Shrimp Toolkit

Resource 1: Shrimp survival rate

Shrimp survival rate in % = ((% Pond1 Survival Rate x number to post larvae stocked in pond 1)+ (% Pond2 Survival Rate x number to post larvae stocked in pond 2) + … + (Pond'n' Survival Rate x number to post larvae stocked in pond 'n')) / (divided by) Total number of post larvae stocked in all ponds

Resource 1a: Glossary

LENGTH 1ft = 0.305m	LENGTH 1m = 3.281ft	AREA $1m^2 = 10.764ft^2$
AREA $1ft^2 = 0.0929m^2$	WEIGHT 1lb = 0.454kg	WEIGHT 1kg = 2.205lb
LIGHT 20 Lux = 1.858ft candle	LIGHT 0.25ft candle = 2.691 Lux	LIGHT 1ft candle = 10.764 Lux

Resource 2: Humane euthanasia, stunning and killing

Killing of shrimp

This advice is based on the available scientific evidence and on RSPCA Australia advice (See Resource 9). However, further research is required before definitive conclusions can be drawn about the humaneness of stunning and killing methods for crustaceans.

Chilling

Crustaceans are cold-blooded animals and reportedly enter a state of torpor at air temperatures of 4°C or below. They are rendered insensible when their body temperature is sufficiently reduced by chilling. Scientific proof of the association between chilling and absence of discomfort, stress or pain is limited. However, this process is commonly considered to be effective, as crustaceans subjected to chilling do not show the behavioural signs of stress that occur when some other killing methods (such as boiling) are used. Further research is needed to fully understand the effects of different chilling methods on crustacean welfare. One major benefit of chilling is that it reduces mobility. This makes crustaceans easier to handle and humanely kill, and also prevents individuals from injuring each other.

Chilling in an ice slurry

Tropical species of crustaceans, and temperate species that are susceptible to cold temperatures, may be stunned by chilling in an ice slurry. Insensibility occurs more quickly in an ice slurry than in air at similar temperatures, because water absorbs heat much faster than air. A saltwater ice slurry must be used for all marine species. Marine crustaceans should never be placed in a freshwater ice slurry, as this is likely to induce osmotic shock. Freshwater crustaceans should never be placed in a saltwater ice slurry. Chilling in an ice slurry is not recommended for temperate marine species that are adapted to colder temperatures. When a saltwater ice slurry is used, the salinity of the water in the slurry decreases as the ice melts, potentially causing osmotic shock if the animal is left in the slurry for too long. For cold-adapted species, this may occur before insensibility has been reached, unless the salinity of the slurry is maintained. Monitoring and proper control of salinity of the slurry may help to overcome this potential welfare problem.

Method of stunning and killing (combined)	Suitable for	Not suitable for
Chilling in an ice slurry.	All tropical crustaceans and temperate species that are susceptible to cold temperatures. A saltwater ice slurry must be used for marine species.	temperate marine species that are adapted to colder temperatures.

Resource 3: Medicine purchase and use records

Medicine purchase records to include: identity of medicine; quantity of medicine; date of purchase; name and address of supplier; batch number(s); and expiry date(s).

Medicine use records to include: the name of the drug or other substance; lot and batch number; quantity of medicine administered; date of treatment; identification of the group to which administered; age of treated animals; number of shrimp treated; date of administration; name of administrator; name of vet issuing prescription; reason for treatment; route of administration; length of treatment; withdrawal times if appropriate; and date of safe slaughter if appropriate.
Veterinary products must be properly labelled and stored appropriately.
Any treatments which have clearly not worked, or have produced an adverse reaction in the treated shrimp, must be reported to the appropriate local authority.
All farms must have a written pharmaceutical waste policy.

