A Critical Review of the Availability, Reliability, and Ecological Relevance of Arctic Species Toxicity Tests for Use in Environmental Risk Assessment

Supplemental Information

Rebecca J. Eldridge a,b, Benjamin P. de Jourdan a, Mark L. Hanson b *

a Huntsman Marine Science Centre, St. Andrews, New Brunswick, Canada
b Department of Environment and Geography, University of Manitoba, Winnipeg, Manitoba, Canada
* Address correspondence to mark.hanson@umanitoba.ca
| Study Number | Authors | Year | Title | Journal | Included / Excluded | Notes |
|--------------|---------|------|-------|---------|---------------------|-------|
| 1            | Andersen, Ø., Frantzen, M., Rosland, M., Timmerhaus, G., Skugor, A., Krasnov, A. | 2015 | Effects of crude oil exposure and elevated temperature on the liver transcriptome of polar cod (*Boreogadus saida*) | Aquatic Toxicology 165, 9-18. | Included | a |
| 2            | Braune, B. M., Scheuhammer, A. M., Crump, D., Jones, S., Porter, E., and Bond, D. | 2012 | Toxicity of methylmercury injected into eggs of thick-billed murres and Arctic terns | Ecotoxicology 21, 2143-2152. | Included | |
| 3            | Busdosh, M. and Atlas, R. M. | 1977 | Toxicity of oil slicks to Arctic amphipods | Arctic 30, 85-92. | Included | a |
| 4            | Camus, L., Brooks, S., Geraudie, P., Hjorth, M., Nahrgang, J., Olsen, G. H., Smit, M. G. D. | 2015 | Comparison of produced water toxicity to Arctic and temperate species | Ecotoxicology and Environmental Safety 113, 248-258. | Included | |
| 5            | Carls, M.G. and Korn, S. | 1983 | Sensitivity of arctic amphipods and fish to petroleum hydrocarbons | Proceedings of the Tenth Annual Aquatic Toxicity Workshop, Halifax, NS, November 7-10, 1983. Ottawa, Ontario: Environment Canada. | Included | |
| 6            | Desforges, J.-P., Levin, M., Jasperse, L., De Guise, S., Eulaers, I., Letcher, R. J., Acquarone, M., Nordoy, E., Folkow, L. P., Jensen, T. H., Grondahl, C., Bertelsen, M. F., Leger, J. S., Almunia, J., Sonne, C., Dietz, R. | 2017 | Effects of polar bear and killer whale derived contaminant cocktails on marine mammal immunity | Environmental Science and Technology 51, 11431-11439. | Included | |
| 7            | Dussauze, M., Camus, L., Le Floch, S., Pichavant-Rafini, K., Geraudie P., Coquille, N., Amerand, A., Lemaire, P., Theron, M. | 2014 | Impact of dispersed fuel oil on cardiac mitochondrial function in polar cod *Boreogadus saida* | Environmental Science and Pollution Research 21(24), 13779-13788. | Included | |
| 8            | Engelhardt, R. | 1981 | Oil pollution in polar bears: exposure and clinical effects | Proceedings of the Arctic Marine Oil Spill Program Technical Seminar, Edmonton, AB, June 16-18, 1981. Ottawa, Ontario: Environment Canada. | Included | a |
| Study Number | Authors | Year | Title | Journal | Included / Excluded | Notes |
|--------------|---------|------|-------|---------|---------------------|-------|
| 9            | Engelhardt, R. | 1983 | Behavioural responses of benthic invertebrates exposed to dispersed crude oil | Proceedings of the Arctic Marine Oil Spill Program Technical Seminar, Edmonton, AB, June 14-16, 1983. Ottawa, Ontario: Environment Canada. | Included | a |
| 10           | Faksness, L.-G., Borseth, J. F., Baussant, T., Hansen, B. H., Altin, D., Tandberg, A. H. S., Ingvarsdottr, A., Aarab, N., Nordtug, T. | 2011 | The effects of different oil spill cleanup technologies on body burden and biomarkers in Arctic marine organisms – a laboratory study | Proceedings of the Arctic Marine Oil Spill Program Technical Seminar, Banff, AB, October 4-6, 2011. Ottawa, Ontario: Environment Canada. | Included | a |
| 11           | Foy, M. D., Sekarak, A. | 1978 | Acute lethal toxicity of oil/dispersant mixtures to selected Arctic species | Proceedings of the Arctic Marine Oil Spill Program Technical Seminar, Edmonton, AB, March 15-17, 1978. Ottawa, Ontario: Environment Canada. | Included | |
| 12           | Foy, M. G. | 1979 | Acute lethal toxicity of Prudhoe Bay Crude Oil and Corexit 9527 to Arctic marine invertebrates and fish from Frobisher Bay, N.W.T. | Proceedings of the Arctic Marine Oil Spill Program Technical Seminar, Edmonton, AB, March 7-9, 1979. Ottawa, Ontario: Environment Canada. | Included | |
| 13           | Frantzen, M., Falk-Petersen, I.-B., Nahrgang, J., Smith, T. J., Olsen, G. H., Hangstad, T. A., Camus, L. | 2012 | Toxicity of crude oil and pyrene to the embryos of beach spawning capelin (*Mallotus villosus*) | Aquatic Toxicology 108, 42-52. | Included | |
| 14           | Frouin, H., Loseto, L. L. et al. | 2012 | Mercury toxicity in beluga whale lymphocytes: limited effects of selenium protection | Aquatic Toxicology 109, 185-193. | Included | |
| 15           | Gardiner, W. W., Word, J. Q., Word, J. D., Perkins, R. A., McFarlin, K. M., Hester, B. W., Word, L. S., Ray, C. M. | 2013 | The acute toxicity of chemically and physically dispersed crude oil to key Arctic species under Arctic conditions during the open water season | Environmental Toxicology and Chemistry 32, 2284-2300. | Included | |
| 16           | Geraudie, P., Nahrgang, J., Forget-Leray, J., Minier, C., Camus, L. | 2014 | In vivo effects of environmental concentrations of produced water on the reproductive function of polar cod (*Boreogadus saida*) | Journal of Toxicology and Environmental Health Part A 77(9-11), 557-573. | Included | |
| Study Number | Authors | Year | Title | Journal | Included / Excluded | Notes |
|--------------|---------|------|-------|---------|---------------------|-------|
| 17           | Grenvald, J. C., Nielsen, T. G., Hjorth, M. | 2013 | Effects of pyrene exposure and temperature on early development of two co-existing Arctic copepods | *Ecotoxicology* 22, 184-198. | Included | |
| 18           | Hansen, B. H., Nordtug, N., Altin, D., Booth, A., Hessen, K. M., Olsen, A. J. | 2009 | Gene expression of GST and CYP330A1 in lipid-rich and lipid poor female *Calanus finmarchicus* (Copepoda: Crustacea) exposed to dispersed crude oil | *Journal of Toxicology and Environmental Health Part A* 72, 131-139. | Included | |
| 19           | Hansen, B. H., Altin, D., Rorvik, S. F., Overjordet, I. B., Olsen, A. J., Nordtug, T. | 2011 | Comparative study on acute effects of water accommodated fractions of an artificially weathered crude oil on *Calanus finmarchicus* and *Calanus glacialis* (Crustacea: Copepoda) | *Science of the Total Environment* 409, 704-709. | Included | |
| 20           | Hansen, B. H., Altin, D., Olsen, A. J., Nordtug, T. | 2012 | Acute toxicity of naturally and chemically dispersed oil on the filter-feeding copepod *Calanus finmarchicus* | *Ecotoxicology and Environmental Safety* 86, 38-46. | Included | |
| 21           | Hansen B.H., Altin D., Rørvik S. Øverjordet, I., Jager T., and Nordtug T. | 2013 | Acute exposure of water soluble fractions of marine diesel on Arctic *Calanus glacialis* and boreal *Calanus finmarchicus*: Effects on survival and biomarker response | *Science of the Total Environment* 449, 276-284. | Included | |
| 22           | Hansen, B. H., Altin, D., Bonaunet, K., Overjordet, I. B. | 2014 | Acute toxicity of eight oil spill response chemicals to temperate, boreal, and Arctic species | *Journal of Toxicology and Environmental Health Part A* 77, 495-505. | Included | |
| 23           | Hjorth, M. and Nielsen, T. G. | 2011 | Oil exposure in a warmer Arctic: Potential impacts on key zooplankton species | *Marine Biology* 158(6), 1339-1347. | Included | |
| 24           | Hsiao, S. I. C. | 1978 | Effects of crude oils on the growth of Arctic marine phytoplankton | *Environmental Pollution* 17, 93-107. | Included | |
| 25           | Jensen, M.H., Nielsen, T.G., Dahlöf, I., | 2008 | Effects of pyrene on grazing and reproduction of *Calanus finmarchicus* and *Calanus glacialis* from Disko Bay, West Greenland | *Aquatic Toxicology* 87, 99-107. | Included | |
| 26           | Jensen, L. K., Carroll, J. | 2010 | Experimental studies of reproduction and feeding for two Arctic-dwelling *Calanus* species exposed to crude oil | *Aquatic Biology* 10, 261-271. | Included | |

*Note: Additional studies are listed with the authors' names and years but their titles and journal information are not provided.*
| Study Number | Authors                                                                 | Year | Title                                                                                                                                                                                                 | Journal                          | Included / Excluded | Notes |
|--------------|--------------------------------------------------------------------------|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|---------------------|-------|
| 27           | Laurel, B. J., Copeman, L. A., Iseri, P., Spencer, M. L., Hutchinson, G., Nordtug, T., Donald, C. E., Meier, S., Allan, S. E., Boyd, D. T., Yiitalo, G. M., Cameron, J. R., French, B. L., Linbo, T. L., Scholz, N. L., Incardona, J. P. | 2019 | Embryonic crude oil exposure impairs growth and lipid allocation in a keystone Arctic forage fish                                                                                                     | iScience 19, 1101-1113.           | Included            |       |
| 28           | Lemcke, S., Holding, J., Moller, E. F., Thyrring, J., Gustavson, K. Juul-Pedersen, T., Sejr, M. K. | 2018 | Acute oil exposure reduces physiological process rates in Arctic phyto- and zooplankton                                                                                                                | Ecotoxicology 28, 26-36.          | Included            |       |
| 29           | Levin, M., E. Gebhard, L. Jasperse, J.-P. Desforges, R. Dietz, C. Sonne, I. Eulaers, A. Covaci, R. Bossi and S. De Guise | 2016 | Immunomodulatory effects of exposure to polychlorinated biphenyls and perfluoroalkyl acids in East Greenland ringed seals (*Pusa hispida*)                                                                 | Environmental Research 151, 244-250. | Included            |       |
| 30           | Moore, Dana                                                              | 2016 | Toxicity of salts, metals, and nitrogenous contaminants to cold-water fish under northern conditions (Chapter 2)                                                                                      | Unpublished doctoral dissertation | Included            |       |
