LEVER

The Model Seafood Welfare Standard
A Science-Based Approach to Fish and Crustacean Welfare

How the Model Seafood Welfare Standard was developed

The Model Seafood Welfare Standard (MSWS) is grounded in independent, peer-reviewed research on finfish and decapod crustaceans, international guidance from bodies such as the World Organisation for Animal Health (WOAH)[1] and the European Food Safety Authority (EFSA)[2], and the iterative input of leading non-profits working on seafood welfare including the RSPCA, The Humane League, Eurogroup for Animals, the Fish Welfare Initiative, the Shrimp Welfare Project, Crustacean Compassion, Albert Schweitzer Foundation, World Animal Protection, Ethical Seafood Research and Lever Foundation, among others.

This evidence base spans the main MSWS components across farmed and wild-caught supply chains, including rearing conditions (water quality, stocking density, environmental enrichment), handling and transport, stunning and slaughter, and capture and onboard handling. The studies measured welfare outcomes such as stress physiology, time to unconsciousness, injury, illnesses, and mortality rates, behaviour, and pain. The MSWS prioritizes measures with strong evidence of welfare benefit and feasibility at scale.

Why seafood welfare matters

Seafood is one of the most significant animal protein sources globally, both in terms of scale and impact. Over 130 billion farmed finfish and an estimated 1 to 2 trillion wild-caught finfish are killed for food each year, a number at least 10 times higher than that of all farmed land animals combined[3]. Shrimp also contribute on an enormous scale, with an estimated 440 billion farmed each year.[4]

Given the vast numbers involved, seafood welfare may be the most important animal welfare area for food companies to address. Improvements in handling, stocking density, capture, and humane slaughter deliver impact at unprecedented scale, while also supporting carbon reduction[5], environmental performance, and brand protection in a rapidly evolving ESG landscape. The MSWS was developed to provide clear, science-based guidelines for these high-impact areas to help food companies respond to growing stakeholder expectations and scale welfare improvements in aquaculture and wild-catch supply chains.

Fish and crustacean sentience

Countless independent scientific studies demonstrate that finfish and decapod crustaceans are capable of pain and other affective states, warranting explicit welfare protections. For fish, peer-reviewed syntheses show conserved nociception and pain-related behaviours across species, including physiological stress responses,

---

[1] Aquatic animal health code
[2] https://www.efsa.europa.eu/en/topics/topic/fish-welfare
[3] https://fishcount.org.uk/fish-count-estimates-2/updated-farmed-fish-crustacean-estimates
[4] https://forum.effectivealtruism.org/posts/Ztqzt4BWMPZW5ECfP/shrimp-welfare-project-s-2030-vision-and-absorbency-plans#:~:text=~440%20billion%20shrimps%20are%20farmed,of%20our%202025%20Funding%20Proposal.
[5] FAO, 2017; MacLeod et al., 2020

avoidance learning, and long-term behavioural changes[6]. Broad literature reviews[7], have documented extensive behavioural and physiological evidence confirming that fish are sentient and capable of suffering. For decapod crustaceans, a UK government-commissioned review by the London School of Economics evaluated over 300 scientific studies and concluded that there is strong evidence of sentience in crabs, lobsters, crayfish, and shrimp[8]. Based on this scientific assessment, decapod crustaceans and cephalopods were formally recognised as sentient animals under the UK Animal Welfare (Sentience) Act 2022.

Science-based authorities used by industry and regulators echo these conclusions and provide clear welfare recommendations. For example, the European Food Safety Authority (EFSA) has issued species-specific scientific opinions on the humane stunning and killing of farmed fish[9], concluding that fish must be rendered immediately unconscious to prevent avoidable suffering. Similarly, the World Organisation for Animal Health (WOAH)'s Aquatic Animal Health Code[10] states that fish should be handled and slaughtered in ways that minimize pain, distress, and suffering, including effective stunning prior to killing. Because fish and decapod crustaceans are sentient animals raised for food, their welfare requires protection through humane farming, capture, handling, and slaughter practices, consistent with internationally recognized animal welfare principles.

