Guidelines for anaesthesia and analgesia of fish

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When should fish be anaesthetised?

Removing aquatic species from the water adds to stress as well as the actual handling of fish, which can also cause abrasions however anaesthetic agents themselves can also cause stress in fish.
External signs of stress include ataxia and tachypnoea. Ataxic fish swim randomly, in short bursts, at high speed, continuously changing direction. Tachypnoeac fish have an increased movement of the operculum. Change in colour as well as less subtle changes in posture and use of the water column is seen with chronic stress.
Procedures that involve more than momentary restraint or require large numbers of fish to be handled should be conducted under sedation, unless the fish have been conditioned to the handling. Consequently it is often necessary to immobilize fish before attempting to perform even the simplest tasks, such as weighing and measuring.

How frequently should we allow a particular fish to be anaesthetised?

Should analgesia be mandatory?

The ability of fish to centrally process pain is frequently contended. However fish have opioid receptors and β-endorphins have been found in salmon. Any procedure which involves invasive methods is certain to cause some degree of pain so steps should be taken to alleviate any suffering which could be caused.

Should we create a set rules or code of best practice for anaesthetising fish?

The most common anaesthetic technique in fish is adding the anaesthetic agent to the water. This is similar to inhalation anaesthesia in terrestrial species as the drug is inhaled through the water, enters the arterial blood and the remainder or metabolites excreted via the gills, kidney and skin. They have a mechanism of action similar to local anaesthetics. Once the fish are placed in the recovery bath the analgesic affects of the anaesthetic drugs are no longer there.

The ideal anaesthetic agent should have a rapid induction and recovery time, with the least possible stress. The anaesthetic agent should provide adequate immobilisation and analgesia for the duration of the procedure and have a wide safety margin. An anaesthetic agent that is easy to administer and water soluble, harmless to the environment and operator is preferred.

- If possible and when appropriate, fish should be starved 12-24 hours prior to anaesthesia as they may regurgitate food. Regurgitated food may reduce water quality and become lodged in the gills.
- The anaesthetic bath and the recovery bath should contain water originating from the aquatic system. This will insure that water parameters are within acceptable range and all at the same temperature.
- The baths should also be aerated using an air diffuser or air stone.

- Fish should be anaesthetised in small batches (3-4 at a time) and remain no longer than 10 minutes in the anaesthetic solution.
- If using MS222 the solution should be buffered

Depth of anaesthesia can be assessed by ataxia, loss of righting reflex and response to stimuli (squeezing the base of the tail). Respiratory rate can be monitored by observing the movement of the operculum. Heart rate can be monitored by using a Doppler or/and ECG (using the pectoral and anal fins). The gills should be pink to light red and pale gills are suggestive of hypoxemia, hypotension or anaemia.

Figure 1 lists common anaesthetic agents and emergency drugs. If respiration stops the concentration of anaesthetic should be decreased or the fish placed in the recovery bath.
Figure 2 lists the preparation methods for stock anaesthetic solutions.

Suggested reading

Carpenter JW (2005). Exotic animal formulary 3rd edition. Elseviers-Saunders. St Louis.

Machin KL (2001). Fish, Amphibian and Reptile Analgesia. In: Veterinary clinics of North America Exotic Animal Practice. 4,1, 19-33.

Mashima TY and Lewbart GA (2000). Pet fish formulary. In: Veterinary clinics of North America Exotic Animal Practice. 3, 1, 117-130.

Ross LG and Ross B (1999). Anaesthesia of fish I and II. In: Anaesthetic and sedative techniques for aquatic animals, 2nd edition. Blackwell Science Ltd, Oxford, p. 58-94.

Stetter MD (2001). Fish and Amphibian Anaesthesia. In: Veterinary Clinics of North America Exotic Animal Practice. 4, 1, 69-82.

Figure 1. Commonly used anaesthetic agents in fish

Inhalation anaesthetics				
Agent		**concentration**	**species**	**comments**
Benzocaine	Ethyl-p-aminobenzoate	25-200mg/l 40mg/l 100mg/l	other Salmonids Tilapias, catfish	
Clove oil	Aqui-S™	6-17mg/l	all	
	Koi Calm™	20-100mg/l 25-100mg/l 100-150mg/l	other Carp Channel catfish	More soluble in hot water
	Clove oil stock solution (table 2)	40-100mg/l		
Halothane		0.5-2ml/l 0.4-0.75ml/l	other Carp	Added directly to water (injecting beneath the water surface using a 25G needle) or by using vaporiser
Isoflurane		0.4-0.75ml/l 0.25-0.4ml/l	Induction maintenance	As above
Lignocaine	Xylocaine Lidocaine	100mg/l 100-150mg/l	Carp, trout other	Do not exceed 1-2mg/kg total dose
MS222	Tricaine methane sulphonate (TMS) Stock solution (table 2)	50mg/l 100-200mg/l 20-85mg/l 15-50mg/l 1g/l spray 1g/l	Salmonids Tilapias Carp	Buffer with sodium bicarbonate (PH 7-7.5) Sedation Spray onto gill Euthanasia
Phenoxyethol	2-phenoxyethanol	0.1-0.5ml/l 385mg/l 0.1-0.5ml/l	other Rainbow trout Carp	Solution bactericidial and fungalcidal

Parental anaesthetic agents (IM or IP)				
Agent		**Dose rate**	**Species**	
Ketamine		66-88mg/kg IM 130mg/kg 30mg/kg	 Trout Cichlid	

Ketamine **Combined with** **Medetomidine** **Reversed with** **Atipamezole**		1-2mg/kg IM 0.05-0.1mg/kg IM 0.2mg/kg IM		
Saffan	Alphaxolone-alphadolone	12mg/kg IM		
ANALGESIA				
Agent		**Dose rate**		**Comments**
Butorphanol		0.05-0.1mg/kg IM 0.4mg/kg IM		Analgesia Analgesia in koi
Ketoprofen		2mg/kg IM (Harms 2005)		Anti-inflammatory affect
EMERGENCY DRUGS				
Agent		**Dose rate**		**Indication**
Doxapram		5mg/kg IV ICe		Respiratory depression
Epinephrine	(1:1000)	0.2-0.5ml IM, IC, IV, ICe		Cardiac arrest

Figure 2. Preparation of immersion anaesthetic stock solutions

Product	**Preparation**
Clove oil (eugenol)	Each ml of clove oil contains approximately 1gram of eugenol. Eugenol is not completely soluble in water and should be diluted 1:10 in 95% ethanol (mix 1 part clove oil with 9 parts 95% ethanol). This will create a stock solution containing 100mg/ml.
MS222 Tricaine methane sulphonate - Fish	Dissolve one gram of MS222 (0.5ml scoop holds approximately 400mg MS222) and 1 gram sodium bicarbonate in 100ml distilled water. This creates a 10mg/ml solution. The solution should be labelled and dated and stored in a dark container protected from light for up to three months. Adding 20ml of this stock solution to 2 litres of tank water will also create an approximate concentration of 200mg/ml.
MS222 Tricaine methane sulphonate - Amphibian	Add 2 grams of MS222 powder to two litres of distilled water to create a 1g/l concentration. Add 34-50ml of 0.5M Na_2HPO_4 or baking soda $NaHCO_3$ to buffer the solution (PH 7 -7.4)

IM intramuscular
IV intravenous
IC intracardiac
ICe intracoelomic