| 31           | Moore, Dana                                                              | 2016 | Toxicity of salts, metals, and nitrogenous contaminants to cold-water fish under northern conditions (Chapter 3)                                                                                      | Unpublished doctoral dissertation | Included            |       |
| 32           | Moore, Dana                                                              | 2016 | Toxicity of salts, metals, and nitrogenous contaminants to cold-water fish under northern conditions (Chapter 4)                                                                                      | Unpublished doctoral dissertation | Included            |       |
| 33           | Moore, Dana                                                              | 2016 | Toxicity of salts, metals, and nitrogenous contaminants to cold-water fish under northern conditions (Chapter 5)                                                                                      | Unpublished doctoral dissertation | Included            |       |
| 34           | Nahrgang, J., Dubourg, P., Frantzen, M.                                  | 2016 | Early life stages of an Arctic keystone species (*Boreogadus saida*) show high sensitivity to a water-soluble fraction of crude oil                                                                  | Environmental Pollution 218, 605-614. | Included            |       |
| 35           | Norregaard, R. D., Nielsen, T. G., Moller, E. F., Strand, J., Espersen, L., Mohl, M. | 2014 | Evaluating pyrene toxicity on Arctic key copepod species *Calanus hyperboreus*                                                                                                                      | Ecotoxicology 23, 163-174.        | Included            |       |
| Study Number | Authors | Year | Title | Journal | Included / Excluded | Notes |
|--------------|---------|------|-------|---------|---------------------|-------|
| 36 | O'Brien, J. W. | 1978 | Toxicity of Prudhoe Bay crude oil to Alaskan Arctic zooplankton | Arctic 31(3), 219-228. | Included |
| 37 | Olsen, G. H., Smit, M. G. D., Carroll, J., Jaeger, I., Smith, T., Camus, L. | 2011 | Arctic versus temperate comparison of risk assessment metrics for 2-methyl-naphthalene | Marine Environmental Research 72, 179-187. | Included |
| 38 | Olsen, A. J., Nordtug, T., Altin, D., Lervik, M., Hansen, B. J. | 2013 | Effects of dispersed oil on reproduction in the cold water copepod Calanus finmarchicus (Gunnerus) | Environmental Toxicology and Chemistry 32(9), 2045-2055. | Included |
| 39 | Overjordet, I. B., Altin, D., Berg, T., Jenssen, B. M., Gabrielsen, G. W., Hansen, B. H. | 2013 | Acute and sub-lethal response to mercury in Arctic and boreal calanoid copepods | Aquatic Toxicology 155, 160-165. | Included |
| 40 | Palace, V. P., Allen-Gil, S. M., Brown, S. B., Evans, R. E., Metner, D. A., Landers, D. H., Lawrence, C. R., Klaiverkamp, J. F., Baron, C. L., Lockhart, W. L. | 2001 | Vitamin and thyroid status in arctic grayling (Thymallus arcticus) exposed to doses of 3,3',4,4'-tetrachlorobiphenyl that induce the phase I enzyme system | Chemosphere 45(2), 185-193. | Included |
| 41 | Pančić, M., Köhler, E., Paulsen, M. L., Toxvaerd, K., Lacroix, C., Le Floch, S., Hjorth, M., Nielsen, T. G. | 2019 | Effects of oil spill response technologies on marine microorganisms in the high Arctic | Marine Environmental Research 151, 104785. | Included |
| 42 | Percy, J. A. and Mullin, T. C. | 1975 | Effects of crude oils on Arctic marine invertebrates | Beaufort Sea Technical Report No. 11. Victoria, BC: Department of the Environment. | Included |
| 43 | Percy, J. A. & Mullin, T. C. | 1977 | Effects of crude oil on the locomotory activity of Arctic marine invertebrates | Marine Pollution Bulletin 8(2), 35-40. | Included |
| 44 | Petersen, D. G., Reichenberg, F., and Dahlloff, I. | 2008 | Phototoxicity of pyrene affects benthic algae and bacteria from the Arctic | Environmental Science and Technology 42, 1371-1376. | Included |
| 45 | Riebell, P. N. and Percy, J. A. | 1989 | Acute toxicity of petroleum hydrocarbons to the Arctic littoral mysid, Mysis oculata (fabricus) | Proceedings of the Arctic Marine Oil Spill Program Technical Seminar, Calgary, AB, June 7-9, 1989. Ottawa, Ontario: Environment Canada. | Included |
| Study Number | Authors                                                                 | Year | Title                                                                                                                                   | Journal                                                                                     | Included / Excluded | Notes                      |
|-------------|-------------------------------------------------------------------------|------|----------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|---------------------|----------------------------|
| 46          | Rodríguez-Torres, R., Almeda, R., Kristiansen, M., Rist, S., Winding, M. S., Nielsen, T. G. | 2020 | Ingestion and impact of microplastics on Arctic Calanus copepods                                                                      | Aquatic Toxicology 228, 105631.                                                            | Included            |                            |
| 47          | Szczybelski, A. S., van den Heuvel-Grave, M. J., Koelmans, A. A., van den Brink, N. W. | 2019 | Biomarker responses and biotransformation capacity in Arctic and temperate benthic species exposed to polycyclic aromatic hydrocarbons | Science of the Total Environment 662, 631-638.                                             | Included            |                            |
| 48          | Thyrring, J., Juhl, B. K., Holmstrup, M.                                  | 2015 | Does acute lead (Pb) contamination influence membrane fatty acid composition and freeze tolerance in intertidal blue mussels in Arctic Greenland? | Ecotoxicology 24, 2036-2042.                                                             | Included            |                            |
| 49          | Toxvaerd, K., Dinh, K. V., Henriksen, O., Hjorth, M., Nielsen, T. G.      | 2018 | Impact of pyrene exposure during overwintering of the Arctic copepod Calanus glacialis                                                 | Environmental Science and Technology 52, 10328-10336.                                      | Included            | a                          |
| 50          | Toxvaerd, K., Pancic, M., Eide, H. O., Soreide, J. E., Lacroix, C., Le Floch, S., Hjorth, M., Nielsen, T. G. | 2018 | Effects of oil spill response technologies on the physiological performance of the Arctic copepod Calanus glacialis                      | Aquatic Toxicology 199, 65-76.                                                            | Included            |                            |
| 51          | Toxvaerd, K., Dinh, K. V., Henriksen, O., Hjorth, M., Nielsen, T. G.      | 2019 | Delayed effects of pyrene exposure during overwintering on the Arctic copepod Calanus hyperboreus                                      | Aquatic Toxicology 217, 105332.                                                           | Included            | a                          |
| 52          | Bejarano, A. C., Gardiner, W. W., Barron, M. G., Word, J. Q.              | 2017 | Relative sensitivity of Arctic species to physically and chemically dispersed oil determined from three hydrocarbon measures of aquatic toxicity | Marine Pollution Bulletin 122, 316-322.                                                    | Excluded            | Not original tox data     |
| 53          | Krumhansl, K. A., Krkosek, W. H., Greenwood, M. M., Ragush, C., Schmidt, J., Grant, J., Barrell, J., Lu, L., Lam, B., Gagnon, G. A., Jamieson, R. C. | 2015 | Assessment of Arctic community wastewater impacts on marine benthic invertebrates                                                    | Environmental Science and Technology 49, 760-766                                          | Excluded            | Monitoring data           |
| 54          | Chapman, P. M., Riddle, M. J.                                            | 2003 | Missing and needed: Polar marine ecotoxicology                                                                                         | Marine Pollution Bulletin 46, 927-928                                                     | Excluded            | Editorial; no original lab data |
| 55          | Chapman, P. M., Riddle, M. J.                                            | 2005 | Toxic effects of contaminants in polar marine environments                                                                              | Environmental Science and Technology 39, 200A-206A                                        | Excluded            | Editorial; no original lab data |
| Study Number | Authors | Year | Title | Journal | Included / Excluded | Notes |
|--------------|---------|------|-------|---------|---------------------|-------|
| 56           | De Hoop, L., Schipper, A. M., Leuven, R. S. E. W., Huijbregts, M. A. J., Olsen, G. H., Smit, M. G. D., Hendriks, A. J. | 2011 | Sensitivity of polar and temperate marine organisms to oil components | Environmental Science and Technology 45, 9017-9023 | Excluded | SSDs; no original data |
| 57           | Dietz, R., Letcher, J. R., Desforges, J.-P. et al. | 2019 | Current state of knowledge on biological effects from contaminants on arctic wildlife and fish | Science of the Total Environment 696, 133792 | Excluded | Review; no original data |
| 58           | Blevin, P., Angelier, F., Tartu, S., Ruault, S., Bustamante, P., Moe, B., Bech, C., Gabrielsen, G. W., Bustnes, J. O., Chastel, O. | 2016 | Exposure to oxychlordane is associated with shorter telomeres in arctic breeding kittiwakes | Science of the Total Environment 563, 125-130 | Excluded | Original Monitoring data |
| 59           | Blevin, P., Tartu, S., Ellis, H. I., Chastel, O., Bustamante, P., Parenteau, C., Herzke, D., Angelier, F., Gabrielsen, G. W. | 2017 | Contaminants and energy expenditure in an Arctic seabird: organochlorine pesticides and perfluoroalkyl substances are associated with metabolic rate in a contrasted manner | Environmental Research 157, 118-126 | Excluded | Monitoring data |
| 60           | Dietz, R., Sonne C. et al. | 2013 | What are the toxicological effects of mercury in Arctic biota? | Science of the Total Environment 443, 775-790 | Excluded | Review; no original data; data included is Monitoring data |
| 61           | Erikstad, K. E., Moum, T., Bustnes, J. O., Reierson, T. K. | 2010 | High levels of organochlorines may affect hatching sex ratio and hatching body mass in Arctic glaucous gulls | Functional Ecology 25, 289-296 | Excluded | Monitoring data |