How aquaculture environments (including stocking density and enrichments) impact animal welfare. High stocking densities are consistently linked to chronic stress and poorer welfare outcomes in finfish, including reduced growth, altered physiological responses, impaired immune function, and increased injury. Studies including Baßmann (2023)[11], Lambert (2024)[12], and others make clear the negative impact of excessively high stocking densities and demonstrate why setting species-specific density limits is both practical and necessary for protecting animal welfare in aquaculture systems.

Environmental enrichment has likewise been shown to improve welfare across a range of farmed fish species. Research and systematic reviews, including Arechavala-Lopez (2022)[13] and Ojelade (2022)[14], document that providing structural complexity and environmental stimulation promotes natural behaviours, increases activity levels, and in some cases improves growth performance and survival. These findings support the inclusion of enrichment requirements as a meaningful welfare intervention rather than an optional husbandry practice.

Providing shelters and structural complexity has been shown to significantly improve welfare in cultured decapod crustaceans by reducing aggression, cannibalism, and injury, while improving survival rates. Studies including Ma

---

[6] Sneddon, L. U. (2019). Evolution of nociception and pain: Evidence from fish models. Philosophical Transactions of the Royal Society B. https://doi.org/10.1098/rstb.2019.0290
[7] Lambert, H. et al. (2022). A Kettle of Fish: A Review of the Scientific Literature for Evidence of Fish Sentience. Animals. https://www.mdpi.com/2076-2615/12/9/1182
[8] Birch, J., Burn, C., Schnell, A., Browning, H., & Crump, A. (2021). Review of the Evidence of Sentience in Cephalopod Molluscs and Decapod Crustaceans. London School of Economics. https://www.lse.ac.uk/business/consulting/reports/sentience-in-cephalopod-molluscs-and-decapod-crustaceans
[9] European Food Safety Authority (EFSA). Scientific Opinion on welfare aspects of stunning and killing farmed fish. https://www.efsa.europa.eu/en/efsajournal/pub/1012
[10] World Organisation for Animal Health (WOAH). Aquatic Animal Health Code – Section 7: Welfare of Farmed Fish. https://www.woah.org/en/what-we-do/standards/codes-and-manuals/aquatic-code-online-access/
[11] Baßmann, B. et al. (2023). The impact of stocking density on fish welfare in aquaculture: A systematic review. Fishes, 8(2), 74. https://www.mdpi.com/2410-3888/8/2/74
[12] Lambert, H. et al. (2024). Welfare considerations in farmed fish: Effects of stocking density on health, behavior, and physiology. Frontiers in Veterinary Science. https://www.frontiersin.org/articles/10.3389/fvets.2023.1335667
[13] Arechavala-Lopez, P. et al. (2022). Environmental enrichment in fish aquaculture: A review of welfare benefits. Reviews in Aquaculture. https://onlinelibrary.wiley.com/doi/10.1111/raq.12666
[14] Ojelade, O. C. et al. (2022). Environmental enrichment and its effects on fish welfare, growth, and survival in aquaculture systems. Animals, 12(20), 2751. https://www.mdpi.com/2076-2615/12/20/2751

et al. (2021)[15], He et al. (2022)[16], and Fruscella et al. (2025)[17] demonstrate that access to refuges allows animals to avoid aggressive encounters, express natural defensive behaviours, and recover following molting, a period when individuals are particularly vulnerable. These findings confirm that environmental complexity is a critical component of humane aquaculture systems for crustaceans, with measurable benefits for both welfare and survival.

MSWS requires that environments — including stocking density, enrichments, crowding, handling, and time out of water — align with high-welfare standards such as those of Global Animal Partnership, RSPCA Assured, Naturland, or Certified Humane. These certification programs include established, science-based environmental welfare requirements that address the key risk factors associated with aquaculture production. Their standards are informed by peer-reviewed research and regulatory guidance, including EFSA scientific opinions and broader animal welfare literature, and translate this scientific evidence into clear, measurable requirements for producers. By aligning with these programs, MSWS ensures that environmental conditions are managed in accordance with practices that have been demonstrated to improve welfare outcomes.

