Major Advisor: Dr. Frank Fish)
- 08-2010 – 05-2014 Cornell University, New York
B.S., Animal Science
- Thesis: Laterality of the Raised Leg Urinary Posture in Domestic Dogs (*Canis lupus familiaris*). (Major Advisor: Dr. Betty McGuire)

JOURNAL PUBLICATIONS

1. Fish, F.E., Nicastro, A.J., Cardenas, K.L., Segre, P.S., **Gough, W.T.**, Kahane-Rapport, S.R., St. Leger, J., Goldbogen, J.A. (2023) Spin-leap performance by cetaceans is influenced by moment of inertia. *In Prep*. (Data creation)
2. Cade, D.E., Kahane-Rapport, S.R., **Gough, W.T.**, Bierlich, K.C., Linsky, J.M.J., Calambokidis, J., Johnston, D.W., Goldbogen, J.A. and Friedlaender, A.S. (2023). Minke whale feeding rate limitations suggest constraints on the minimum body size for engulfment filtration feeding. *Nature Ecology & Evolution* **7**: 535-546. (Data creation, Experimental analysis).
3. Segre, P.S., di Clemente, J., Kahane-Rapport, S.R., **Gough, W.T.**, Meyer, M.A., Lombard, A.T., Goldbogen, J.A. and Penry, G.S. (2022). High-speed chases along the seafloor put Bryde's whales at risk of entanglement. *Conservation Science and Practice* **4**: e12646. (Data creation).
4. **Gough, W.T.**, Cade, D.E., Czapanskiy, M.F., Potvin, J., Fish, F.E., Kahane-Rapport, S.R., Savoca, M.S., Bierlich, KC, Johnston, D.W., Friedlaender, A.S., Szabo, A., Bejder, L. and Goldbogen, J.A. (2022). Fast and furious: energetic tradeoffs and scaling of high-speed foraging in rorqual whales. *Integrative and Organismal Biology* **4**: obac038. (Conceptualization, Data creation, Experimental design, Manuscript writing)
5. Segre, P.S., **Gough, W.T.**, Roualdes, E.A., Cade, D.E., Czapanskiy, M.F., Fahlbusch, J., Kahane-Rapport, S.R., Oestreich, W.K., Bejder, L., Bierlich, K.C., Burrows, J.A., Calambokidis, J., Chenoweth, E.M., Di Clemente, J., Durban, J.W., Fearnbach, H., Fish, F.E., Friedlaender, A.S., Hegelund, P., Johnston, D.W., Nowacek, D.P., Oudejans, M.G., Penry, G.S., Potvin, J., Simon, M., Stanworth, A., Straley, J.M., Szabo, A., Videsen, S.K.A., Visser, F., Weir, C.R., Wiley, D.N. and Goldbogen, J.A. (2022). Scaling of maneuvering performance in baleen whales: larger whales outperform expectations. *Journal of Experimental Biology* **225**: jeb243224. (Data creation, Experimental analysis)