| 62           | Fisk, A. T., de Wit, C. A. | 2005 | An assessment of the toxicological significance of anthropogenic contaminants in Canadian Arctic wildlife | Science of the Total Environment 351, 57-93 | Excluded | Monitoring data |
| 63           | Goutte, A., Barbraud, C. et al. | 2015 | Survival rate and breeding outputs in a high Arctic seabird exposed to legacy persistent organic pollutants and mercury | Environmental Pollution 200, 1-9 | Excluded | Monitoring data |
| 64           | Hansen, B., Jager, T., Altin, D., Overjordet, I., Olsen, A., Salaberry, I. et al. | 2016 | Acute toxicity of dispersed crude oil on the cold-water copepod Calanus finmarchicus: Elusive implications of lipid content | Journal of Toxicology and Environmental Health Part A 79, 13-15, 549-557 | Excluded | No original tox data (further investigations of toxic mechanisms from previous studies) |
| Study Number | Authors                                                                 | Year | Title                                                                                           | Journal                                                                                                                            | Included / Excluded | Notes                          |
|------------|-------------------------------------------------------------------------|------|--------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|---------------------|--------------------------------|
| 65         | Gustavson, L., Ciesielski, T. M., Bytinskvik, J., Styrishave, B., Hansen, M., Lie, E., Aars, J., Jenssen, B. M. | 2015 | Hydroxylated polychlorinated biphenyls decrease circulating steroids in female polar bears (Ursus maritimus) | Environmental Research 138, 191-201                                                                                                  | Excluded            | Monitoring data                |
| 66         | Gutleb, A.C., P. Cenijn, M. van Velzen, E. Lie, E. Ropstad, J.U. Skaare, T. Malmer, A. Bergman, G.W. Gabrielsen and J. Legler | 2010 | In vitro assay shows that PCB metabolites completely saturate thyroid hormone transport capacity in blood of wild polar bears (Ursus maritimus). | Environmental Science and Technology 44, 3149-3154                                                                             | Excluded            | Monitoring data                |
| 67         | Haarr,A., K. Hylland, N. Eckbo, G.W. Gabrielsen, J.O. Bustnes, D. Herzke, P. Blevin, O. Chastel, S.A. Hanssen, B. Moe, K. Sagerup and K. Borgå | 2018 | DNA damage in breeding Arctic seabirds: Baseline, sensitivity to oxidative stress and association to organohalogen contaminants | Environmental Toxicology and Chemistry 37, 1084-1091                                                                            | Excluded            | Monitoring data                |
| 68         | Hallanger, I.G., E.H. Jorgensen, E. Fuglei, O. Ahlstrom, D.C.G. Muir and B.M. Jenssen | 2012 | Dietary contaminant exposure affects plasma testosterone, but not thyroid hormones, vitamin A, and vitamin E, in male juvenile foxes (Vulpes lagopus) | Journal of Toxicology and Environmental Health A 75, 1298-1313                                                                          | Excluded            | Not marine/aquatic              |
| 69         | Hargreaves, A.L., D.P. Whiteside and G, Gilchrist                      | 2010 | Concentrations of 17 elements, including mercury, and their relationship to fitness measures in arctic shorebirds and vitamin their eggs | Science of the Total Environment 408, 3153-3161                                                                               | Excluded            | Monitoring data                |
| 70         | Hegseth, Marit Nøst; Camus, Lionel; Helgason, Lisa Bjørnsdatter; Bocchetti, Raffaela; Gabrielsen, Geir Wing; Regoli, Francesco | 2011a | Hepatic antioxidant responses related to levels of PCBs and metals in chicks of three Arctic seabird species | Comparative Biochemistry and Physiology - Part C 154, 28-35                                                                   | Excluded            | Monitoring data                |
| 71         | Hegseth, Marit Nøst; Camus, Lionel; Gorbi, Stefania; Regoli, Francesco; Gabrielsen, Geir W | 2011c | Effects of exposure to halogenated organic compounds combined with dietary restrictions on the antioxidant defense system in herring gull chicks | Science of the Total Environment 409, 2717-2724                                                                                   | Excluded            | Natural exposure/not deliberate tox data/not quantifiable for tox endpoints |
| 72         | Hegseth, Marit Nøst; Gorbi, Stefania; Bocchetti, Raffaela; Camus, Lionel; Gabrielsen, Geir Wing; Regoli, Francesco. | 2014 | Effects of contaminant exposure and food restriction on hepatic autophagic lysosomal parameters in herring gull (Larus argentatus) chicks | Comparative Biochemistry and Physiology - Part C 164, 43-50                                                                   | Excluded            | Natural exposure/not deliberate tox data/not quantifiable for tox endpoints |
| Study Number | Authors | Year | Title | Journal | Included / Excluded | Notes |
|--------------|---------|------|-------|---------|---------------------|-------|
| 73           | Heinz, G., D.J. Hoffman, J. Klimstra, K. Stebbins, S. Konrad and C. Erwin | 2009 | Species differences in the sensitivity of avian embryos to methylmercury | Archives of Environmental Contamination and Toxicology 56, 129-138 | Excluded | Not Arctic |
| 74           | Helgason, L.B., J. Verreault, B.M. Braune, K. Borgå, R. Primicerio, B.M. Jenssen and G.W. Gabrielsen | 2010 | Relationship between persistent halogenated organic contaminants and TCDD-toxic equivalents on EROD activity and retinoid and thyroid hormone status in northern fulmars | Science of the Total Environment 408, 6117-6123 | Excluded | Monitoring data |
| 75           | Hylland, K., Aspholm, O. O., Knutsen, J. A., and Ruus, A. | 2006 | Biomarkers in fish from dioxin-contaminated fjords | Biomarkers 11, 97-117 | Excluded | Monitoring data |
| 76           | Knott, K.K., P. Schenk, S. Beyerlein, D. Boyd, G.M. Ylitalo and T.M. O'Hara | 2011 | Blood-based biomarkers of selenium and thyroid status indicate possible adverse biological effects of mercury and polychlorinated biphenyls in Southern Beaufort Sea polar bears | Environmental Research 111, 1124-1136 | Excluded | Monitoring data |
| 77           | Krey, A., M. Kwan and H.M. Chan, 2014 | In vivo and in vitro changes in neurochemical parameters related to mercury concentrations from specific brain regions of polar bears (Ursus maritimus) | Environmental Toxicology and Chemistry 33, 2463-2471 | Excluded | Monitoring data |
| 78           | Krey, A., S.K. Ostertag and H.M. Chan | 2015 | Assessment of neurotoxic effects of mercury in beluga whales (Delphinapterus leucas), ringed seals (Pusa hispida), and polar bears (Ursus maritimus) from the Canadian Arctic | Science of the Total Environment 15, 237-247 | Excluded | Monitoring data |
| 79           | Kuzyk, Z.A., P.V. Hodson, S.M. Solomon and K.J. Reimer | 2005 | Biological responses to PCB exposure in shorthorn sculpin from Sagleek Bay, Labrador | Science of the Total Environment 351-352, 285-300 | Excluded | Monitoring data |
| 80           | Letcher, R.J., J.O. Bustnes, R. Dietz, B.M. Jenssen, E.H. Jørgensen, C. Sonne, J. Verreault, M.M. Vijayan and G.W. Gabrielsen | 2010 | Exposure and effects assessment of persistent organohalogen contaminants in Arctic wildlife and fish | Science of the Total Environment 408, 2995-3043 | Excluded | Review on Monitoring data |
| 81           | Nomiyama, K., S. Hirakawa, A. Eguchi, C. Kanbara, D. Imaeda, J. Yoo, T. Kunisue, E.-Y. Kim, H. Iwato and S. Tanabe | 2014 | Toxicological assessment of polychlorinated biphenyls and their metabolites in the liver of Baikal seal (Pusa sibirica) | Environmental Science and Technology 48, 13530-13539 | Excluded | Monitoring data |
| Study Number | Authors | Year | Title | Journal | Included / Excluded | Notes |
|--------------|---------|------|-------|---------|---------------------|-------|
| 82           | Bäckman, O. Pelkonen, M. Tysklind, T. Hirvi and E. Helle | 2003 | Contaminant exposure and effects in Baltic ringed and grey seals as assessed by biomarkers | Marine Environmental Research 55, 73-99 | Excluded | Monitoring data |
| 83           | Oskam, I., E. Ropstad, E. Lie, A. Derocher, Ø. Wiig, E. Dahl, S. Larsen and J.U. Skaare | 2004 | Organochlorines affect the steroid hormone cortisol in free-ranging polar bears (Ursus maritimus) at Svalbard, Norway | Journal of Toxicology and Environmental Health A 67, 959-977 | Excluded | NO ACCESS |
| 84           | Provencher, J.F., M.R. Forbes, H.L. Hennin, O.P. Love, B.M. Braune, M.L. Mallory and H.G. Gilchrist | 2016 | Implications of mercury and lead concentrations on breeding physiology and phenology in an Arctic bird | Environmental Pollution 218, 1014-1022 | Excluded | Monitoring data |
| 85           | Sonne, C., P.S. Leifsson, R.Dietz, E.W. Born, R.J. Letcher, L. Hyldstrup, F.F. Riget, M. Kirkegaard, D.C.G Muir | 2006b | Xenoendocrine pollutants may reduce size of sexual organs in East Greenland polar bears (Ursus maritimus) | Environmental Science and Technology 40, 5668-5674 | Excluded | Monitoring data |
| 86           | Sonne, C., M. Kirkegaard, J. Jacobsen, B.M. Jenssen, R.J. Letcher and R. Dietz | 2014a | Altered 25-hydroxyvitamin D3 in liver tissue from Greenland sledge dogs (Canis familiaris) dietary exposed to organohalogen polluted minke whale (Balaenoptera acutirostrata) blubber | Ecotoxicology and Environmental Safety 104, 403-408 | Excluded | Not Arctic test species |
| 87           | Sonne, C., R. Dietz, F.F. Rigét, R.J. Letcher, K. Munk Pedersen and B. Styrishave | 2014b | Steroid hormones in blood plasma from Greenland sledge dogs (Canis familiaris) dietary exposed to organohalogen polluted minke whale (Balaenoptera acutirostrata) blubber | Toxicology and Environmental Chemistry 96, 273-286 | Excluded | Not Arctic test species |
| 88           | Tartu, S., Lendvai, A., Blevin, P., Herzke, D., Bustamante, P., Moe, B., Gabrielsen, G.W., Bustnes, J.O. and O. Chastel | 2015b | Increased adrenal responsiveness and delayed hatching date in relation to polychlorinated biphenyl (PCB exposure in Arctic breeding black-legged kittiwakes (Rissa tridactyla). | General and Comparative Endocrinology 219, 165-172 | Excluded | Monitoring data |