Studies across aquaculture species show that managing environmental factors such as stocking density, enrichment, and handling reduces stress and aggression, lowers rates of injury and cannibalism, and improves growth and survival. By lowering mortality and improving feed efficiency, these measures also reduce wasted inputs and contribute to lowering the carbon footprint and environmental impact of seafood production.

How aquaculture water conditions impact animal welfare

Suboptimal water quality is one of the primary drivers of stress, impaired health, and mortality in aquaculture systems. Low dissolved oxygen reduces growth, compromises immune function, and increases mortality risk, while elevated ammonia and carbon dioxide impair respiratory function, alter behavior, and increase susceptibility to disease.[18] [19] Maintaining water quality within species-appropriate ranges has been shown to improve growth and survival, reduce physiological stress, and lower mortality. For example, maintaining adequate dissolved oxygen improves welfare and performance in farmed salmonids, while controlling ammonia and carbon dioxide prevents gill damage, metabolic stress, and impaired swimming capacity. [20] [21] Regulatory guidance from EFSA and the EU Platform on Animal Welfare further emphasizes that routine monitoring and corrective action are necessary to prevent avoidable welfare harms and production losses.[22]

These findings support MSWS's requirement for daily tracking of key water quality parameters as a critical welfare safeguard.

---

[15] Ma, H. et al. (2021). Effects of shelter availability on behavior, growth, and survival of swimming crabs (Portunus trituberculatus). Animals, 11(2), 370.
https://www.mdpi.com/2076-2615/11/2/370
[16] He, J. et al. (2022). Effects of habitat structure on aggression, survival, and welfare in cultured crustaceans. Frontiers in Marine Science. https://www.frontiersin.org/articles/10.3389/fmars.2022.1018565
[17] Fruscella, V. et al. (2025). Shelter provision improves survival and reduces aggression in cultured decapod crustaceans: A systematic review. Aquaculture Reports. https://pmc.ncbi.nlm.nih.gov/articles/PMC12383070
[18] European Food Safety Authority (EFSA). (2009). Scientific Opinion on welfare aspects of farmed fish: Stunning and killing methods and environmental conditions. https://www.efsa.europa.eu/en/efsajournal/pub/1012
[19] Samaras, A. et al. (2023). Effects of dissolved oxygen on growth, metabolism, and welfare of farmed fish. Aquaculture, 562, 738746. https://doi.org/10.1016/j.aquaculture.2022.738746
[20] Thorarensen, H. & Farrell, A. (2023). The biological requirements for dissolved oxygen and CO_2 in aquaculture. Aquaculture, 564, 739033. https://doi.org/10.1016/j.aquaculture.2022.739033
[21] Goodwin, A. et al. (2016). Nitrogenous waste toxicity and gill damage in fish exposed to ammonia. Reviews in Aquaculture, 8(2), 115-121. https://doi.org/10.1111/raq.12082
[22] European Commission. (2022). Platform on Animal Welfare – Guide to Good Practices for the Welfare of Farmed Fish. https://food.ec.europa.eu/system/files/2022-07/aw_platform_plat-conc_guide_farmed-fish_en.pdf

How disease and mortality tracking in aquaculture impact animal welfare

Disease outbreaks are one of the primary causes of mortality in aquaculture, with significant impacts on animal welfare, production efficiency, and environmental performance. Infectious diseases cause physiological stress, impair immune function, and can lead to substantial cumulative mortality if not properly prevented, detected, and managed. Routine monitoring and investigation of mortality are critical management tools, allowing early detection of disease outbreaks and timely intervention, which improves welfare outcomes and reduces overall losses. Prompt treatment and effective health management reduce mortality and limit pathogen transmission, safeguarding both animal welfare and production stability.[23] [24] Because feed production and farm operations account for the majority of aquaculture's greenhouse gas emissions, reducing mortality directly lowers the carbon intensity and environmental footprint of seafood production.[25] [26]

The MSWS requirement for daily monitoring and investigation of disease and mortality provides a clear, science-based framework to support early intervention, improve animal health, and reduce preventable losses. By strengthening survival and production efficiency, these requirements help protect animal welfare while also improving the environmental performance and sustainability of seafood supply chains.

