

**Patrick James O'Malley Miller**  
*Curriculum vitae*

Professor of Biology  
Sea Mammal Research Unit, Gatty Marine Laboratory  
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**Research Interests:** My research focuses on ecology and behaviour of marine mammals, and the advancement of methodological techniques including ocean and tagging instrumentation. Specific research interests include: acoustic communication and social behaviour, diving physiology and ecology, foraging behaviour, the role of diving predators in the marine ecosystem, and effects of anthropogenic noise.

**Languages:** English, Italian, Japanese

**Education:**

- PhD in Biological Oceanography, Joint degree from the Woods Hole Oceanographic Institution, Woods Hole, MA and the Massachusetts Institute of Technology, Cambridge, MA. September 2000. Thesis: "Maintaining contact: design and use of acoustic signals in killer whales, *Orcinus orca*". Advisor: Peter L. Tyack
- Bachelor of Science in Zoology, University of Washington, Seattle; with distinction, 1994
- Bachelor of Science in Foreign Service, Georgetown University, Washington, DC; Japanese/Asian Studies Certificate. Study Abroad: Sophia University, Tokyo, 1988.

**Work Experience:**

- School of Biology, Sea Mammal Research Unit, University of St. Andrews, April 2006 - present. Senior Research Fellow and Lecturer (appointed June 2007) promoted to Reader (August, 2013) and Professor (2016) studying: acoustic communication, marine ecology sensory ecology, diving and foraging in marine mammals, buoyancy and body condition, effects of anthropogenic disturbance.
- Atmosphere and Ocean Research Institute, University of Tokyo, Tokyo, Japan, June–Sept 2006; Oct–Nov 2011; Sept–Dec 2015; Oct 2021–May 2022. Visiting Professor. Behavioural ecology of marine top predators using the bio-logging method.
- Sea Mammal Research Unit, University of St. Andrews, October 2002 – April 2006. Royal Society USA/Canada Research Fellow studying the influence of underwater sound on the ecology of deep-diving mammals.
- Sea Mammal Research Unit, University of St. Andrews, October 2004 – October 2005. Head of instrumentation group with 6 engineering staff developing and commercializing world-class instruments for the study of marine mammal behaviour.
- Woods Hole Oceanographic Institution,. Postdoctoral Investigator (2000-3) & Guest Investigator (2003-present). Studying diving and communication of sperm whales, effects of anthropogenic noise on whale behavior using a digital acoustic tag.
- Massachusetts Institute of Technology, 2001-2002. Postdoctoral Associate. Used human-speech processing algorithms to develop and analyse corpus of killer whale sounds recorded with a beamforming hydrophone array.

- Chuo Trust & Banking, New York Branch. 1989-1991. Assistant VP, loan officer.

#### **Fieldwork Experience:**

- Miller has substantial field experience conducting complex field methodologies with cetaceans, including: tagging using pole and aerial launching systems, biopsy sample collection, playback of natural and anthropogenic sounds, photo-identification, photogrammetry, towed and fixed passive acoustics, and active acoustic scanning of marine mammals. Miller has been permit holder on several Canadian, Icelandic and Norwegian permits, and a listed operator on several US and Norwegian permits.

#### **Fellowships and Awards:**

- Kobe Prize for advances in Marine Biology, 2013. Awarded in recognition of fundamental advances in our understanding of the sperm whale.
- Royal Society International (USA) Fellow, October 2002 – April 2006. Research fellowship to study the ecological influence of sound on deep-diving mammals at the Sea Mammal Research Unit, University of Saint Andrews, Scotland.
- Ruth and Paul Fye Award for Excellence, 2001, for best student paper in Biological Oceanography from 1994-2000 for Miller & Tyack, 1998, Deep-Sea Research II.
- National Science Foundation Graduate Fellow, 1994-1997.