Resource 4: Health and welfare plan

1. The health and welfare plan will be reviewed at the start of every production cycle or on an annual basis by those with responsibility for the health and welfare of the shrimp, which may include the vet, health manager, stockpersons, nutritionist and other relevant personnel
2. The plan will include future husbandry plans, risk assessment, monitoring and control of health and diseases
3. Training in medicine administration and recognition of signs of poor health and welfare
4. Infectious disease control used and planned
5. Parasite control
6. Management of non-infectious (management-induced) disease and injury
7. Physical injury, control and monitoring.
8. Predator control
9. Fungal infection
10. Algae/bio/jellyfish blooms
11. Deformity
12. Health and disease incidence record-keeping
13. Written plan to respond to sudden increases in morbidity or mortality
14. Monitoring of KPIs and KWIs, and action planned to deal with increases in KWI or KPI levels
15. Corrective Action Plan within the health and welfare plan, to bring performance in line with good practice
16. Methods and records of slaughter

Resource 5: Biosecurity plan

1. Emergency contact list
2. Named biosecurity person(s)
3. Employee training in biosecurity
4. Lines of separation (LOS) including fences and separate areas), how they are used to protect the animals and people
5. Biosecurity entry procedures
6. Biosecurity exit procedures
7. Biosecurity requirements for visitors (visitor book, PPE)
8. Biosecurity requirements for feed and other deliveries (recording entry, PPE, disinfection)
9. Cleaning and disinfection operating procedures
10. Disinfectant chemicals used (approvals, safe use, dilutions, replenishment)
11. Control of pathogens that can come from the surrounding environment into the farm (such as predator and vector control)
12. Control of pathogens that can spread from the farm to the surrounding environment (such as effluent filtration/sterilisation, and waste such as dead-shrimp management)
13. Spreading of pathogens within the farm.
14. Vermin, vector and wildlife control
15. Visitors and vehicle movements
16. Movement and disinfection of fixed and movable equipment and staff between sites
17. Stock separation, isolation, sanitary and hygiene procedures between working areas
18. Day-to-day cleaning/disinfection and terminal disinfection of buildings, equipment, enclosures and nets.
19. Animal movements (new animals in, movement of animals out)
20. Dealing with sick and dead animals (safe, hygienic disposal)

Resource 6: Water quality

Guide: water quality parameters for shrimp (indicative only, water quality very dependent on local conditions including, stocking density, feeding, diurnal temperature changes, water flow rates, turbulence and sediment disturbance, rainfall - data from multiple sources, see publications in shrimp bibliography for further detailed information regarding water quality).

Alkalinity: 120-150 ppm (optimum alkalinity range 120-200 ppm).

Total Ammonia Nitrogen: Less than 0.5 mg/l.

pH: Range between 7.7 to 8.3 units.

Salinity: Range between 25 to 35 ppt.

Dissolved oxygen: Adequate amounts of dissolved oxygen can help maintain the nitrification process, which is important for removing ammonia from culture water. The nitrification process balances the concentrations of ammonium, nitrate and nitrite for better shrimp growth. The suitable dissolved oxygen range needed to prevent ammonium build up is >5 ppm.

CO_2: The limit of carbon dioxide for most cultured animals, such as shrimp, could be 15-20 mg/l, but 10 mg/l is preferable. (Shrimp in recirculating aquaculture systems may appear lethargic, as carbon dioxide increases in recirculating aquaculture systems (RAS) systems above the 50 mg/l)

Water solids: <400mg/l of suspended solids, and 10-50ml per litre of settleable solids.

Other measures required by some aquaculture assurance schemes (See Resource 7)

- Chlorophyll a
- 5-day biochemical oxygen demand Secchi disk visibility
- Soluble phosphorus
- Total ammonia nitrogen
- Phytoplankton abundance and species