How mutilations impact animal welfare

Common mutilation practices in aquaculture, including fin clipping, eyestalk ablation in shrimp, and other invasive handling procedures, have been shown to cause significant pain, physiological stress responses, impaired immune function, and reduced survival.[27]

Eyestalk ablation in shrimp, a practice historically used to stimulate reproduction, is associated with endocrine disruption, immune suppression, and increased mortality, with documented long-term welfare consequences.[28] Fin clipping and invasive tagging in fish cause tissue damage, impair swimming performance, and increase susceptibility to infection.[29] Importantly, studies demonstrate that eliminating eyestalk ablation improves long-term broodstock survival and reproductive stability in shrimp,[30] while replacing fin clipping with non-invasive identification methods reduces injury and mortality in fish.[31] More broadly, scientific reviews conclude that invasive physical alterations compromise both welfare and productivity by negatively affecting growth, survival, and stress resilience.[32]

The MSWS prohibition of mutilations, including eyestalk ablation and other invasive physical alterations, directly addresses these well-documented welfare risks. By eliminating practices that cause pain, physiological stress, and

---

[23] Ndashe, K. et al. (2023). Disease and mortality risk in aquaculture systems: A global review. Fishes, 8(1), 49. https://www.mdpi.com/2410-3888/8/1/49
[24] Rowley, A. et al. (2024). Emerging infectious diseases in aquaculture and their impact on fish welfare and production. One Health, 18, 100630. https://www.sciencedirect.com/science/article/pii/S2352771424000630
[25] FAO. (2017). Greenhouse gas emissions from aquaculture. https://www.fao.org/3/i3437e/i3437e.pdf
[26] Zhang, W. et al. (2024). Environmental performance and carbon intensity of aquaculture production systems. Aquaculture Reports, 34, 101914. https://www.sciencedirect.com/science/article/pii/S2352513424000338
[27] Diggles, B. K. (2019). Welfare considerations for farmed crustaceans and fish subjected to invasive procedures. Journal of the World Aquaculture Society, 50(5), 902–931. https://doi.org/10.1111/jwas.12667
[28] Fotedar, S., & Evans, L. (2011). Health management during eyestalk ablation in shrimp. Aquaculture, 319(3–4), 269–273. https://doi.org/10.1016/j.aquaculture.2011.06.019
[29] Mulcahy, D. M. (2003). Surgical implantation and fin clipping effects in fish. Aquaculture, 212(1–4), 111–124. https://doi.org/10.1016/S0044-8486(02)00291-8
[30] Alfaro-Montoya, J. et al. (2019). Effects of eyestalk ablation on reproductive performance and survival in penaeid shrimp. Aquaculture Research, 50(4), 1071–1081. https://doi.org/10.1111/are.13971
[31] Prentice, E. et al. (2022). Welfare implications of fin clipping versus alternative tagging methods. Fishes, 7(6), 375. https://www.mdpi.com/2410-3888/7/6/375
[32] Arechavala-Lopez, P. et al. (2020). Fish welfare in aquaculture: A systematic review. Frontiers in Marine Science, 7, 273. https://doi.org/10.3389/fmars.2020.00273

increased mortality, MSWS ensures that aquatic animals are not subjected to avoidable harm during production. This requirement aligns with the scientific consensus that preventing invasive procedures improves survival, health, and overall welfare outcomes, while also supporting more efficient and sustainable production systems by reducing preventable losses.