#### **Peer Review Publications (co-authors under my lab supervision listed in *italics*):**

- Wensveen, P.J., Isojunno, S., Kvadsheim, P.H., Lam, F.P.A., Curé, C, von Benda-Beckmann, A.M. **Miller**, P.J.O. in revision. Distance matters to sperm whales: Behavioural disturbance in response to both sonar received level and source distance.
- Woo, K.Y, *Isojunno*, S. and **Miller**, P. J. O. 2023. Habitat use of the northern bottlenose whale *Hyperoodon ampullatus* near Jan Mayen, North Atlantic. *Marine Ecology Progress Series* 717: 119-136. <https://doi.org/10.3354/meps14374>
- Adachi*, T., Lovell, P., Turnbull, J., Fedak, M., Picard, B., Guinet, C., Biuw, M., Keates, T.R., Holser, R. R., Costa, D. P., Crocker, D. E. and **Miller**, P.J.O. 2023. Body condition changes at sea: onboard calculation and telemetry of body density in diving animals. *Methods in Ecology and Evolution* 00:1–18 DOI: 10.1111/2041-210X.14089
- Burslem*, A., *Isojunno*, S., Pirota, E., **Miller**, P.J.O. 2022. Modelling the impact of condition-dependent responses and lipid store availability on the consequences of disturbance in a cetacean. *Conservation Physiology* 10. <https://doi.org/10.1093/conphys/coac069>
- Tyack, P.L., Thomas, L., Costa, D., Hall, A. J., Harris, C. M., Harwood, J., Krauss, S., **Miller**, P.J.O., Moore, M., Photopoulou, T., Pirota, E., Rolland, R., Schwacke, L., Simmons, S. & Southall, B. 2022. Managing the effects of multiple stressors on wildlife populations in their ecosystems: developing a cumulative risk approach. *Proc Roy Soc B* 289: 2022-2058. <https://doi.org/10.1098/rspb.2022.2058>
- Kleivane, L., Kvadsheim, P.H., Bocconcelli, A., Øien, N., **Miller**, P.J.O. 2022. Equipment to tag, track and collect biopsies from whales and dolphins: the ARTS, DFHorten and LKDart systems. *Animal Biotelemetry* 10:32 <https://doi.org/10.1186/s40317-022-00303-0>
- de Greef, E., Einfeldt, A. L., **Miller**, P. J. O., Ferguson, S. H., Garroway, C. J., Lefort, K. J., Paterson, I. G., Bentzen, P., Feyrer, L. J. Submitted. Genomics reveal population structure, evolutionary history, and signatures of selection in the northern bottlenose