6. Cade, D.E., **Gough, W.T.**, Czapanskiy, M.F., Fahlbusch, J.A., Kahane-Rapport, S.R., Linsky, J.M.J., Nichols, R.C., Oestreich, W.K., Wisniewska, D.M., Friedlaender, A.S. and Goldbogen, J.A. (2021). Tools for integrating inertial sensor data with video bio-loggers, including estimation of animal orientation, motion, and position. *Animal Biotelemetry* **9**: 1-21. (Conceptualization, Data creation, Experimental design, Manuscript writing)
7. Savoca, M.S., Czapanskiy, M.F., Kahane-Rapport, S.R., **Gough, W.T.**, Fahlbusch, J.A., Bierlich, K.C., Segre, P.S., Di Clemente, J., Penry, G.S., Wiley, D.N., Calambokidis, J., Nowacek, D.P., Johnston, D.W., Pyenson, N.D., Friedlaender, A.S., Hazen, E.L. and Goldbogen, J.A. (2021). Baleen whale prey consumption based on high resolution foraging measurements. *Nature* **599**: 85-90. (Data creation, Experimental analysis)
8. Modest, M., Irvine, L., Andrews-Goff, V., **Gough, W.T.**, Johnston, D., Nowacek, D., Pallin, L., Read, A., Moore, R.T. and Friedlaender, A. (2021). First description of migratory behavior of humpback whales from an Antarctic feeding ground to a tropical calving ground. *Animal Biotelemetry* **9**: 42. (Experimental analysis)
9. Czapanskiy, M.F., Savoca, M.S., **Gough, W.T.**, Segre, P.S., Wisniewska, D.M., Cade, D.E. and Goldbogen, J.A. (2021). Modelling short-term energetic costs of sonar disturbance to cetaceans using high-resolution foraging data. *Journal of Applied Ecology* **58**: 1643-1657. (Experimental design, Experimental analysis)
10. Fish, F.E., Sheehan, M.J., Adams, D.S., Tennett, K.A. and **Gough, W.T.** (2021). A 60:40 split: differential mass support in dogs. *Anatomical Record* **304**: 78-89. (Experimental analysis)
11. **Gough, W.T.**, Smith, H.J., Savoca, M.S., Czapanskiy, M.F., Fish, F.E., Potvin, J., Bierlich, K.C., Cade, D.E., Di Clemente, J., Kennedy, J., Segre, P.S., Stanworth, A., Weir, C.R. and Goldbogen, J.A. (2021). Scaling of oscillatory kinematics and Froude efficiency in baleen whales. *Journal of Experimental Biology* **224**: jeb237586. (Conceptualization, Data creation, Experimental design, Experimental analysis, Manuscript writing)
12. Segre, P.S., Potvin, J., Cade, D.E., Calambokidis, J., Di Clemente, J., Fish, F.E., Friedlaender, A.S., **Gough, W.T.**, Kahane-Rapport, S.R., Oliveira, C., Parks, S.E., Penry, G.S., Simon, M., Stimpert, A.K., Wiley, D.N., Bierlich, K.C., Madsen, P.T. and Goldbogen, J.A. (2020). Energetic and physical limitations on the breaching performance of large whales. *eLife* **9**. (Conceptualization, Data creation, Experimental design, Experimental analysis, Manuscript writing)
13. Goldbogen, J.A., Cade, D.E., Wisniewska, D.M., Potvin, J., Segre, P.S., Savoca, M.S., Hazen, E.L., Czapanskiy, M.F., Kahane-Rapport, S.R., DeRuiter, S.L., Gero, S., Tønnesen, P., **Gough, W.T.**, Hanson, M.B., Holt, M.M., Jensen, F.H., Simon, M., Stimpert, A.K., Arranz, P., Johnston, D.W., Nowacek, D.P., Parks, S.E., Visser, F., Friedlaender, A.S., Tyack, P.L., Madsen, P.T. and Pyenson, N.D. (2019). Why whales are big but not bigger: Physiological drivers and ecological limits in the age of ocean giants. *Science* **366**: 1367–1372. (Data creation, Experimental analysis, Manuscript writing)
14. Goldbogen, J.A., Cade, D.E., Calambokidis, J., Czapanskiy, M.F., Fahlbusch, J.A., Friedlaender, A.S., **Gough, W.T.**, Kahane-Rapport, S.R., Savoca, M.S., Ponganis, K.V. and Ponganis, P.J. (2019). Extreme bradycardia and tachycardia in the world's largest animal. *Proceedings of the National Academy of Sciences* **4**: 25329-25332. (Data creation, Manuscript writing)
15. **Gough, W.T.**, Segre, P.S., Bierlich, K.C., Cade, D.E., Potvin, J., Fish, F.E., Dale, J., Di Clemente, J., Friedlaender, A.S., Johnston, D.W., Kahane-Rapport, S.R., Kennedy, J., Long, J.H., Oudejans, M., Penry, G., Savoca, M.S., Simon, M., Videsen, S.K.A., Visser, F., Wiley, D.N. and Goldbogen, J.A. (2019). Scaling of swimming performance in baleen whales. *Journal of Experimental Biology* **222**: jeb204172. (Conceptualization, Data creation, Experimental design, Experimental analysis, Manuscript writing)
16. **Gough, W.T.**, Fish, F.E., Wainwright, D.K. and Bart-Smith, H. (2018). Morphology of the core fibrous layer of the cetacean tail fluke. *Journal of Morphology* **279**: 757-765. (Conceptualization, Data creation, Experimental design, Experimental analysis, Manuscript writing)