How wild fisheries bycatch rates impact animal welfare

In addition to welfare harms to targeted fish, wild-catch fishing methods can also kill and cause suffering to huge numbers of non-targeted species (bycatch) which are simply discarded back into the ocean after capture. Gill nets for example are associated with high bycatch rates of non-target species, including protected marine animals, contributing to biodiversity loss and ecosystem disruption.[33] Lost or abandoned fishing gear ("ghost gear") continues to entangle marine life and represents both ecological damage and wasted biomass.[34]

The MSWS limits bycatch rates to 20% of the total volume of fish captured. While global bycatch rates are around 11%, for some fisheries, species and companies, bycatch can reach as high as 50%.[35] [36] The 20% threshold is a commonly used benchmark recommended by Monterey Bay Aquarium and others as a highly achievable target. [37] [38] [39] [40] [41]

By prohibiting capture methods associated with extremely high bycatch rates, the MSWS reduces animal suffering, minimizes mortality in non-target species, and lowers the environmental and biodiversity impact of seafood supply chains.

How duration of capture and pre-slaughter mortality in wild fisheries impact animal welfare

The duration of capture is a critical determinant of animal welfare during wild capture. The longer fish and crustaceans remain crowded in nets or suspended on hooks prior to being hauled in and slaughtered, the longer they experience intense physiological stress, exhaustion, injury, and impaired respiratory function.[42]

Prolonged capture duration has been shown, across all wild-catch fishing methods, to significantly worsen physiological stress indicators such as blood chemistry imbalance and to increase exhaustion, crowding, crushing,

---

[33] Lewison, R. L. et al. (2014). Global patterns of marine mammal, seabird, and turtle bycatch. Science, 344(6181), 126–130. https://doi.org/10.1126/science.1257486
[34] Macfadyen, G. et al. (2009). Abandoned, lost or otherwise discarded fishing gear. FAO Fisheries and Aquaculture Technical Paper No. 523. https://www.fao.org/3/i0620e/i0620e.pdf
[35] Gilman, Eric, et al. "Benchmarking Global Fisheries Discards." Scientific Reports, vol. 10, 2020, article 14017. PubMed Central, https://pmc.ncbi.nlm.nih.gov/articles/PMC7441149/
[36] Monterey Bay Aquarium. Seafood Watch: Environmental Sustainability of Wild-Caught Tuna and Tuna-like Species, Western and Central Pacific Ocean (WCPO): Drifting Longlines. 3 Nov. 2025. Seafood Watch, https://www.seafoodwatch.org/globalassets/sfw-data-blocks/reports/t/seafood-watch-tuna-pelagic-wcpo-28119.pdf
[37] Gilman, Eric, et al. "Benchmarking Global Fisheries Discards." Scientific Reports, vol. 10, 2020, article 14017. PubMed Central, https://pmc.ncbi.nlm.nih.gov/articles/PMC7441149/.
[38] Kelleher, Kieran. Discards in the World's Marine Fisheries: An Update. Food and Agriculture Organization of the United Nations, 2005. FAO, https://www.fao.org/4/y5936e/y5936e00.htm
[39] Pérez Roda, Maria Amparo, et al. A Third Assessment of Global Marine Fisheries Discards. FAO Fisheries and Aquaculture Technical Paper No. 633, Food and Agriculture Organization of the United Nations, 2019. FAO Open Knowledge, https://openknowledge.fao.org/handle/20.500.14283/ca2905en
[40] Benaka, Leslie R., et al. U.S. National Bycatch Report: First Edition Update 3. NOAA Fisheries, 2019. NOAA, https://media.fisheries.noaa.gov/dam-migration/nbr_update_3.pdf
[41] Monterey Bay Aquarium, Seafood Watch. Seafood Watch® Fisheries Update Summary. 2015. Seafood Watch, https://www.seafoodwatch.org/globalassets/sfw/pdf/standards-revision-reference/2015-standards-revision/public-consultation-2/seafood-watch-fisheries-update-summary.pdf
[42] Schuck-Paim, C. et al. (2025). Air exposure and welfare impacts in commercially captured fish. Scientific Reports. https://www.nature.com/articles/s41598-025-04272-1

barotrauma, scale loss, and pre-slaughter mortality.[43 44] For example, gill nets can leave fish entangled for extended periods, resulting in asphyxiation, injury, and delayed mortality.[45] Reviews and field studies consistently identify haul duration as one of the primary determinants of injury and survival outcomes during capture.