- whale, *Hyperoodon ampullatus*. *Molecular Ecology* 31: 4919-4931.  
<https://doi.org/10.1111/mec.16643>
- Samarra, F.I.P., Selbmann, A., Aoki, K., **Miller**, P.J.O. 2022. Observations of cetaceans in the waters of the Surtsey Nature Reserve between 2008 and 2021. *Surtsey Research* 15: 89-96. <https://doi.org/10.33112/surtsey.15.7>
- Miller**, P.J.O., *Isojunno*, S., *Siegal*, E., Lam, F.P.A., Kvadsheim, P., Curé, C. 2022. Behavioral responses to predatory sounds predict sensitivity of cetaceans to anthropogenic noise within a soundscape of fear. *Proceedings of the National Academy of Sciences*: Vol. 119 (13) e2114932119  
<https://doi.org/10.1073/pnas.2114932119>
- Miller, P.J.O. 2022. We've discovered why some whales stop feeding in response to the sound of sonar. *The Conversation* <https://theconversation.com/weve-discovered-why-some-whales-stop-feeding-in-response-to-the-sound-of-sonar-179541>
- Booth, C. G., Brannan, N., Dunlop, R., Friedlander, A., *Isojunno*, S., **Miller**, P.J.O., Quick, N., Southall, B. & Pirotta, E. 2022. A sampling, exposure and receptor framework for identifying factors that modulate behavioural responses to disturbance in cetaceans. *Journal of Animal Ecology* 91: 1948-1960. DOI: 10.1111/1365-2656.13787
- Siegal*, E., Hooker, S. K., *Isojunno*, S., **Miller**, P. J. O. 2022 Beaked whales and state-dependent decision-making: how does body condition affect the starvation-predation trade-off? *Proc. Roy. Soc. B*: **289**: 20212539.  
<https://doi.org/10.1098/rspb.2021.2539>
- Pirotta, E., Thomas, L., Costa, D. P., Hall, A. J., Harris, C. M., Harwood, J., Kraus, S. D., **Miller**, P. J. O., Moore, M. M., Photopoulou, T., Rolland, R. M., Schwacke, L., Simmons, S. E., Southall, B. L., Tyack, P. L. 2022. Understanding the combined effects of multiple stressors: a new perspective on a longstanding challenge. *Science of the Total Environment* 821 153322.  
<http://dx.doi.org/10.1016/j.scitotenv.2022.153322>
- Curé, C., *Isojunno*, S., Siemensma, M. J., Wensveen, P., Buisson, C., Sivle, L. D., *Benti*, B., Roland, R., Kvadsheim, P. H., Lam, F-P. A. & **Miller**, P. J. O. 2021. Severity scoring of behavioral responses of sperm whales (*Physeter macrocephalus*) to novel continuous and conventional pulse active sonar. *J of Marine Science and Engineering* Vol. 9, No. 4, 444. <https://doi.org/10.3390/jmse9040444>
- Isojunno*, S., von Benda-Beckmann, A.M., Wensveen, P.J., Kvadsheim, P.H., Lam, F.P.A., *Gkikopoulou*, K.C., Pöyhönen, V., Tyack, P.L., *Benti*, B., Foskolos, I., Bort, J., Neves, M., Biassoni, N., **Miller**, P.J.O. 2021. Sperm whales exhibit variation in echolocation tactics with depth and sea state but not naval sonar exposures. *Mar. Mamm. Sci.* DOI: 10.1111/mms.12890
- Benti*, B., **Miller**, P.J.O., Biuw, M., Curé, C. 2021. Indication that the behavioural responses of humpback whales to killer whale sounds are influenced by trophic relationships. *Mar Ecol Prog Ser.* 660, 217-232. DOI: <https://doi.org/10.3354/meps13592>
- Aoki, K. *Isojunno* S., *Bellot* C., *Iwata* T., *Kershaw*, J. *Akiyama* Y., *Martin-Lopez* LM, *Ramp* C., *Biuw* M., *Swift* R., *Wensveen* P., *Pomeroy* P., *Narazaki* T., *Hall* A., *Sato* K., **Miller** PJO. 2021. Aerial photogrammetry and tag-derived tissue density reveal