17. McGuire, B. and **Gough, W.T.** (2017). Body size influences urinary posture but not hindlimb laterality in shelter dogs. *Journal of Veterinary Behavior: Clinical Applications and Research* **21**: 38-44. (Experimental design, Manuscript writing)
18. **Gough, W.T.** and McGuire, B. (2015). Urinary Posture and Motor Laterality in Dogs (*Canis lupus familiaris*) at Two Shelters. *Applied Animal Behaviour Science* **168**: 61-70. (Conceptualization, Data creation, Experimental design, Experimental analysis, Manuscript writing)
19. **Gough, W.T.**, Farina, S.C. and Fish, F.E. (2015). Aquatic Burst Locomotion by Hydroplaning and Paddling in Common Eiders (*Somateria mollissima*). *Journal of Experimental Biology* **218**: 1632-1638. (Eider duck photograph accepted for the month of July in the Journal of Experimental Biology Annual Calendar). (Data creation, Experimental design, Experimental analysis, Manuscript writing)

CONFERENCE ABSTRACTS

1. 2022 - **Gough, W.T.**, Cade, D.E., Potvin, J., Kahane-Rapport, S., Goldbogen, J.A. Scaling of lunge feeding kinematics and energetics in baleen whales. (Oral Talk – 24th Biennial Conference on the Biology of Marine Mammals, Palm Beach, FL)
2. 2022 - **Gough, W.T.**, Cade, D.E., Potvin, J., Kahane-Rapport, S., Goldbogen, J.A. Scaling of lunge feeding kinematics and energetics in baleen whales. (Oral Talk – Annual Meeting of the Society for Integrative and Comparative Biology, Phoenix, AZ)
3. 2022 - Fish, F.E., **Gough, W.T.***, Goldbogen, J.A. Avoiding the tyranny of wave drag in large whales. (Oral Talk – Annual Meeting of the Society for Integrative and Comparative Biology, Phoenix, AZ)
4. 2020 - **Gough, W.T.**, Cade, D.E.*, Potvin, J., Kahane-Rapport, S.R., Goldbogen, J.A. Scaling of lunge feeding kinematics in baleen whales. (Poster – Ocean Science Meeting, San Diego, CA)
5. 2020 – Czapanskiy, M.F., Savoca, M.S., **Gough, W.T.**, Cade, D.E.*, Segre, P.S., Goldbogen, J.A. and Wisniewska, D.M. Large baleen and small toothed whales face greatest energetic consequences from sonar disturbance. (Poster – Ocean Science Meeting, San Diego, CA)
6. 2020 - Smith, H.J., **Gough, W.T.**, Goldbogen, J.A., Savoca, M.S., Czapanskiy, M.F., Fish, F.E., Potvin, J., Bierlich, K.C. and Kennedy, J. The physics of whale movement: drag and thrust production to measure whale propulsive efficiency. (Poster – Ocean Science Meeting, San Diego, CA)
7. 2020 - **Gough, W.T.**, Cade, D.E., Potvin, J., Kahane-Rapport, S.R., Goldbogen, J.A. Scaling of lunge feeding kinematics in baleen whales. (Poster – Annual Meeting of the Society for Integrative and Comparative Biology, Austin, TX)
8. 2020 - Smith, H.J., **Gough, W.T.***, Savoca, M.S., Czapanskiy, M.F., Fish, F.E., Potvin, J., Cade, D.E., Bierlich, K.C., Kennedy, J. and Goldbogen, J.A. The physics of whale movement: drag and thrust production to measure whale propulsive efficiency. (Poster – Annual Meeting of the Society for Integrative and Comparative Biology, Austin, TX)
9. 2019 - **Gough, W.T.**, Segre, P., Bierlich, K.C., Cade, D., Potvin, J., Fish, F., Dale, J., Di Clemente, J., Friedlaender, A., Johnston, D., Kahane-Rapport, S., Kennedy, J., Long, J., Oudejans, M., Penry, G., Savoca, M., Simon, M., Videsen, S., Visser, F., Wiley, D. and Goldbogen, J. Scaling of swimming performance in the largest animals (Lightning Talk – World Marine Mammal Conference, Barcelona, Spain)
10. 2019 - **Gough, W.T.**, Segre, P.S., Cade, D.E., Fish, F.E., Kennedy, J.H., Sienkiewicz, R., Potvin, J. and Goldbogen, J.A. Comparative kinematics and hydrodynamics of mysticete cetaceans: morphological and ecological correlates with swimming performance. (Oral Talk - Annual Meeting of the Society for Integrative and Comparative Biology, Tampa, FL)