| 89           | van den Berghe, M., L. Weijs, S. Habran, K. Das, C. Bugli and S. Pillet | 2013 | Effects of polychlorobiphenyls, polybromodiphenyl ethers, organochlorine pesticides and their metabolites on vitamin A status in lactating grey seals | Environmental Research 120, 18-26 | Excluded | Monitoring data |
| 90           | Verboven, N., J. Verreault, R.J. Letcher, G.W. Gabrielsen and N. Evans | 2009 | Nest temperature and incubation behavior of arctic-breeding glaucous gulls exposed to persistent organic pollutants | Animal Behaviour 77, 411-418 | Excluded | Monitoring data |
| Study Number | Authors | Year | Title | Journal | Included / Excluded | Notes |
|--------------|---------|------|-------|---------|---------------------|-------|
| 91           | Verreault, J., J.U. Skaare, B.M. Jenssen and G.W. Gabrielsen | 2004 | Effects of organochlorine contaminants on thyroid hormone levels in Arctic breeding glaucous gulls, *Larus hyperboreus* | *Environmental Health Perspectives* 112, 532-537 | Excluded | Monitoring data |
| 92           | Villanger, G.D., K.M. Gabrielsen, K.M. Kovacs, C. Lydersen, E. Lie and M. Karimi, | 2013 | Effects of complex organohalogen contaminant mixtures on thyroid homeostasis in hooded seal (*Cystophora cristata*) mother-pup pairs. | *Chemosphere* 92, 828-842. | Excluded | Monitoring data |
| 93           | Wren, C.D., D.B. Hunter, J.F. Leatherland and P.M. Stokes | 1987 | The effects of polychlorinated biphenyls and methylmercury, singly and in combination, on mink. I: Uptake and toxic responses | *Archives of Environmental Contamination and Toxicology* 16, 441-447. | Excluded | Not in an Arctic context, not aquatic/marine |
| 94           | Braithwaite, L.F., Aley, M.G. and Slater, D.L. | 1983 | The effects of oil on the feeding mechanism of the bowhead whale. | Anchorage, AK; USDOI, MMS, Alaska OCS Region. | Excluded | Not publicly accessible |
| 95           | Carrasco-Navarro v. Jaeger I., Honlanen J., Kukkonen, J., Carroll J., and Camus L. | 2015 | Bioconcentration, biotransformation and elimination of pyrene in the arctic crustacean *Gammarus setosus* (Amphipoda) at two temperatures. | *Marine Environmental Research* 110, 101-109 | Excluded | Monitoring data |
| 96           | Harvey H.R., Taylor K.A., Pie H.V., and Mitchelmore C.L. | 2013 | Polycyclic aromatic and aliphatic hydrocarbons in Chukchi Sea biota and sediments and their toxicological response in the Arctic cod, *Boreogadus saida* | *Deep Sea Research Part II* 102, 32-55 | Excluded | Monitoring data |
| 97           | Heintz R.A., Short J.W., and Rice S.D. | 1999 | Sensitivity of fish embryos to weathered crude oil: Part II. Increased mortality of pink salmon (*Oncorhynchus gorbuscha*) embryos incubating downstream from weathered Exxon Valdez crude oil. | *Environmental Toxicology and Chemistry* 18(3), 494-503 | Excluded | Not in an Arctic context |
| 98           | Hodson, P.V., Khan C.W., Saravanabhavan G., Clarke L., Brown R.S., Hollebone, B., Wang, Z., Short, J., Lee, K., King, T. | 2007 | Alkyl PAH in crude oil cause chronic toxicity to early life stages of fish | *Proceedings of the Arctic and Marine Oil Spill Program*, Edmonton, AB, June 5-7, Ottawa, Ontario: Environment Canada. | Excluded | Not Arctic species |
| Study Number | Authors | Year | Title | Journal | Included / Excluded | Notes |
|--------------|---------|------|-------|---------|---------------------|-------|
| 99           | Nordtug T., Olsen A., Altn D., Overrein I., Stoøy W., Hansen B., and De Laender F. | 2011 | Oil droplets do not affect assimilation and survival probability of first feeding larvae of northeast Arctic cod | Science of the Total Environment 412-413, 148-153 | Excluded | Atlantic cod (Gadus morhua) not Arctic cod (Boreogadus saida); species and temperatures do not reflect exposures in an Arctic context |
| 100          | Rogstad, T. W., Sonne, C., Villanger, G. D., Ahistom, O., Fuglei, E., Muir, D., Jorgensen, E., Munro Jenssen, B. | 2017 | Concentrations of vitamin A, E, thyroid and testosterone hormones in blood plasma and tissues from emaciated adult male Arctic foxes (Vulpes lagopus) dietary exposed to persistent organic pollutants (POPs) | Environmental Research 154, 284-290 | Excluded | Original data but not marine/aquatic |
| 101          | Ørland N., Englehardt F., Juck F., Hurst R., and 1 other author. | 1981 | Effect of crude oil on polar bears. | Environmental Studies No. 24, Northern Affairs Program, Ottawa Canada. | Excluded | Not publicly accessible |
| 102          | Smith, T. and Geraci J. | 1975 | The effect of contact and ingestion of crude oil on ringed seals of the Beaufort Sea | Beaufort Sea Technical Report 1975, Department of Environment: Victoria, B.C. | Excluded | Interim report without final results |
| 103          | Bechmann, R. K., Larsen, B. K., Taban, I. C., Hellgren, L. I., Moller, P., Sanni, S. | 2010 | Chronic exposure of adults and embryos of Pandalus borealis to oil causes PAH accumulation, initiation of biomarker responses and an increase in larval mortality | Marine Pollution Bulletin 60, 2087-2098 | Excluded | Not in an Arctic context |
| 104          | Sundt, R. C., Pampanin, D. M., Grung, M., Barsiene, J., Ruus, A. | 2011 | PAH body burden and biomarker responses in mussels (Mytilus edulis) exposed to produced water from a North Sea oil field: Laboratory and field assessments | Marine Pollution Bulletin 62, 1498-1505 | Excluded | Not in an Arctic context |
| 105          | Olsen, G. H., Carroll, M. L | 2007 | Benthic community response to petroleum associated components in Arctic versus temperate marine sediments | Marine Biology 151, 2167-2176 | Excluded | Monitoring data |
| 106          | Paine, M. D., Leggett, W. C., McRuer, J. K., Frank, K. T. | 1992 | Effects of Hibernia crude oil on capelin (Mallotus villosus) embryos and larvae | Marine Environmental Research 33(3), 159-187 | Excluded | Not in an Arctic context |
| Study Number | Authors | Year | Title | Journal | Included / Excluded | Notes |
|--------------|---------|------|-------|---------|---------------------|-------|
| 107          | Kirkegaard, M., Sonne, C., Dietz, R., Letcher, R. J., Jensen, A. L, Hansen, S. S., Jenssen, B. M., Grandjean, P. | 2011 | Alterations in thyroid hormone status in Greenland sledge dogs exposed to whale blubber contaminated with organohalogen compounds | Ecotoxicology and Environmental Safety 74, 157-163 | Excluded | Not Arctic test species |
| 108          | Kirkegaard, M., Sonne, C., Jakobsen, J., Jenssen, B. M., Letcher, R. J., Dietz, R. | 2010 | Organohalogen in a whale-blubber-supplemented diet affects hepatic retinol and renal tocopherol concentrations in Greenland sled dogs (Canis familiaris) | Journal of Toxicology and Environmental Health Part A Current Issues 73, 773-786 | Excluded | Not Arctic species |
| 109          | Sonne, C., Wolkers, H., Leifsson, P. S., Ibarg, T., Jenssen, B. M., Fuglei, E., Ahlstrom, O., Dietz, R., Kirkegaard, M., Muir, D. C. G., Jorgensen, E. H. | 2009 | Chronic dietary exposure to environmental organochlorine contaminants induces thyroid gland lesions in Arctic foxes (Vulpes lagopus) | Environmental Research 109(6), 702-711 | Excluded | Histopathology; not tox data |
| 110          | Sonne, C., Wolkers, H., Leifsson, P. S., Ibarg, T., Jenssen, B. M., Fuglei, E., Ahlstrom, O., Dietz, R., Kirkegaard, M., Muir, D. C. G., Jorgensen, E. H. | 2009 | Mineral density and biomechanical properties of bone tissue from male Arctic foxes (Vulpes lagopus) exposed to organochlorine contaminants and emaciation | Comparative Biochemistry and Physiology Part C 149(1), 97-103 | Excluded | Not tox data |
| 111          | Trudel, K. | 1978 | Effects of crude oil and crude oil/Corexit 9527 suspensions on carbon fixation by a marine phytoplankton community | Proceedings of the Arctic and Marine Oil Spill Program, Edmonton, AB, March 15-17, 1978. Ottawa, Ontario: Environment Canada. | Excluded | Not Arctic species or in an Arctic context |
| 112          | Duval, W. | 1979 | The sublethal effects of hydrocarbons on the bioenergetics and productivity of selected marine fauna | Proceedings of the Arctic and Marine Oil Spill Program, Edmonton, AB, March 15-17, 1979. Ottawa, Ontario: Environment Canada. | Excluded | Not Arctic species; no hard data in abstract |
| 113          | Wells, P. G. and Harris, G. W. | 1980 | The acute toxicity of dispersants and chemically dispersed oil | Proceedings of the Arctic and Marine Oil Spill Program | Excluded | Not Arctic species |
| 114          | Fink, R. P. and Duval, W. S. | 1980 | Sublethal and lethal effects of the water-soluble fraction of Prudhoe Bay crude oil on juvenile Cotto salmon (Oncorhynchus kisutch) | Proceedings of the Arctic and Marine Oil Spill Program | Excluded | Not Arctic species |
| Study Number | Authors | Year | Title | Journal | Included / Excluded | Notes |
|--------------|---------|------|-------|---------|---------------------|-------|
| 115          | Peakall, D., Gilman, A. P. | 1980 | The sublethal effects of oil dispersants on seabirds | Proceedings of the Arctic and Marine Oil Spill Program | Excluded | Summary of research; hard data published elsewhere |
| 116          | Andersen, J. W., Kiesser, S. L., Riley, R. G., Thomas, B. L., Bean, R. M. | 1980 | Toxicity of chemically dispersed oil to shrimp exposed to constant and decreasing concentrations in a flowing system | Proceedings of the Arctic and Marine Oil Spill Program | Excluded | Not in an Arctic context |
| 117          | Fink, R. P., Harwood, L. A., Duval, W. S. | 1981 | The sublethal effects of dispersed crude oil on an estuarine isopod | Proceedings of the Arctic and Marine Oil Spill Program | Excluded | Not Arctic species or in an Arctic context |
| 118          | Lambert, G. and Peakall, D. B. | 1981 | Thermoregulatory metabolism in mallard ducks exposed to crude oil and dispersant | Proceedings of the Arctic and Marine Oil Spill Program | Excluded | Not Arctic species or in an Arctic context |
| 119          | Sheppard, E. P. and Georgiou, P. | 1981 | The mutagenicity of Prudhoe Bay crude oil and its burn residues | Proceedings of the Arctic and Marine Oil Spill Program | Excluded | Not toxicity tests |
| 120          | Lehtinen, K.-J., Suomalainen, S., Lehtinen, C., Mattsson, J., Reiland, S., Linden, O. | 1982 | Physiological effects on fish chronically exposed to low levels of petroleum hydrocarbons | Proceedings of the Arctic and Marine Oil Spill Program | Excluded | Not in an Arctic context |
| 121          | Nes, H. and Norland, S. | 1983 | Effectiveness and toxicity of oil dispersants | Proceedings of the Arctic and Marine Oil Spill Program | Excluded | Not in an Arctic context or with Arctic species |