- patterns of lipid-store body condition of humpback whales on their feeding grounds. Proc. R. Soc. B .288: 20202307 <http://doi.org/10.1098/rspb.2020.2307>
- von Benda-Beckmann, A.M., *Isojunno*, S. Zandvriet, M., Ainslie, M.A., Wensveen, P.J., Tyack, P.L., Kvadsheim, P.H., Lam, F.P.A., **Miller**, P. J. O. 2020. Modeling potential masking of echolocating sperm whales exposed to continuous 1-2kHz naval sonar. J. Acoust. Soc. Am., 149, 2908 (2021); doi: 10.1121/10.0004769
- Iwata, T., Biuw, M., Aoki, K. **Miller**, P.J.O., Sato, K. 2020. Using an omnidirectional video logger to observe the underwater life of marine mammals: humpback whale resting behaviour. Behavioral Process, in revision.
- Kershaw*, J.L., Ramp, C.A., Sears, R., Plourde, S., Brosset, P., **Miller**, P.J.O. Hall, A.J. 2020. Declining reproductive success in the Gulf of St Lawrence's humpback whales (*Megaptera novaeangliae*) reflects ecosystem shifts on their feeding grounds. Global Change Biology 27, 1027-1041 <https://doi.org/10.1111/gcb.15466>
- Isojunno*, S., Wensveen, P.J., Lam, F.P.A., Kvadsheim, P.H., von Benda-Beckmann, A.M., Martín-López, L.M., Kleivane, L., *Siegal*, E.M., **Miller**, P.J.O. 2020. When the noise goes on: received sound energy predicts sperm whale responses to both intermittent and continuous navy sonar. J Exp Biol 223: jeb219741 doi:10.1242/jeb.219741
- Fahlman, A., Sato, K, **Miller**, P. 2020. Improving estimates of diving lung volume in air-breathing vertebrates. J. Exp Biol 223 jeb216846
- Warren, V.E., **Miller**, P.J.O., Tyack, P.L. 2020. Short-term responses of sperm whales *Physeter macrocephalus* to the attachment of suction cups. Mar. Ecol Prog Ser. 645: 219-234.
- Annebelle Kok, Lisette van Kolfshoten, James Campbell, Alexander von Benda-Beckmann, Patrick **Miller**, Hans Slabbekoorn, and Fleur Visser. 2020. Diving apart together: Call propagation in diving long-finned pilot whales. J Exp Biol, 3, jeb207878. doi:10.1242/jeb.207878
- Hooker, S.K. and **Miller** P.J.O. submitted. Northern bottlenose whale, *Hyperoodon ampullatus* Forster, 1770. In: Handbook of the Mammals of Europe. Series Editors: Klaus Hackländer, Frank E. Zacos. Springer. In Production.
- Anna Selbmann, Volker B. Deecke, Ivan D. Fedutin, Olga A. Filatova, Patrick J. O. **Miller**, Jörundur Svavarsson, Filipa I. P. Samarra. 2020. A comparison of Northeast Atlantic killer whale (*Orcinus orca*) stereotyped call repertoires. Mar. Mamm. Sci. DOI: 10.1111/mms.12750
- Curé C, S *Isojunno*, H Vester, F Visser, M Oudejans, N *Biassoni*, M Massenet, L Barluet de Beauchesne, P Wensveen, L Sivle, P Tyack, P **Miller** (2019). Evidence for discrimination between feeding sounds of familiar fish and unfamiliar mammal-eating killer whale ecotypes by long-finned pilot whales. Animal Cognition Vol. 0123456789 <https://doi.org/10.1007/s10071-019-01282-1>
- Wensveen, P.J., *Isojunno*, S., Hansen, R.R., von Benda-Beckmann, A.M., Kleivane, L., van IJsselmuide, S., Lam, F.P.A., Kvadsheim, P.H., DeRuiter, S.L., Curé, C., *Narazaki*, T., Tyack, P.L., **Miller**, P.J.O. 2019. Northern bottlenose whales in a pristine environment respond strongly to close and distant navy sonar signals. Proc. Roy. Soc. B 286: 20182592. <http://dx.doi.org/10.1098/rspb.2018.2592>