11. 2019 - Sheehan, M.J., Fish, F., Adams, D.S., Tennett, K.A. and **Gough, W.T.** A 60/40 split: differential weight support in dogs. (Poster - Annual Meeting of the Society for Integrative and Comparative Biology, Tampa, FL).
12. 2017 - **Gough, W.T.**, Fish, F., Wainwright, D., Lewis, G. and Bart-Smith, H. Physical properties and anisotropy in the central tissue layer of cetacean tail flukes. (Poster - 22nd Biennial Conference of the Society for Marine Mammalogy, Halifax, Nova Scotia, Canada).
13. 2017 - **Gough, W.T.**, Fish, F.E., Lewis, G.A. and Bart-Smith, H. Physical properties and anisotropy in the central tissue layer of cetacean tail flukes. (Oral Talk - Annual Meeting of the Society for Integrative and Comparative Biology, New Orleans, LA)
14. 2017 - Adams, D.S., Gallagher, E., **Gough, W.T.**, Tennett, K.A. and Fish, F.E. Passive spanwise flexibility of harbor porpoise flukes: equivalence of dorsal and ventral flexion. (Poster - Annual Meeting of the Society for Integrative and Comparative Biology, New Orleans, LA).
15. 2016 - **Gough, W.T.**, Wainwright, D.K. and Fish, F.E. Micro-CT scanning the cetacean tail fluke. (Oral Talk - Mid-Atlantic Regional Meeting of the Society for Integrative and Comparative Biology, Newark, NJ)
16. 2016 - **Gough, W.T.**, Fish, F.E. and Bart-Smith, H. Physical properties of the sub-dermal fibrous layer in cetacean tail flukes. (Poster - 11th International Congress of Vertebrate Morphology, Washington, DC)
17. 2016 - **Gough, W.T.**, Fish, F.E. and Bart-Smith, H. Physical properties of the sub-dermal fibrous layers in cetacean tail flukes. (Poster - Annual Meeting of the Society for Integrative and Comparative Biology, Portland, OR).
18. 2016 - Fish, F.E., **Gough, W.T.**, Tennett, K.A., Adams, D.S. and St Leger, J. Flexibility of the flukes of free-swimming cetaceans. (Oral Talk - Annual Meeting of the Society for Integrative and Comparative Biology, Portland, OR)
19. 2015 - **Gough, W.T.**, Fish, F.E. and Bart-Smith, H. Physical properties of the sub-dermal fibrous layers in cetacean tail flukes. (Oral Talk - Mid-Atlantic Regional Meeting of the Society for Integrative and Comparative Biology, Newark, NJ)
20. 2013 - **Gough, W.T.**, Farina, S.C. and Fish, F.E. Burst locomotion by hydroplaning and running in Common Eiders (*Somateria mollissima*). (Oral Talk - Annual Meeting of the Society for Integrative and Comparative Biology, Austin, TX)
21. 2013 - **Gough, W.T.**, Farina, S.C. and Fish, F.E. Aquatic burst locomotion by hydroplaning and running in female Common Eiders (*Somateria mollissima*). (Poster - 10th International Congress of Vertebrate Morphology, Barcelona, Spain)
22. 2013 - **Gough, W.T.**, Farina, S.C. and Fish, F.E. Aquatic burst locomotion by hydroplaning and running in female Common Eiders (*Somateria mollissima*). (Poster - Annual Meeting of the Society for Experimental Biology, Valencia, Spain)

TEACHING

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| 2023 | Marine Mammal Science and Conservation (MBIO 650) (~6 students) <ul style="list-style-type: none"> • University of Hawaii at Manoa (HIMB) led by Dr. Lars Bejder • Led two days of teaching / training related to the history and modern usage of biologging technologies. |
| 2020 | Biologging Tag Data Processing Workshop (~50 attendees) <ul style="list-style-type: none"> • Stanford University / UC Santa Cruz in collaboration with Dr. David Cade. • Co-designed / co-instructed a week-long workshop to train members of the scientific community to 1) properly setup and deploy archival biologging tags, 2) process the resulting data into useable formats, and 3) design |

- experiments to answer novel biomechanical, behavioral, or physiological questions.
- 2018 Biologging and Biotelemetry (BIOHOPK 234H) (~10 students)
- Stanford University (Hopkins Marine Station) led by Dr. Jeremy Goldbogen.
 - Assisted with class preparation and activities to train students on the proper use and potential utility of biologging devices.
- 2018 Animal and Plant Physiology (BIO 84) (~ 40 students)
- Stanford University led by Drs. Craig Heller, Robert Sapolsky, and Jose Dinneny.
 - Led two weekly discussion sessions to reinforce lecture material focused on multiple physiological processes in plant and animal systems.
 - Proctored exams and assisted with grading of all class materials.
- 2013 - 2014 Anatomy and Function of Marine Vertebrates (BIOSM 3210)
- Cornell University (Shoals Marine Laboratory) led by Dr. Frank Fish
 - Helped students develop and complete individual, research-based final projects pertaining to multiple marine vertebrate lineages.
 - Prepared lab and dissection materials and assisted with grading class materials.
- 2013 Vertebrate Anatomy, Physiology, and Evolution (BIOEE 2740)
- Cornell University led by Dr. Betty McGuire.
 - Assisted with lab material preparation and proctoring of laboratory examinations.