Resource 7: Links to assurance standard organisations involved in aquaculture

RSPCA (UK) Assured Standards

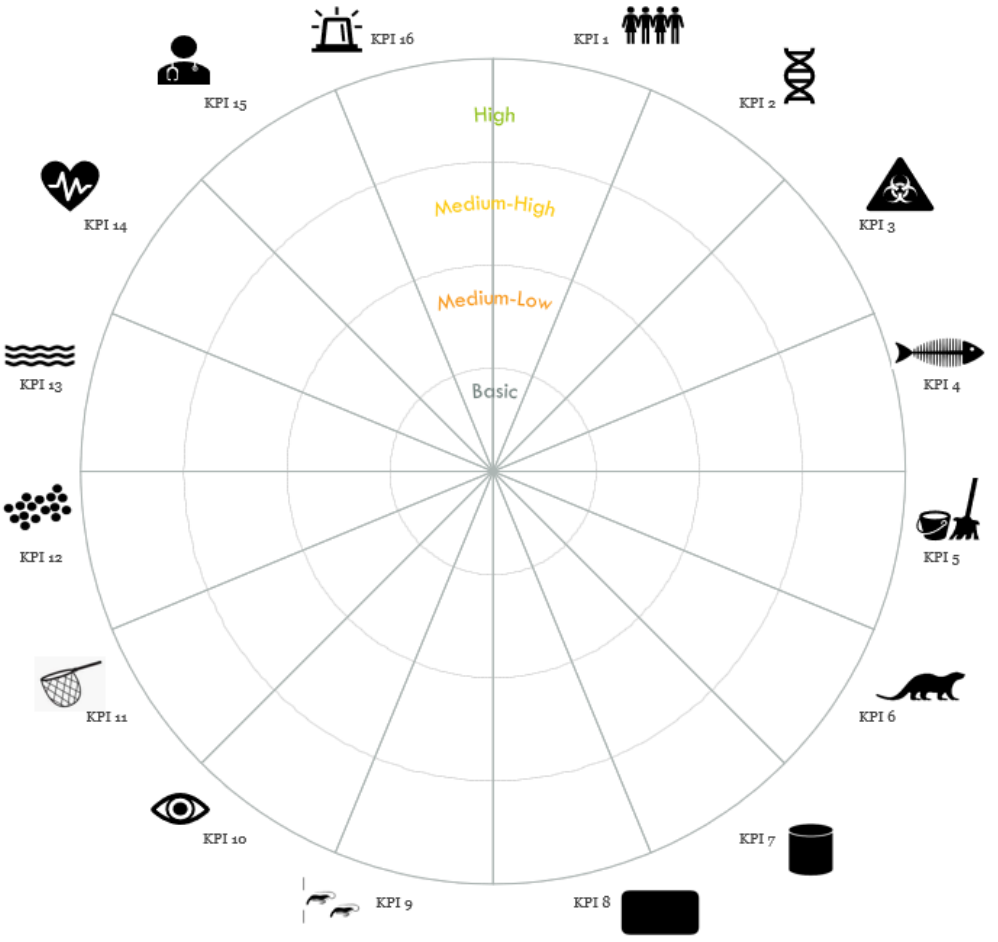
Aquaculture Stewardship Council

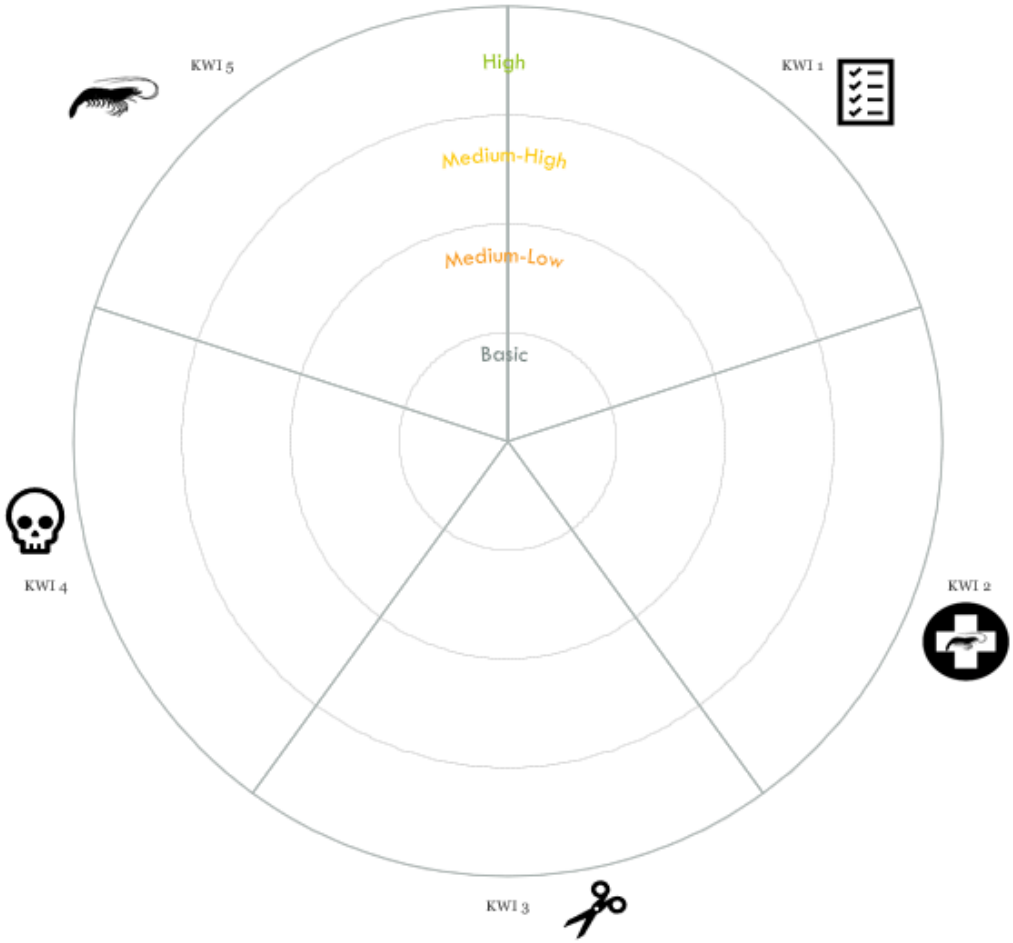
GLOBALGAP aquaculture standards

Best Aquaculture Practices

Scottish Salmon Producers' Organisation Code of Good Practice for Scottish fin fish culture

Resource 8 Blank sector charts





Resource 9: Published resources and further reading

General welfare and fish welfare background

Ashley, P.J., Sneddon, L.U., and McCrohan, C.R., (2007): Nociception in fish: stimulus-response properties of receptors on the head of trout Oncorhynchus mykiss (Brain Research, 116:47-54)

Ashley, P.J., Ringrose, S., Edwards, K.L., Wallington, E., McCrohan, C.R. and Sneddon, L.U., (2009): Effect of noxious stimulation upon antipredator responses and dominance status in rainbow trout (Animal Behaviour, 77:403-410)

BBFAW Investor Briefing (August 2015): How are Investors Using the Business Benchmark on Farm Animal Welfare?

BBAFW Investor Briefing (November 2017): How Companies Are Using the Business Benchmark on Farm Animal Welfare

BBFAW: The Business Benchmark on Farm Animal Welfare Report 2019

Braithwaite, V., (2010): Do Fish Feel Pain? (Oxford University Press)

Compassion in World Farming, Strategic Plan 2013–2017, For Kinder, Fairer Farming Worldwide