- Harris, C.M., Burt, M.L., Allen, A., Wensveen, P.J., **Miller**, P., Sivle, L. 2019. Foraging behavior and disruption in blue, fin, and humpback whales in relation to sonar exposure: the challenges of generalizing responsiveness in species with high individual variability. *Aquatic Mammals* 45: 646-660.
- Kershaw*, J.L., Brownlow, A., Ramp, C.A., **Miller**, P.J.O., Hall, A.J. 2019. Assessing cetacean body condition: is total lipid content in blubber biopsies a useful monitoring tool? *Aquatic Conservation: Marine and Freshwater Ecosystems* 29: 271-282.
- von Benda-Beckmann, A.M., Wensveen, P.J., Prior, M., Ainslie, M.A., Hansen, R.R., *Isojunno*, S., Lam, F.P.A., Kvadsheim, P.H., **Miller**, P.J.O. 2019. Predicting acoustic dose associated with marine mammal behavioural responses to sound as detected with fixed acoustic recorders and satellite tags. *J Acoust Soc Am*. 145: 1401-1416.
- Hooker, S.K., Aguilar De Soto, N., Baird, R.W., Carroll, E.L., Claridge, D., Feyrer, L., **Miller**, P.J.O., Onoufriou, A., Schorr, G., *Siegal*, E., Whitehead, H. 2019. Future directions in research on beaked whales. *Frontiers in Marine Science* 5 DOI=10.3389/fmars.2018.00514.
- Isojunno*, S., **Miller**, P.J.O. 2018. Movement and biosonar behavior during prey encounters indicate that male sperm whales switch foraging strategy with depth. *Frontiers in Ecology and Evolution*. 28 November 2018, <https://doi.org/10.3389/fevo.2018.00200>
- Tavares*, S.B., Samarra, F.I.P., Pascoal, S., Graves, J.A., **Miller**, P.J.O. 2018. Killer whales (*Orcinus orca*) in Iceland show weak genetic structure among diverse isotopic signatures and observed movement patterns. *Ecology and Evolution* 8 (23): 11900-11913. <https://doi.org/10.1002/ece3.4646>
- Mitochondrial haplotypes and microsatellite genotypes used in this study are available from the Dryad Digital Repository: <https://doi.org/10.5061/dryad.674k8j4>.
- Isojunno* S., Aoki, K., Curé, C., Kvadsheim, P.K., **Miller**, P.J.O. 2018. Breathing patterns indicate cost of exercise during diving and response to experimental sound exposures in long-finned pilot whales. *Frontiers in Physiology* 9:1462. doi: 10.3389/fphys.2018.01462
- Danisheskaya, A.Y., Filatova, O.A., Samarra, F.I.P., **Miller**, P.J.O., Ford, J.K.B., Yurk, H., Matkin, C.O., Hoyt, E. 2018. Crowd intelligence can discern between repertoires of killer whale ecotypes. *Bioacoustics* DOI: 10.1080/09524622.2018.1538902
- Narazaki*, T., *Isojunno*, S., Nowacek, D.P., *Swift*, R., Friedlaender, A.S., Ramp, C., Smout, S., Aoki, K., Deecke, V.B., Sato, K., **Miller**, P.J.O. 2018. Body density of humpback whales (*Megaptera novaeangliae*) in feeding aggregations estimated from hydrodynamic gliding performance. *PLoS ONE* 13(7): e0200287. <https://doi.org/10.1371/journal.pone.0200287>
- Harris, C.M., Thomas, L., Falcone, E.A., Hildebrand, J., Houser, D., Kvadsheim, P.H., Lam, F.P.A., **Miller**, P.J.O., Moretti, D.J., Read, A.J., Slabbekoorn, H., Southall, B.L., Tyack, P.L., Wartzok, D., Janik, V.M. 2018. Marine mammals and sonar: dose-response studies, the risk-disturbance hypothesis and the role of exposure context. *J. Appl. Ecol.* 55: 396-404. DOI: 10.1111/1365-2664.12955