| 122          | Bardot, C., Bocard, C., Castaing, G., Gatellier, C. | 1984 | The importance of a dilution process to evaluate effectiveness and toxicity of chemical dispersants | Proceedings of the Arctic and Marine Oil Spill Program | Excluded | Not in an Arctic context or with Arctic species |
| 123          | Bobra, A. M., Abernethy, S., Wells, P. G. and Mackay, D. | 1984 | Recent toxicity studies at the University of Toronto | Proceedings of the Arctic and Marine Oil Spill Program | Excluded | Not in an Arctic context or with Arctic species |
| 124          | Lockhart, W. L., Billeck, B. N., Danell, R. W., deMarch, B. G. E., Duncan, D. A. | 1984 | Comparative toxicity of several oil/dispersant mixtures to representative freshwater organisms | Proceedings of the Arctic and Marine Oil Spill Program | Excluded | Not in an Arctic context or with Arctic species |
| 125          | Sveum, P. and Sendstad, E. | 1985 | Oil polluted seaweeds in the Arctic: Short term effects on decomposers and fate of the oil | Proceedings of the Arctic and Marine Oil Spill Program | Excluded | Not toxicity data |
| 126          | McAuliffe, C. D. | 1986 | Organism exposure to volatile hydrocarbons from untreated and chemically dispersed crude oils in field and laboratory | Proceedings of the Arctic and Marine Oil Spill Program | Excluded | Review of studies |
| Study Number | Authors | Year | Title | Journal | Included / Excluded | Notes |
|--------------|---------|------|-------|---------|---------------------|-------|
| 127          | Bakke, T. | 1986 | Experimental long term oil pollution in a Boreal rocky shore environment | Proceedings of the Arctic and Marine Oil Spill Program | Excluded | Not in an Arctic context |
| 128          | Klokk, T. | 1986 | Effects of oil and clean-up methods on shoreline vegetation | Proceedings of the Arctic and Marine Oil Spill Program | Excluded | Not in an Arctic context |
| 129          | Sveum, P. | 1987 | Fate and effects of dispersed and non dispersed oil on Arctic mud flats | Proceedings of the Arctic and Marine Oil Spill Program | Excluded | Monitoring data; not tox data |
| 130          | Crowell, M. J. and Lane, P. A. | 1988 | Recovery of a Nova Scotian saltmarsh during two growing seasons following experimental spills of crude oil and the dispersant Corexit 9527 | Proceedings of the Arctic and Marine Oil Spill Program | Excluded | Not Arctic |
| 131          | Carter, J. and Ernst, R. | 1989 | Tainting in sea scallops (*Placopecten magellanicus*) exposed to the water-soluble fraction of crude oil and natural gas condensate | Proceedings of the Arctic and Marine Oil Spill Program | Excluded | Not in an Arctic context |
| 132          | Jenssen, B. M., Ekker, M., Vongraven, D., Silverstone, M. | 1991 | Body weight development and thermoregulation of oil-contaminated grey seal pups (*Halichoerus grypud*) at the Froan Archipelago, Norway | Proceedings of the Arctic and Marine Oil Spill Program, Vancouver, BC, June 10-11, 1991. Ottawa, Ontario: Environment Canada. | Excluded | Field study |
| 133          | Lockhart, W. L. and Metner, D. A. | 1991 | Oil-sensitive biomarker studies of fish from Arctic Canada | Proceedings of the Arctic and Marine Oil Spill Program, Vancouver, BC, June 10-11, 1991. Ottawa, Ontario: Environment Canada. | Excluded | Summary of studies |
| 134          | Lockhart, W. L. and Danell, R. W. | 1992 | Field and experimental tainting of Arctic freshwater fish by crude and refined petroleum products | Proceedings of the Arctic and Marine Oil Spill Program, Edmonton, AB, June 10-12, 1992. Ottawa, Ontario: Environment Canada. | Excluded | Not toxicology data |
| 135          | Ackman, R. G. and Heras, H. | 1992 | Tainting by short-term exposure of Atlantic salmon to water soluble petroleum hydrocarbons | Proceedings of the Arctic and Marine Oil Spill Program, Edmonton, AB, June 10-12, 1992. Ottawa, Ontario: Environment Canada. | Excluded | Not toxicology data |
| Study Number | Authors | Year | Title | Journal | Included / Excluded | Notes |
|--------------|---------|------|-------|---------|---------------------|-------|
| 136          | Daykin, M., Sergy, G., Aurand, D., Shigenaka, G., Wang, Z., Tang, A. | 1994 | Aquatic toxicity resulting from in situ burning of oil-on-water | Proceedings of the Arctic and Marine Oil Spill Program, Vancouver, BC, June 8-10, 1994, Ottawa, Ontario: Environment Canada. | Excluded | Not Arctic species or in an Arctic context |
| 137          | Vandermeulen, J. H., Vignier, V., Mossman, D. | 1994 | Toxicology of Hibernia crude oil in parr and smolt of Atlantic salmon (Salmo salar) | Proceedings of the Arctic and Marine Oil Spill Program, Vancouver, BC, June 8-10, 1994. Ottawa, Ontario: Environment Canada. | Excluded | Not in an Arctic context |
| 138          | Coelho, G. M., Bragin, G. E., Aurand, D. V., Clark, J. R., Wright, D. A. | 1995 | Field and laboratory investigation of the toxicity of physically and chemically dispersed oil | Proceedings of the Arctic and Marine Oil Spill Program, Vancouver, BC, June 8-10, 1994. Ottawa, Ontario: Environment Canada. | Excluded | Not Arctic species or in an Arctic context |
| 139          | Singer, M. M., George, S., Jacobsopn, S., Weetman, L. L., Blondina, G., Tjeerdema, R. S., Aurand, D., Sowby, M. L. | 1996 | Evaluation of the aquatic effects of crude oil, dispersants, and their mixtures | Proceedings of the Arctic and Marine Oil Spill Program | Excluded | Overview of papers in the field |
| 140          | Lockhart, W. L., Billeck, B. N., Evans, R. E., Danell, R. A., Carneiro, J. | 1996 | Toxicology studies with a high-boiling lubricating oil (Esstic 46 CF) used in a hydroelectric generating station | Proceedings of the Arctic and Marine Oil Spill Program | Excluded | Not Arctic species or in an Arctic context |
| 141          | Lockart, W. L., Duncan, D. A., Billeck, B. N., Danell, R. A., Ryan, M. J. | 1997 | Chronic toxicity of the ‘water-soluble fraction’ of Norman Wells crude oil to juvenile fish | Proceedings of the Arctic and Marine Oil Spill Program, Vancouver, BC, June 11-13, 1997. Ottawa, Ontario: Environment Canada. | Excluded | Not Arctic species or in an Arctic context |
| 142          | Blenkinsopp, S. and Sergy, G. | 1997 | Evaluation of the toxicity of the weathered crude oil used at the Newfoundland offshore burn experiment (NOBE) and the resultant burn residue | Proceedings of the Arctic and Marine Oil Spill Program, Vancouver, BC, June 11-13, 1997. Ottawa, Ontario: Environment Canada. | Excluded | Not Arctic species or in an Arctic context |
| Study Number | Authors | Year | Title | Journal | Included / Excluded | Notes |
|--------------|---------|------|-------|---------|---------------------|-------|
| 143          | Fuller, C., Bonner, J., McDonald, T., Page, C., Bragin, G., Clark, J., Aurand, D., Hernandez, A., Ernest, A. | 1999 | Comparative toxicity of simulated beach sediments impacted with both whole and chemical dispersions of weathered Arabian medium crude oil | Proceedings of the Arctic and Marine Oil Spill Program, Calgary, AB, June 2-4, 1997. Ottawa, Ontario: Environment Canada. | Excluded | Not Arctic species or in an Arctic context |
| 144          | Brakstad, O. G., Faksness, L.-G., Stokland, O., Altin, D., and Singsaas, I. | 2000 | Disappearance and biological effects of crude oils after sedimentation on subtidal soft-bottom seabed sediments: Experiments in a laboratory seabed mesocosm | Proceedings of the Arctic and Marine Oil Spill Program, Vancouver, BC, June 14-16, 2000. Ottawa, Ontario: Environment Canada. | Excluded | Not tox data |
| 145          | Armsworthy, S., Cranford, P. J., Tremblay, G. H., and Lee, K. | 2000 | Chronic toxicity of Orimulsion to the sea scallop Placopecten magellanicus: influences on survival, feeding, digestion and growth | Proceedings of the Arctic and Marine Oil Spill Program, Vancouver, BC, June 14-16, 2000. Ottawa, Ontario: Environment Canada. | Excluded | Not in an Arctic context |
| 146          | McFarlin, K. M., Perkins, R. A., Leigh, M. B. | 2012 | The effects of crude oil and Corexit 9500 on the indigenous Arctic microbial community | Proceedings of the Arctic and Marine Oil Spill Program, Vancouver, BC, June 5-7, 2012. Ottawa, Ontario: Environment Canada. | Excluded | No results (results pending) |
| 147          | McFarlin, K. M., Perkins, R. A., Leigh, M. B. | 2014 | Oil biodegradation by Arctic marine microorganisms | Proceedings of the Arctic and Marine Oil Spill Program, Canmore, AB, June 3-5, 2014. Ottawa, Ontario: Environment Canada. | Excluded | Not tox data |
| 148          | Dussauze et al. | 2014 | Effect of dispersed oil on fish cardiac tissue respiration: A comparison between a temperate (Dicentrarchus labrax) and an arctic (Boreogadus saida) species | Proceedings of the Arctic and Marine Oil Spill Program, Canmore, AB, June 3-5, 2014. Ottawa, Ontario: Environment Canada. | Excluded | Same study as paper assessed already (conference abstract) |
| 149          | Percy, J. A. | 1977 | Responses of Arctic marine benthic crustaceans to sediments contaminated with crude oil | Environmental Pollution 13, 1-10 | Excluded | Same study as paper assessed already (conference abstract) |
| Study Number | Authors | Year | Title | Journal | Included / Excluded | Notes |
|--------------|---------|------|-------|---------|---------------------|-------|
| 150          | Rice, S. D., Short, J. W., Karinen, J. F. | 1976 | Toxicity of Cook Inlet crude oil and No. 2 fuel oil to several Alaskan marine fishes and invertebrates | In Sources, Effects, and Sinks of Hydrocarbons in the Aquatic Environment Proc. Symp., American University, Washington D. C., pp. 394-406 | Excluded | Not publicly accessible |
| 151          | Rice, S. D., Short, J. W., Brodersen, C. C., Mecklenburg, T. A., Moles, D. A., Misch, C. J., Cheatham, D. L., and Karinen, J. F. | 1976 | Acute toxicity and uptake-depuration studies with Cook Inlet crude oil, Prudhoe Bay crude oil, No. 2 fuel oil and several subarctic marine organisms | NWFC Processed Report, National Marine Fisheries Service. Seattle. 90 p. | Excluded | Not publicly accessible |
| 152          | Schneider, D. E. | 1980 | Physiological responses of arctic epibenthic invertebrates to winter stresses and exposure to Prudhoe Bay crude oil dispersions | In Environmental Assessment of the Alaskan Continental Shelf, Annual Reports of Principal Investigators, Vol. 1, Receptors – Birds, Plankton, Littoral, Benthos. Boulder, CO: USDOC, NOAA, OCSEAP, pp. 413-474 | Excluded | Not publicly accessible |