Ellis, T., North, B., Scott, A.P., Bromage, N.R., Porter, M., and Gadd, D., (2002): The relationships between stocking density and welfare in farmed rainbow trout (Journal of Fish Biology, 61: 493-531)

Ellis, T., Yildiz, H.Y., López-Olmeda, J., Spedicato, M.T., Tort, L., Øverli, Ø., and Martins, C.I.M., (2012): Cortisol and finfish welfare (38:163-188)

European Bank for Reconstruction and Development: Sub-sectoral environmental guidelines: intensive livestock farming

Galhardo, L., Almeida, O., and Oliveira, R.F., (2011): Measuring motivation in a cichlid fish: An adaptation of the push-door paradigm (Applied Animal Behaviour Science, 130:60-70)

Gov UK: The Welfare of Farmed Animals (England) Regulations 2007

Gov UK: Animal Welfare Act 2006

Humane Slaughter Association: Slaughter methods

Huntingford, F.A., Adams, C., Braithwaite, V.A., Kadri, S., Pottinger, T.G., Sandøe, P., and Turnbull, J.F., (2006): Current issues in fish welfare (Journal of Fish Biology, 68:332-372)

IFC (2014): Good Practice Note: Improving Animal Welfare in Livestock Operations (2014)

Martins, C.I.M., Galhardo, L., Noble, C., Damsgård, B., Spedicato, M.T., Zupa, W., Beauchaud, M., Kulczykowska, E., Massabuau, J.C., Carter, T., Planellas, S.R., and Kristiansen, T., (2012): Behavioural indicators of welfare in farmed fish (Fish Physiology and Biochemistry, 38:17-41)