As noted, prolonged capture duration has also been shown to dramatically increase pre-slaughter mortality rates. Higher pre-slaughter mortality is a major animal welfare issue for two reasons. First, most animals that die during the capture period experience intense suffering and a prolonged death. Second, some animals that die during the capture period are not able to enter the food chain, meaning the animal suffering has not even resulted in food production. [46 47 48 49 50 51 52 53 54]

Taken together, prolonged duration of capture and the heighted pre-slaughter mortality rates that result represent by far the biggest animal welfare problem in wild fisheries. They are the primary source of suffering for wild-caught fish and crustaceans. Shorter haul times and rapid landing significantly reduce these harms by limiting crowding, stress, physical injury, and physiological exhaustion, as well as by lowering pre-slaughter mortality.

The MSWS requirements limit capture duration to 90 minutes for trawls, gillnets, seines, longlines and similar, and to 12 hours for pots, traps and dredges. Research makes clear that when capture durations exceed these periods, injury and pre-slaughter increase substantially. [55 56 57 58 59 60 61]

---

[43] Veldhuizen, L. J. L. et al. (2018). Welfare of wild-caught fish in commercial fisheries: A review. Fish and Fisheries, 19(5), 911–930. https://doi.org/10.1111/faf.12299
[44] Garratt, M. et al. (2022). Welfare impacts of trawl capture and crowding on fish physiology and survival. Journal of Applied Animal Welfare Science, 25(3), 1–16. https://doi.org/10.1080/10888705.2022.2036615
[45] Tomás, J. et al. (2024). Effects of soak time and air exposure on post-release survival of gill-net captured fish. Fisheries Research, 271, 106944. https://doi.org/10.1016/j.fishres.2024.106944
[46] Veldhuizen, L. J. L., et al. "Fish Welfare in Capture Fisheries: A Review of Injuries and Mortality." Fisheries Research, vol. 204, 2018, pp. 41–48. Elsevier, https://doi.org/10.1016/j.fishres.2018.02.001
[47] Cook, Katrina V., et al. "A Synthesis to Understand Responses to Capture Stressors among Fish Discarded from Commercial Fisheries and Options for Mitigating Their Severity." Fish and Fisheries, vol. 20, no. 1, 2019, pp. 25–43. Wiley, https://doi.org/10.1111/faf.12322
[48] Davis, Michael W. "Key Principles for Understanding Fish Bycatch Discard Mortality." Canadian Journal of Fisheries and Aquatic Sciences, vol. 59, no. 11, 2002, pp. 1834–1843. Canadian Science Publishing, https://doi.org/10.1139/f02-139
[49] Patterson, David A., et al. Review and Evaluation of Fishing-Related Incidental Mortality for Pacific Salmon. Canadian Science Advisory Secretariat, Research Document 2017/010, Fisheries and Oceans Canada, 2017.
[50] Gilman, Eric, et al. "Causes and Methods to Estimate Cryptic Sources of Fishing Mortality." Journal of Fish Biology, vol. 83, no. 4, 2013, pp. 766–803. Wiley, https://doi.org/10.1111/jfb.12148
[51] Madsen, Niels, et al. "Estimating Discard Mortality in Commercial Fisheries without Fish Dying: A 3R Challenge." Animals, vol. 12, no. 6, 2022, article 714. MDPI, https://doi.org/10.3390/ani12060714