| 153          | Mageau, C., Engelhardt, F. R., Gilfillan, E. S. and Boehm, P. D. | 1987 | Effects of short-term exposure to dispersed oil in Arctic invertebrates | Arctic 40(1), 62-171 | Excluded | Already assessed this study in the form of a conference paper |
| 154          | McFarlin, K. M. and Perkins, R. A. | 2011 | Toxicity of physically and chemically dispersed oil to selected Arctic species | 2011 International Oil Spill Conference | Excluded | Already assessed this study in a paper published by a different author |
| 155          | Cross, W. E. | 1982 | In situ studies of the effects of oil and dispersed oil on primary productivity of ice algae and on under-ice amphipod communities | In Special Studies – 1981 study results, Baffin Island Oil Spill Working Report 81-10: 61 p. | Excluded | Monitoring data; not publicly accessible but data published in Cross & Martin 1987 (below) and NA |
| Study Number | Authors | Year | Title | Journal | Included / Excluded | Notes |
|--------------|---------|------|-------|---------|---------------------|-------|
| 156          | Cross, W. E. and Martin, C. M. | 1983 | In situ studies of the effects of oil and chemically treated oil on primary productivity of ice algae and on under-ice microfauna and macrofaunal communities | In: Special studies – 1982 study results, Baffin Island Oil Spill Working Report 82-7, 103 p. | Excluded | Monitoring data; not publicly accessible but data published in Cross & Martin 1987 (below) and NA |
| 157          | Cross, W. E. and Martin, C. M. | 1987 | Effects of oil and chemically treated oil on nearshore under-ice meiofauna studied in situ | Arctic 40, 258-265 | Excluded | |
| 158          | Hsiao, S. I. C., Kittle, D. W., and Foy, M. G. | 1978 | Effects of crude oils and the oil dispersant Corexit on primary production of Arctic marine phytoplankton and seaweed | Environmental Pollution 15, 209-221 | Excluded | Monitoring data |
| 159          | Federle, T. W., Vestal, J. R., Hater, G. R., Miller, M. C. | 1979 | Effects of Prudhoe bay crude oil on primary production and zooplankton in Arctic tundra thaw ponds | Marine Environmental Research 2(1), 3-18 | Excluded | Field study |
| 160          | Miller, M. C., Hater, G. R., Vestal, J. R. | 1977 | Effect of Prudhoe crude oil on carbon assimilation by planktonic algae in an Arctic pond | In Environmental Chemistry and Cycling Processes, Pine Ridge, TN. | Excluded | Field study |
| 161          | Bergstein, P. E. and Vestal, J. R. | 1978 | Crude oil biodegradation in Arctic tundra ponds | Arctic 31(3), 153-411 | Excluded | Field study |
| 162          | Jordan, M. J., Hobbie, J. E., Peterson, B. J. | 1978 | Effect of petroleum hydrocarbons on microbial populations in an Arctic lake | Arctic 31(3), 153-411 | Excluded | Field study |
| 163          | Miller, M. C., Alexander, V., Barsdate, R. J. | 1978 | The effects of oil spills on phytoplankton in an Arctic lake and ponds | Arctic 31(3), 192-218 | Excluded | Field study |
| 164          | Mozley, S. C. and Butler, M. G. | 1978 | Effects of crude oil on aquatic insects of tundra ponds | Arctic 31(3), 229-241 | Excluded | Field study |
| 165          | Walker, D. A., Webber, P. J., Everett, K. R., Brown, J. | 1978 | Effects of crude and diesel spills on plant communities at Prudhoe Bay, Alaska, and the derivation of oil spill sensitivity maps | Arctic 31(3), 242-259 | Excluded | Field study |
| 166          | McFarlin, K. M., Perkins, R. A. | 2010 | Evaluating the biodegradability and effects of dispersed oil using Arctic test species and conditions: Phase I activities | Proceedings of the Arctic and Marine Oil Spill Program, Halifax, NS, June 7-9, 2010. Ottawa, Ontario: Environment Canada. | Excluded | Not tox data |
| Study Number | Authors | Year | Title | Journal | Included / Excluded | Notes |
|--------------|---------|------|-------|---------|---------------------|-------|
| 167          | McFarlin, K. M., Perkins, R. A. | 2011 | Evaluating the biodegradability and effects of dispersed oil using Arctic test species and conditions: Phase II activities | Proceedings of the Arctic and Marine Oil Spill Program, Banff, AB, June 4-6, 2011. Ottawa, Ontario: Environment Canada. | Excluded | Not tox data |
| 168          | Perkins, R. A. | 2000 | Selection of potential cold water marine species for testing of oil, dispersants, and chemically dispersed oil | Proceedings of the Arctic and Marine Oil Spill Program, Vancouver, BC, June 14-16, 2000. Ottawa, Ontario: Environment Canada. | Excluded | Not tox data |
| 169          | Gerlich, H. S., Holmstrup, M., Bjerregaard, P., Slotsbo, S. | 2020 | Mercury (Hg2+) interferes with physiological adaptations to freezing in the arctic earthworm Enchytraeus albidus | Ecotoxicology and Environmental Safety 204, 111005. | Excluded | Terrestrial |
| 170          | Reinardy, H. C., Pedersen, K. B., Nahrgang, J., Frantzen, M. | 2019 | Effects of mine tailings exposure on early life stages of Atlantic cod. | Environmental Toxicology and Chemistry 38(7), 1446-1454 | Excluded | Not an Arctic test species |
| 171          | Caputo, S., Papale, M., Rizzo, C., Giannarelli, S., Conte, A., Moscheo, F., Graziano, M., Aspholm, P. E., Onor, M., De Domenico, E., Misericocchi, S., Michaud, L., Azzaro, M., Lo Guidice, A. | 2019 | Metal resistance in bacteria from contaminated Arctic sediment is driven by metal local inputs. | Archives of Environmental Contamination and Toxicology 77(2), 291-307 | Excluded | Monitoring data |
| 172          | Brown, J., Whiteley, N. M., Bailey, A. M., Graham, H., Hop, H., Rastrick, S. P. S. | 2020 | Contrasting responses to salinity and future ocean acidification in Arctic populations of the amphipod Gammarus setosus. | Marine Environmental Research 162, 105176 | Excluded | Not tox data |
| 173          | Brix, K. V., Baker, J., Morris, W., Ferry, K., Pettem, C., Elphick, J., Tear, L. M., Napier, R., Adzic, M., DeForest, D. K. | 2021 | Effects of maternally transferred egg selenium on embryo-larval survival, growth, and development in Arctic grayling (Thymallus arcticus). | Environmental Toxicology and Chemistry 40(2), 380-389 | Excluded | Monitoring data |
| 174          | Rowlands, E., Galloway, T., Manno, C. | 2021 | A Polar outlook: Potential interactions of micro- and nano-plastic with other anthropogenic stressors. | Science of the Total Environment 754, 142379 | Excluded | Not tox data |
| Study Number | Authors | Year | Title | Journal | Included / Excluded | Notes |
|--------------|---------|------|-------|---------|---------------------|-------|
| 175          | Camus, L., Smit, M. G. D. | 2019 | Environmental effects of Arctic oil spills and spill response technologies, introduction to a 5 year joint industry effort. | Marine Environmental Research 144, 250-254 | Excluded | Not tox data |
| 176          | Fahd, F., Veitch, B., Khan, F. | 2020 | Risk assessment of Arctic aquatic species using ecotoxicological biomarkers and Bayesian network. | Marine Pollution Bulletin 156, 111212 | Excluded | Modelling data |
| 177          | Pacyna-Kuchta, A. D., Jakubas, D., Frankowski, M., Polkowska, Z., Wojczulanis-Jakubas, K. | 2020 | Exposure of a small Arctic seabird, the little auk (*Alle alle*) breeding in Svalbard, to selected elements throughout the course of a year. | Science of the Total Environment 732, 139103 | Excluded | Monitoring data |
| 178          | Mirimin, L., Hickey, A., Barrett, D., DeFaolite, F., Boschetti, S., Venkatesh, S., Graham, G. T. | 2020 | Environmental DNA detection of Arctic char (*Salvelinus alpinus*) in Irish lakes: Development and application of a species-specific molecular assay. | Environmental DNA 2(2), 221-233 | Excluded | Monitoring data |
| 179          | Hansen, B. H., Sorensen, L., Storseth, T. R., Nepstad, R., Altin, D., Krause, D., Meier, S., Nordtug, T. | 2019 | Embryonic exposure to produced water can cause cardiac toxicity and deformations in Atlantic cod (*Gadus morhua*) and haddock (*Melanogrammus aeglefinus*) larvae. | Marine Environmental Research 148, 81-86 | Excluded | Not Arctic test species |
| 180          | Jain, A., Krishnan, K. P., Begum, N., Singh, A., Thomas, F. A., Gopinath, A. | 2020 | Response of bacterial communities from Kongsfjorden (Svalbard, Arctic Ocean) to macroalgal polysaccharide amendments. | Marine Environmental Research 155, 104874 | Excluded | Not tox data |

*a Study includes post-exposure monitoring for recovery potential and/or latent effects observation.*
Table S2: Justification of environmentally relevant concentrations of compounds tested on Arctic species from studies assessed in this review.

| Substance                                      | Environmentally Relevant Concentration Threshold | Justification                                                                                                                                                                                                 | Study Number |
|------------------------------------------------|-------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| **OIL-RELATED CONTAMINANTS**                   |                                                 |                                                                                                                                                                                                             |              |
| Chemical dispersant                            | < 1000 mg/L                                     | Concentrations of dispersants in the water column after application in an oil spill are highly variable and difficult to measure. Estimates range from 5 mg/L (Negri et al., 2018) to 10 mg/L (Wells, 1984) based on measured concentrations in field experiments to 271 mg/L to 904 mg/L (Bejarano, 2018) based on worst-case exposure scenarios calculated from dispersant application rates over a depth of 0.01 m. Therefore, environmentally relevant concentrations for this review will capture the upper end of this range. | 7b, 11a, 12b, 15b, 20b, 22b, 42b |
| Shoreline washing agent (SWA)                 | Based on exposure scenario                      | Data pertaining to concentrations of shoreline washing agents in the water column after application are not readily available as this substance is sprayed on the shoreline. If effort has been made to represent field conditions through exposure duration or scenario, study will be scored with a 1.                                                                 | 22a          |