Nordgreen, J., Garner, J.P., Janczak, A.M., Ranheim, B., Muir, W.M. and Horsberg, T.E., (2009, a): Thermonociception in fish: effects of two different doses of morphine on thermal threshold and post-test behaviour in goldfish (Carassius auratus). Applied Animal Farmed fish welfare practices: salmon farming as a case study (Behaviour Science, 119:101-107)

Nordgreen, J., Kolsrud, H.H., Ranheim, B., and Horsberg, T.E., (2009, b): Pharmacokinetics of morphine after intramuscular injection in common goldfish Carassius auratus and Atlantic salmon Salmo salar (Diseases of Aquatic Organisms, 88:55-63)

OIE: Terrestrial Animal Health Code (2019)

OIE Terrestrial Animal Health Code (2019): Chapter 7.5, Slaughter of Animals

OIE: Aquatic Animal Health Code (2019)

OIE: The OIE Strategy on Antimicrobial Resistance and the Prudent Use of Antimicrobials (2016)

Poli, M.M., (2009): Farmed fish welfare-suffering assessment and impact on product quality (Italian Journal of Animal Science, 8:sup1, 139-160, DOI: 10.4081/ ijas.2009.s1.139)

RSPCA (2018): RSPCA Welfare Standards for farmed Atlantic salmon

RSPCA (2018): RSPCA Welfare Standards for farmed rainbow trout

Sneddon, L.U., (2003, a): Trigeminal somatosensory innervation of the head of a teleost fish with particular reference to nociception (Brain Research, 972:44-52)

Sneddon, L.U., (2003, b): The evidence for pain in fish. Use of morphine as an anaesthetic (Applied Animal Behaviour Science, 83:153-162)

Share Action: What we do

Turnbull, J., Bell, A., Adams, C., Bron, J., and Huntingford, F., (2005): Stocking density and welfare of cage farmed Atlantic salmon: application of a multivariate analysis (Aquaculture 243:121-132)

Vet Sustain (2019): The Veterinary Sustainability Goals

World Bank Group: General Environmental, Health and Safety (EHS) Guidelines, (April 2007)

World Vet Antimicrobial Stewardship: McDonald's Corporation – Vision for Antimicrobial Stewardship in Food Animals (March 2015)

Shrimp

ASC (2019): Shrimp Standard (Version 1.1)

ASC (2019): Shrimp Audit Manual Standard (Version 1.1)

Barr, S., Laming, P.R., Dick, J.T.A., and Elwood, R.W., (2008): Nociception or pain in a decapod crustacean? (Animal Behaviour 75:745-751)

Benchmark: Setting a New Benchmark for Shrimp Welfare

BAP (2014): Aquaculture Facility Certification, Finfish, Crustacean, Mollusk Hatcheries and Nurseries

Charity Entrepreneurship (2020): Shrimp welfare

Elwood, R.W., (2012): Evidence for pain in decapod crustaceans (Animal Welfare 21(S2):23-27)

FAO Fisheries & Aquaculture Department (2006-2018): Cultured Aquatic Species Information Programme. Penaeus vannamei. Cultured Aquatic Species Information Programme (text by Briggs, M)

FAO (2020): Globefish Trade Statistics: Shrimp

Jackson, et al., (2003): Nitrogen budget and effluent nitrogen components at an intensive shrimp farm (Aquaculture, Volume 218, Issues 1-4)

Kir, M. and Kumlu, M., (2006): Acute Toxicity of Ammonia to *Penaeus semisulcatus* Postlarvae in Relation to Salinity (Journal of the World Aquaculture Society, 37(2):231-235)

Monterey Bay Aquarium (2004): Farmed Shrimp Report

Páez-Osuna, F. (2001): The environmental impact of shrimp aquaculture: a global perspective (Environmental Pollution 112:229-231)

Páez-Osuna, F. (2001): The Environmental Impact of Shrimp Aquaculture: Causes, Effects, and Mitigating Alternatives (Environmental Management Vol. 28, No. 1)

RSPCA Australia: What is the most humane way to kill crustaceans for human consumption?

Sustainable Fisheries Partnership (2011): Working towards sustainable shrimp feed (video)

The Fish Site (2020): How to handle ammonia spikes when farming shrimp

The Fish Site (2020: Maintaining water quality in RAS: the essentials

The Fish Site (2020): Top 10 tips for shrimp farming – the basics