MENTORING

- Samantha Salaz Summer Internship – 2023
- Comparing accelerometry and video methods for measuring duration and frequency of nursing events in Maui humpback whale calves.
- Trevor Thompson Summer Internship – 2023
- Comparing the kinematics of bubble-net feeding in humpback whales from multiple distinct geographic regions.
- Isabella Venegas Salinas High School Internship – 2022
- Measured the rotation of orca whales performing kick-feeding behaviors using five biologging tags deployed in Norway.
- Hayden Smith CSUMB REU Summer Program – 2019
- Quantifying the physics and efficiency of whale movement across scale through the calculation of drag and thrust.
- Resulting in a co-first authored publication (Gough et al., 2021)**
- Xitlaali Castellanos Salinas High School Internship – 2019
- Quantifying the swimming performance of humpback whales using a tail-attached tag.
 - **Resulting in an acknowledgement (Gough et al., 2019)**

OUTREACH

- 2019 - 2022 Stanford University – Salinas High School Internship Program
- Co-led design and logistics for a partnered internship between Hopkins Marine Station and Salinas High School.
 - Managed pairings of 8-10 high school interns per year with graduate student / post-doctoral mentors.
 - Designed final seminars to give interns a chance to present their work to their peers and parents.
- 2019 Pacific Grove Natural History Museum – Science Saturday
- Presented cetacean research to a public audience of adults and children
- 2015 American Museum of Natural History – Milstein Science Series

2013 - 2014

- Presented simple marine biomechanics and locomotion concepts to a public audience of adults and children.
- Cornell University – Expand Your Horizons
- Assisted and led scientific activities for a group of 15-20 7th grade girls.

GRANTS

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| 2019 | \$7000 – Lederberg Award – Hopkins Marine Station |
| 2018 | \$500 – Travel Grant – Stanford Biosciences Office of Graduate Education |
| 2013 | \$500 – Travel/Housing Award – Cornell College of Agriculture and Life Sciences |
| 2013 | \$500 – Travel Grant – Cornell Department of Undergraduate Biology |
| 2011 | \$500 – Henry E. and Nancy Horton Bartels Scholarship – Shoals Marine Laboratory |

FIELDWORK

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| 2023 – Present | Underwater behavior of Hawaiian monk seals <ul style="list-style-type: none">• Primary Collaborators – Dr. Stacie Robinson, Dr. Charles Littnan, Kirby Parnell• Tagging Hawaiian monk seals using animal-borne data loggers and analysis of resultant kinematic data. |
| 2017 – Present California, USA Massachusetts, USA Hawaii, USA Alaska, USA Plettenberg Bay, SA | Biomechanics of large rorqual whales and “Blackfish” dolphins <ul style="list-style-type: none">• Primary Collaborators – Dr. Jeremy Goldbogen, Dr. Dave Cade, Dr. Ari Friedlaender, Dr. David Johnston, Dr. David Wiley, Dr. Lars Bejder, Dr. Andy Szabo, Dr. Gwenith Penry, Jens Currie• Tagging whales and dolphins using animal-borne data loggers and analysis of resultant kinematic data, with use of morphological UAS drone data for further scaling analyses. |
| 2013 – 2015 Maine, USA | Kinematics of escape behaviors in Common Eider ducks <ul style="list-style-type: none">• Primary Collaborators – Dr. Frank Fish, Dr. Stacy Farina• Observational and video data collection of swimming Common Eider ducks in the waters surrounding Shoals Marine Laboratory. |
| 2012 – 2015 New York, USA | Scent-marking behavior in domesticated dogs <ul style="list-style-type: none">• Primary Collaborator – Dr. Betty McGuire• Collection of urinary behavior data during weekly dog walks at local SPCA shelters. |

REFEREE/REVIEWER STATUS

Journal of Experimental Biology
Science Advances
Marine Mammal Science