| Crude oil (mechanically dispersed or chemically dispersed) | Based on exposure scenario | Environmentally realistic concentrations of oil in an oil spill are highly variable depending on many factors. If effort has been made to represent field conditions through exposure concentration, duration, scenario (i.e., spiked decline over constant exposure), study will be scored with a 1. | 1, 3b, 3c, 3d, 5a, 7a, 8, 9, 10, 11b, 12a, 13a, 15a, 18, 19, 20a, 20c, 24, 26, 27, 34, 36, 38, 41a, 41b, 41c, 42a, 43, 45a, 50 |
| Heavy fuel oil                                 | < 1000 µg/L TPH < 1000 µg/L THC                 | The vast majority (95%) of seawater samples taken after the Deepwater Horizon oil spill contained < 250 µg/L TPH (Wade et al., 2016); however, maximum values reached 11,400 mg/L (directly above wellhead; Sammarco et al., 2013). It has been reported that water column samples that were not directly above wellhead with concentrations above 1000 µg/L did not contain high concentrations of PAHs that correspond to these TPH measurements; thus, the TPHs measured were likely from non-petroleum, organic sources (Wade et al., 2016). For this reason, 1000 µg/L has been selected as the maximum environmentally relevant concentration threshold for these compounds. | 28           |
| Substance                  | Environmentally Relevant Concentration Threshold | Justification                                                                                                                                                                                                 | Study Number |
|----------------------------|-------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| Pyrene                     | < 189 µg/L                                      | Maximum reported concentration of PAHs measured in the water column after the Deepwater Horizon oil spill (Diercks, A.-R. et al., 2010).                                                                         | 13b, 17, 23, 25, 35, 44, 47, 49, 51 |
|                            | < 1398 nM                                       | This is the United States criteria for maximum allowable concentration of pyrene and seawater; therefore, concentrations up to this value (at least) are likely to occur (Grenvald et al., 2013). |              |
|                            | Study-specific for sediment (see Szczbelski et al., 2019) | Concentrations are justified within the text based on concentrations of PAHs found in sediments near where the exposure was conducted.                                                                   |              |
| 2-methylnaphthalene        | < 189 µg/L                                      | Maximum reported concentration of PAHs measured in the water column after the Deepwater Horizon oil spill (Diercks, A.-R. et al., 2010).                                                                         | 37           |
| Naphthalene                | < 189 µg/L                                      | Maximum reported concentration of PAHs measured in the water column after the Deepwater Horizon oil spill (Diercks, A.-R. et al., 2010).                                                                         | 5b           |
| Diesel (marine/Arctic)     | < 1:10,000 dilution                             | Identified as an environmentally realistic worst-case scenario (Hansen et al., 2013).                                                                                                                        | 3a, 21       |
| Produced water             | < 350 ng/L PAH                                  | The composition of produced water is highly variable depending on many factors. Discharge is instantaneously diluted as it reaches the water column, where modelling predicts that concentrations of PAHs (a component of the discharge) can be 25 to 350 ng/L within one kilometre from the source, and 4 to 8 ng/L within five to ten kilometres from the source (Durell et al., 2006). Environmental relevance of concentrations from studies that report measured PAH values will use these values for scoring. | 4, 16        |
|                            | Any dilutions of concentrate                   | Any dilutions of concentrate as long as concentrate was made to mimic realistic discharge.                                                                                                                   |              |
| INORGANIC CONTAMINANTS      |                                                 |                                                                                                                                                                                                          |              |
| Methylmercury (MeHg)       | 1.41 µg/g dry weight in biota                  | Concentrations of methylmercury naturally occurring in the Arctic environment are not this high; however, this compound bioaccumulates in the tissues of organisms feeding at high trophic levels. This value was obtained as the maximum from concentrations of total mercury found in eggs of arctic seabirds (black-legged kittiwakes, northern fulmars, and thick-billed murres) between 1975 and 2003 (Braune, 2007). | 2            |
|                            | 1 µg/g wet weight in biota                     | This value was obtained as the maximum from concentrations of total mercury found in arctic fish muscle between 1990 and 2009 (AMAP, 2011). Wet weight concentrations were not reported for birds.                                                                 |              |
| Total mercury (THg)        | In solution: 2.9 ng/L                           | This is the highest value that was measured in surface seawater as a result of snowmelt deposition                                                                                                           | 39           |
| Substance          | Environmentally Relevant Concentration Threshold | Justification                                                                                                                                                                                                 | Study Number |
|--------------------|--------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| Substances         | In an Arctic region (Dommergue et al., 2010). The season in which this phenomenon occurs coincides with major biological events (i.e., phytoplankton blooms followed by zooplankton blooms); therefore, Arctic species will potentially encounter these concentrations of THg in seawater. |                                                                                                                                                |              |
| Inorganic Mercury  | Study-specific (see Frouin et al., 2012)         | Bioaccumulation of Hg in marine mammals can reach high levels and be absorbed into every component of the body (organs, blood, tissues, and cells; Das et al. 2016). Chronic, low exposures over time can result in exceedingly high concentrations in biota. Due to the difficulty of defining a single threshold value for these complex interactions, thresholds for these compounds, and others where bioaccumulation is a significant factor to consider, will be based on study-specific scenarios. | 14a          |
| Organic Mercury    | Study-specific (see Frouin et al., 2012)         | Bioaccumulation of Hg in marine mammals can reach high levels and be absorbed into every component of the body (organs, blood, tissues, and cells; Das et al. 2016). Chronic, low exposures over time can result in exceedingly high concentrations in biota. Due to the difficulty of defining a single threshold value for these complex interactions, thresholds for these compounds, and others where bioaccumulation is a significant factor to consider, will be based on study-specific scenarios. | 14b          |
| Lead               | < 3000 µg Pb/g dry weight                        | Range of possible uptake into soft tissue for the common mussel *Mytilus edulis* (Schulz-Baldes, 1974).                                                                                                           | 48           |
| Microplastics      | 14,400 particles/L                               | The greatest concentration of microplastics found in Arctic snow (Bergmann et al., 2019).                                                                                                                       | 46           |
| Cl                  | 640 mg/L                                         | CCME Water Quality Guideline for the Protection of Aquatic Life (CCME, 2011).                                                                                                                                   | 30           |
| Aluminum           | 21.2 µg/L                                        | Maximum concentration measured in the field by Moore et al., 2016.                                                                                                                                              | 31, 32       |
| Arsenic            | 5.0 µg/L                                         | CCME Water Quality Guideline for the Protection of Aquatic Life (CCME, 2001).                                                                                                                                   | 31, 32       |
| Cadmium            | 1.0 µg/L                                         | CCME Water Quality Guideline for the Protection of Aquatic Life (CCME, 2014).                                                                                                                                   | 31, 32       |
| Chromium           | 8.9 µg/L                                         | CCME Water Quality Guideline for the Protection of Aquatic Life (CCME, 1999a).                                                                                                                                   | 31, 32       |
| Copper             | 0.6 µg/L                                         | Maximum concentration measured in the field by Moore et al., 2016.                                                                                                                                              | 31, 32       |
| Nickel             | 18.5 µg/L                                        | Maximum concentration measured in the field by Moore et al., 2016.                                                                                                                                              | 31, 32       |
| Zinc               | 37 µg/L                                          | CCME Water Quality Guideline for the Protection of Aquatic Life (CCME, 2018).                                                                                                                                   | 31, 32       |