[52] Tenningen, Magnus, et al. "Pre-Catch and Discard Mortality in Northeast Atlantic Herring and Mackerel Fisheries: Consequences for Stock Estimates and Advice." ICES Journal of Marine Science, vol. 78, no. 7, 2021, pp. 2603–2617. Oxford UP, https://doi.org/10.1093/icesjms/fsab146
[53] Schuck-Paim, Cynthia, et al. "Quantifying the Welfare Impact of Air Asphyxia in Rainbow Trout Slaughter for Policy and Practice." Scientific Reports, vol. 15, 2025, article 19850. Nature Portfolio, https://doi.org/10.1038/s41598-025-04272-1
[54] Uhlmann, Saskia S., et al. "Injury, Reflex Impairment, and Survival of Beam-Trawled Flatfish." ICES Journal of Marine Science, vol. 73, no. 4, 2016, pp. 1244–1254, https://doi.org/10.1093/icesjms/fsv252
[55] Veldhuizen, L. J. L., et al. "Fish Welfare in Capture Fisheries: A Review of Injuries and Mortality." Fisheries Research, vol. 204, 2018, pp. 41–48, https://doi.org/10.1016/j.fishres.2018.02.001
[56] Cook, Katrina V., et al. "A Synthesis to Understand Responses to Capture Stressors among Fish Discarded from Commercial Fisheries and Options for Mitigating Their Severity." Fish and Fisheries, vol. 20, no. 1, 2019, pp. 25–43, https://doi.org/10.1111/faf.12322
[57] Tomás, M., et al. "Investigating the Effects of Pelagic Trawling on the Welfare of Atlantic Herring (Clupea harengus)." Scientific Reports, vol. 14, 2024, article 15311, https://doi.org/10.1038/s41598-024-65533-5
[58] Svalheim, R. A., et al. "Impact of Gillnet Soaking Time on Survival, Stress Physiology, and Muscle Quality in Atlantic Cod (Gadus morhua)." Animal Biotelemetry, vol. 13, 2025, article 7, https://doi.org/10.1186/s40317-025-00393-8
[59] Savina, E., et al. "Testing the Effect of Soak Time on Catch Damage in a Coastal Gillnet Fishery Targeting Common Sole (Solea solea)." Food Control, vol. 70, 2016, pp. 180–186, https://doi.org/10.1016/j.foodcont.2016.05.048
[60] Roth, Bjørn, et al. "Stress Associated with Commercial Longlining and Recreational Fishing of Saithe (Pollachius virens) and the Subsequent Effect on Blood Gases and Chemistry." Fisheries Research, vols. 115–116, 2012, pp. 110–114, https://doi.org/10.1016/j.fishres.2011.05.003
[61] Stevens, B. G. "The Ups and Downs of Traps: Environmental Impacts, Entanglement, Mitigation, and Benefits of Pots and Traps to Capture Fish and Crustaceans." ICES Journal of Marine Science, vol. 78, no. 2, 2021, pp. 584–596, https://doi.org/10.1093/icesjms/fsaa19

The MSWS also limits catch load to 50% of hold capacity. Research has made clear that limiting hold capacity in this way substantially reduces injury, suffering, and pre-slaughter mortality. [62] [63][64] [65] [66] [67]

How time out of water in wild fisheries impacts animal welfare

The duration of air exposure is another important determinant of animal welfare during wild capture. Minimizing time out of water is essential to prevent suffocation and prolonged distress. Experimental studies show that even brief air exposure causes severe stress responses, while loss of consciousness without stunning can take many minutes.[68] The MSWS limits time out of water to one minute to substantially reduce suffering, as well as to improve survival outcomes for discarded bycatch.