- Fahlman, A., Tyack, P. L., **Miller**, P. J. O., Kvadsheim, P. H. 2017. How human disturbance might cause gas bubbles to form in deep diving whales and how that might affect them. Frontiers for Young Minds. doi:10.3389/frym.2017.00062.
- Isojunno, S., Sadykova, D., DeRuiter, S., Curé, C., Visser, F., Thomas, L., **Miller**, P. J. O., Harris, C. M. 2017. Individual, ecological, and anthropogenic influences on activity budgets of long-finned pilot whales. Ecosphere 8(12):e02044. 10.1002/ecs2.2044
- Wensveen, P.J., Kvadsheim, P., Lam, F.P.A., von Benda-Beckmann, A.M., Sivle, S., Visser, F., Curé, C., Tyack, P.L., **Miller**, P.J.O. 2017.. Lack of behavioural responses of humpback whales (*Megaptera novaeangliae*) indicate limited effectiveness of sonar mitigation. J. Exp Biol, 220, 4150-4161. Featured in Inside JEB.
- Visser, F., Kok, A.C.M., Oudejans, M.G., Scott-Hayward, L.A.S., DeRuiter, S.L., Alves, A.C., Antunes, R.N., Isojunno, S., Pierce, G.J., Slabbekoorn, H., Huisman, J. & **Miller**, P.J.O. 2017. Vocal foragers and silent crowds: context-dependent vocal variation in Northeast Atlantic long-finned pilot whales. Behavioral Ecology and Sociobiology. 71, 12, 170
- Aoki, K., Sato, K., Isojunno, S., Narazaki, T., **Miller**, P.J.O. 2017. High diving metabolic rate indicated by high-speed transit to depth in negatively buoyant long-finned pilot whales. J. Exp. Biol. 220, 3812-3811. Featured in Inside JEB.
- Samarra, F.I.P., Tavares, S.B., Béesau, J., Deecke, V.B., Fennell, A., **Miller**, P.J.O., Pétursson, H., Sigurjónsson, J. & Víkingsson, G.A. 2017. Movements and site fidelity of killer whales (*Orcinus orca*) relative to seasonal and long-term shifts in herring (*Clupea harengus*) distribution. Marine Biology 164, 159.
- Kvadsheim, P.H., DeRuiter, S., Sivle, L.D., Goldbogen, J., Roland-Hansen, R., **Miller**, P.J.O., Lam, F-P.A., Calambokidis, J., Friedlaender, A., Visser, F., Tyack, P.L., Kleivane, L. & Southall, B. 2017. Avoidance responses of minke whales to 1–4 kHz naval sonar. Marine Pollution Bulletin 121, 60-68.
- Tavares, S.B., Samarra, F.I.P. & **Miller**, P.J.O. 2017 A multilevel society of herring-eating killer whales indicates adaptation to prey characteristics. Behavioral Ecology 28, 500-514.
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- Gaëtan, R., Filatova, O.A., Samarra, F.I.P., Fedutin, I.D., Lammers, M. & **Miller**, P.J.O. 2016. Icelandic herring-eating killer whales feed at night. Marine Biology 164, 32.
- Southall, B.L., Nowacek, D.P., **Miller**, P.J.O., Tyack, P.L. 2016. Experimental field studies to measure behavioral responses of cetaceans to sonar. Endangered Species Research, 31, 293-315.

- Miller**, P., *Narazaki*, T., *Isojunno*, S., Aoki, K., Smout, S., Sato, K. 2016. Body density and diving gas volume of the northern bottlenose whale (*Hyperoodon ampullatus*). J. Exp. Biol. 219, 2458-2468.
- Filatova, O.A., Samarra, F.I.P., Barrett-Lennard, L.G., **Miller**, P.J.O., Ford, J.K.B., Yurk, H., Matkin, C.O. & Hoyt, E. 2016. Physical constraints of cultural evolution of dialects in killer whales. J. Acoustical Society of America 140, 3755-3764.
- von Benda-Beckmann, A.M., *Wensveen*, P.J., Samarra, F.I.P., Beerens, S.P. & **Miller**, P.J.O. 2016. Separating underwater ambient noise from flow noise recorded on stereo acoustic tags attached to marine mammals. Journal of Experimental Biology. 219, 2271-2275.
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- Martin Lopez*, L.M., Aguilar de Soto, N., **Miller**, P.J.O. & Johnson, M. 2016. Tracking the kinematics of caudal-oscillatory swimming: a comparison of two on-animal sensing methods. Journal of Experimental Biology 219, 2103-2109.
- Visser, F., Curé, C., Kvadsheim, P.H., Lam, F.P.A., Tyack, P.L. & **Miller**, P.J.O. 2016. Disturbance-specific social responses in long-finned pilot whales, *Globicephala melas*. Scientific Reports. 6, 11 p. 28641.
- Samarra, F.I.P., Deecke, V.B. & **Miller**, P.J.O. 2016 Low-frequency signals produced by Northeast Atlantic killer whales (*Orcinus orca*). Journal of the Acoustical Society of America. 139, 1149-1157.
- Isojunno*, S., Curé, C., Kvadsheim, P.K., Lam, F.P.A., Tyack, P.L., *Wensveen*, P., **Miller**, P.J.O. 2016. Sperm whales reduce foraging effort during exposure to 1-2 kHz sonar and killer whale sounds. Ecological Applications, 26 (1): 77-93.
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