| NO2                 | 5.83 mg/L                                        | Maximum concentration measured in the field by Moore et al., 2016.                                                                                                                                              | 33           |
| NO3                 | 310 mg/L                                         | Maximum concentration measured in the field by Moore et al., 2016.                                                                                                                                              | 33           |
| Substance | Environmentally Relevant Concentration Threshold | Justification | Study Number |
|-----------|-----------------------------------------------|---------------|--------------|
| NH3 $^a$  | 0.019 mg/L                                    | CCME Water Quality Guideline for the Protection of Aquatic Life (CCME, 2010). | 33           |
| NH4 $^a$  | 200 mg/L                                      | Maximum concentration measured in the field by Moore et al., 2016. | 33           |
| Na2SO4    | 0.350 g/L                                     | Maximum observed WQO measured in the field by Moore et al., 2016. | 30           |
| Na2MoO4   | 73 µg/L                                       | CCME Water Quality Guideline for the Protection of Aquatic Life (CCME, 1999b). | 30           |

**PHENOLS AND FLAME RETARDANTS**

| Substance | Environmentally Relevant Concentration Threshold | Justification | Study Number |
|-----------|-----------------------------------------------|---------------|--------------|
| PCBs      | In biota: 600 mg/kg lipid weight              | PCBs measured in blubber have reached 574 mg/kg lipid weight (Buckman et al., 2011); therefore, the environmentally realistic concentration for this exposure scenario captures the upper end of this measurement. | 6a, 6b, 40, 29a, 29b, 29c, 29d |
| Phenol    | < 1000 µg/L                                   | The maximum environmentally realistic concentration of total petroleum hydrocarbons, of which phenol is one when measured during an oil spill (see justification for crude oil) | 45b           |

$^a$ Values are for acute exposure in freshwater environments to mirror the exposure scenario from this study.

$^b$ Value is for all compounds containing chloride; see Moore et al., 2016.
Table S3: Description of purity and/or grade of substances that have been tested on Arctic species from studies assessed in this review that do not have easily measured purities or grades.

| Substance      | Purity/Grade                                                                 |
|----------------|-----------------------------------------------------------------------------|
| Chemical dispersant | Artificially weathered (AWT), naturally weathered (NWT), or fresh (FR) will be reported as the purity. Weathering process and time included. Score will be given depending on reporting of dispersant type. |
| Oil or fuel    | Weathered (WT) or fresh (FR) will be reported as the purity. Weathering process and time included. Score will be given depending on reporting of oil or fuel type. |
Table S4: Relevant environmental parameters upon which scoring was based for organisms used as test species in studies assessed in this review.

| Test Type | Organism Type                        | Minimum Parameters Identified              |
|-----------|--------------------------------------|--------------------------------------------|
| **In vivo** | Fish, crustaceans, other invertebrates, molluscs | Temperature and dissolved oxygen           |
|           | Primary producers                    | Temperature, light, photoperiod, pH        |
|           | Birds                                | Temperature                                |
|           | Mammals                              | Temperature and dissolved oxygen           |
| **In vitro** | All                                 | Temperature, media type                    |
| Knowledge Gap                                                                 | Recommendation                                                                                                                                                                                                 |
|------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Lack of standard toxicity and recovery test methods for Arctic species.     | Strive toward developing standard laboratory tests (whole organism and *in vitro*), and in the absence of standard tests provide a thorough description of what was modified from standard methods.                          |
| Lack of toxicity data for Arctic-focused risk assessments in general, especially for some ecologically important groups. | Generate toxicity data using organisms that are likely the most sensitive first (i.e., algae). Emphasize the development and refinement of models and surrogates (e.g., temperate species) using these data and confirm protection with ongoing toxicity testing. |
| Lack of diversity in compounds tested on Arctic organisms.                  | Design repeatable and reliable experiments using standard reference toxicants so that results can be compared across space and time.                                                                               |
| Inconsistencies in oil spill related research has led to a lack of comparability between studies, Arctic or otherwise. | Focus research on developing, validating, and refining laboratory methods and predictive effects models.                                                                                                         |
| Lack of highly relevant sublethal and chronic endpoints assessed in Arctic toxicity testing. | Prioritize the incorporation of these endpoints into future Arctic toxicity test protocols.                                                                                                                  |
Figure S1: Number of unique toxicity tests (n = 253) that met inclusion criteria outlined in the present review from 1975 to 2020. Blue line is cumulative output of toxicity tests over time. Spearman’s correlation coefficient (rho) = 0, p = 1.
Figure S2: Proportion of each compound group observed among all unique toxicity tests captured in this review (n = 253 as of June 2021) by decade.
**Figure S3**: Number of unique Arctic species toxicity tests captured in this review (n = 253 as of June 2021) by organism group, with organism type within bars (number below each bar is total number of unique tests).
Figure S4: Proportion of marine and freshwater unique toxicity tests captured in this review (n = 253 as of June 2021) by organism type (number below each bar is total number of unique tests).
Figure S5: Proportion of marine and freshwater unique toxicity tests captured in this review (n = 253 as of June 2021) by test compound group.
Figure S6: Scores (as percentage) over time ($n = 253$) for criterion group A (test substance) across all studies assessed in the present review. Spearman’s correlation coefficient ($\rho$) = 0.09, $p = 0.16$. 
Figure S7: Scores (as a percentage) over time (n = 253) for criterion group B (test organism and test system) across all studies assessed in the present review. Spearman’s correlation coefficient (rho) = 0.65, p < 0.001.
Figure S8: Scores (as a percentage) over time (n = 253) for criterion group C (test design, statistics, and results) across all studies assessed in the present review. Spearman's correlation coefficient (rho) = 0.56, $p < 0.001$. 
Figure S9: Overall scores (as a percentage) over time (n = 253) across all studies assessed in the present review. Spearman’s correlation coefficient (rho) = 0.5, $p < 0.001$. 
Figure S10: Relationship between overall score and the journal impact factor at the time of publication across all studies assessed in the present review. Spearman’s correlation coefficient (rho) = 0.33, p < 0.00
Figure S11: Percentage of unique toxicity tests (n = 253 as of June 2021) that achieved a score of 1 for each criterion in Group A (test substance). Criterion 1: test substance purity and/or grade reported; Criterion 2: any measured concentrations analytically confirmed; Criterion 3: individual initial measured concentrations analytically confirmed; Criterion 4: individual final measured concentrations analytically confirmed; Criterion 5: greater than or equal to three concentrations tested, excluding control; Criterion 6: at least one ecologically relevant concentration tested.
Figure S12: Percentage of unique toxicity tests (n = 253 as of June 2021) that achieved a score of 1 for each criterion in Group B (test organism and test system). Criterion 7: strain or source identified; Criterion 8: initial test organism characteristics described; Criterion 9: standard protocol followed; Criterion 10: test conditions reported.
Figure S13: Percentage of unique toxicity tests (n = 253 as of June 2021) that achieved a score of 1 for each criterion in Group C (test design, statistics, and results). Criterion 11: greater than or equal to three replicates included; Criterion 12: statistical methods described; Criterion 13: concentration-response model and parameters provided; Criterion 14: raw data reported; Criterion 15: control values reported and criteria met.
Figure S14: Percentage of unique toxicity tests \((n = 253)\) that achieved a score of 1 in each critical study criterion outlined in the scoring rubric presented in this study. Number above each bar corresponds to percentage of tests with a score of 1 for that criterion.
Figure S15: Percentage of unique toxicity tests (n = 253) by organism type that achieved a score of 1 in each critical study criterion outlined in the scoring rubric presented in this study.
Figure S16: Relevance scores for all experimental combinations assessed in this study (i.e., test substance/test species/endpoint combinations, n = 596) by test substance type. Bars are standard error and letters above each column indicate statistical significance between groups ($p < 0.05$) based on Kruskal-Wallis rank sum tests.
Figure S17: Overall and relevance scores for all experimental combinations collected in this study by organism group (n = 596). Size of circle corresponds to number of studies. Numerical values in each quadrant refer to percentage of data points with a relevance score between 0 and 3 (inclusive) and an overall score of < 50% (bottom left quadrant) or > 50% (bottom right quadrant), and relevance score between 4 and 6 (inclusive) and an overall score of < 50% (top left quadrant) or > 50% (top right quadrant).
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