How different stunning and slaughter methods impact animal welfare

Conventional slaughter methods such as asphyxiation in air, ice slurry, or exposure to carbon dioxide can cause prolonged distress and delayed loss of consciousness in fish and crustaceans. Scientific assessments by the European Food Safety Authority (EFSA) have documented that these methods may leave animals conscious for extended periods while experiencing physiological stress, aversive reactions, and impaired respiratory function.[69] Experimental and observational studies confirm that such methods result in prolonged suffering and delayed insensibility, highlighting significant welfare risks when effective stunning is not applied.[70] International regulatory authorities, including the World Organisation for Animal Health (WOAH), similarly recognize that slaughter without effective stunning exposes aquatic animals to avoidable pain and distress and recommend practices that ensure rapid loss of consciousness.[71]

In contrast, electrical and mechanical stunning methods, when correctly applied, induce rapid insensibility and significantly reduce behavioural and physiological indicators of distress. These methods shorten the time to unconsciousness, reduce struggling and injury, and improve welfare outcomes compared to non-stun slaughter methods. EFSA has concluded that effective stun-kill systems are essential to ensure immediate and irreversible loss of consciousness prior to death, thereby minimizing suffering during slaughter.

The MSWS requirement that slaughter must use electrical or mechanical stunning directly addresses these scientifically established welfare risks. By ensuring animals are rendered insensible before death, MSWS prevents avoidable suffering associated with prolonged asphyxiation or delayed loss of consciousness. This requirement

---

[62] Anders, Neil, et al. "Vitality as a Measure of Animal Welfare during Purse Seine Pumping Related Crowding of Atlantic Mackerel (Scomber scombrus)." Scientific Reports, vol. 12, 2022, article 21949, https://doi.org/10.1038/s41598-022-26373-x

[63] Anders, Neil, et al. "Physiological Response and Survival of Atlantic Mackerel Exposed to Simulated Purse Seine Crowding and Release." Conservation Physiology, vol. 9, no. 1, 2021, article coab076, https://doi.org/10.1093/conphys/coab076

[64] Digre, H., et al. "Pumping of Mackerel (Scomber scombrus) Onboard Purse Seiners and the Effects on Mortality, Catch Damage, and Fillet Quality." Fisheries Research, vol. 174, 2016, pp. 65–75, https://doi.org/10.1016/j.fishres.2015.09.009

[65] Anders, Neil, et al. "Physiological and Flesh Quality Consequences of Pre-Mortem Crowding Stress in Wild-Caught Mackerel (Scomber scombrus)." PLOS ONE, vol. 15, no. 2, 2020, e0228454, https://doi.org/10.1371/journal.pone.0228454

[66] Handegard, Nils Olav, et al. "Effects on Schooling Function in Mackerel of Sub-Lethal Capture-Related Stressors: Crowding and Hypoxia." Royal Society Open Science, vol. 4, no. 11, 2017, article 170432, https://doi.org/10.1098/rsos.170432

[67] Breen, Mike, et al. "A Review of Possible Mitigation Measures for Reducing Mortality Caused by Slipping from Purse-Seine Fisheries." ICES CM 2012/C:12, International Council for the Exploration of the Sea, 2012.

[68] Brownscombe, J. W. et al. (2022). Physiological impairment thresholds associated with air exposure in fish. https://www.fecpl.ca/wp-content/uploads/2022/09/brownscombe-et-al-identifying-thresholds-in-air-exposure.pdf

[69] European Food Safety Authority (EFSA). (2009). Scientific Opinion on welfare aspects of the main systems of stunning and killing farmed fish. https://www.efsa.europa.eu/en/efsajournal/pub/1012

[70] Gräns, A. et al. (2015). Physiological stress responses and welfare impacts of conventional slaughter methods in fish. Journal of Fish Biology, 86(3), 1017–1030. https://doi.org/10.1111/jfb.12624

[71] World Organisation for Animal Health (WOAH). Aquatic Animal Health Code – Chapter 7: Welfare of Farmed Fish. https://www.woah.org/en/what-we-do/standards/codes-and-manuals/aquatic-code-online-access/

aligns with EFSA and WOAH guidance and reflects the scientific consensus that humane stunning is essential to protecting animal welfare while also improving product quality and supporting responsible seafood production.