25 MAY 2018

OIA18-0215

Rachel Maria Stedman
fyi-request-7499-29ca7e3d@requests.fyi.org.nz

Dear Rachel Maria Stedman

OFFICIAL INFORMATION ACT REQUEST

I refer to your official information request on 21 March 2018 regarding the use of live crayfish in restaurants.

The following information is released to you under the Official Information Act 1982 (OIA):

- Information relating to the development of the Animal Welfare (Care and Procedures) Regulations, and the Commercial Slaughter Code of Welfare issued under sections 75 and 76 of the Animal Welfare Act 1999;
- Four animal welfare cases investigated by the Ministry for Primary Industries (MPI) which relate to crayfish in restaurants;
- *Survey of Methods Used for Killing Rock Lobsters in New Zealand* and *Animal Welfare in the Fish and Crustacean Industry*, two reports commissioned by MPI which partly inform the approach taken to live crayfish in restaurants; and
- Submissions made by the New Zealand Rock Lobster Industry Council (NZRLIC) and the Royal Society for the Prevention of Cruelty to Animals (RSPCA) relating to the 2015 amendments to the Animal Welfare Act 1999, and MPI's feedback on the RSPCA submission.

Some information has been withheld pursuant to section 9(2)(a) of the OIA to protect the privacy of natural persons. Information which is not within the scope of your request has also been removed for your convenience.

MPI has considered releasing email correspondence as part of this response. After searching through the email database using the relevant keywords from your request, a large number of email were identified as potentially applicable. To go through this email correspondence to determine which items are within the scope of your request would take a significant amount of time and resource, and therefore these have not been provided pursuant to section 18(f) of the OIA, as the information cannot be made available without substantial collation and research.

MPI is satisfied that in the circumstances of this case, the withholding of the information is not outweighed by other considerations which render it desirable in the public interest to make the information available. You have the right under section 28(3) of the OIA to seek an investigation and review by the Ombudsman of our decision to withhold information and/or refuse part of your request.

Yours sincerely

Grant Bryden
Director Biosecurity and Animal Welfare Policy

Feedback Rock Lobster Commercial Slaughter – Seafood NZ

12 October 2015

Good afternoon to all

I have had a few days to canvass views from across the rock lobster supply chain and the responses have been mixed other than on one topic. The undoubted consensus is "please be careful" when contemplating any transition to a regulatory environment.

The live lobster business is principally about keeping lobsters alive. All animal welfare concerns are properly addressed as a consequence, and in the absence of a formal regulatory framework. The feedback I have received indicates that the very clear preference is to avoid a regulatory framework in order to allow for the greatest flexibility in handling and transportation of lobsters and always within the scope of the existing COP.

Lobster processors do not 'slaughter' large quantities of product and when they do slaughter any they follow the standards in the long established and routinely reviewed COP.

In 2014 less than 0.5% of total production was processed to tails. So approximately 13.5 tonnes of live lobsters slaughtered. Slaughter is a side-line or by-product of our core business.

- One area of concern is that regulations should not constrain the techniques for rendering lobsters insensible. The current minimum standard 22e (iii) allows for lobsters that are already insensible (moribund) to be killed (tailed) without having to chill or electrically stun them. One processor indicated that drowning in fresh water is also a viable option and one used widely in the Australian lobster industry. Others would argue that a fresh water treatment has potential to reduce product quality but there is no argument that it is effective in rendering lobsters insensible.
- Then concerns as to what constitutes 'insensible' in the context of a regulatory framework. Is there a physical 'test' – necessarily a visual inspection – which determines that particular status of a lobster? Will that 'test' be transferred to regulation?
- Then to concerns over extent of liability. It is crucial that animal welfare responsibility not be extended beyond the effective control of the producer/processor/LFR/exporter, which generally is considered to be when a container of live lobsters is accepted by the LFR; when a polybin of live lobsters is handed over to a domestic customer; or when the plane carrying a shipment of live lobsters touches down in Asia or elsewhere; although LFRs/processors/exporters cannot exert control over the lobster shipments once they have been delivered to airports in New Zealand.

That pretty much summarises the initial feedback. I greatly appreciate that you have already made a commitment to 'getting it right' and will be seeking further technical advice. As noted above there is a very strong feeling across the major industry participants that the current code and associated standards are more than adequate; are routinely observed; and that animal welfare concerns are well met by the lobster industry as a matter of course.

It seems to me that the interest in regulating arises from agency concerns over the manner in which lobsters are allegedly offered for sale in restaurants here in New Zealand. A notorious Seven Sharp video clip elicited an almost immediate response from MPI in Auckland for example.

In my view the state of the lobster served in the restaurant was deliberately misrepresented by the complainant at the time. But even if you do not agree with that view it seems to me that a very simple response would be a domestic food service industry regulation which creates an offence where lobsters are handled other than in accordance with the current code and associated standards i.e. they need to be dispatched before being served – or before being cooked and served.

Very keen to talk some more about these issues and will work in with your availability over the next few weeks if you are running to any self-imposed deadline.

Kind regards

s 9(2)(a)

5 October 2015

Hi s 9(2)

Thanks for the information sent today.

I have copied the relevant details to industry personnel with long experience in live lobster handling and exporting and have asked for written feedback before Wednesday afternoon this week. I am confident we will get sufficient response to your questions which I have highlighted. I expect #'s 2, 3 and 4 to be no problem.

I personally have some hesitation in regards to the wording of #1 as it converts to regulation. We (industry) use the term 'to dispatch a rock lobster before consumption' and to do that we recommend that live lobsters be placed in a freezer/chiller until all physical movement is observed to have ended – which occurs before the lobster begins to freeze.

If those instructions are followed then a lobster is reliably dead – we have killed it prior to further preparation and consumption. 'From chill to kill' is a continuous process not a two stage one. Whereas #1 implies that there is a reliable measure of "insensible" as opposed to dead.

Or am I being too pedantic?

Kind regards

s 9(2)

NZ Rock Lobster Industry Council

Private Bag 24-901

Wellington 6142

New Zealand

s 9(2)(a) <lobster@seafood.co.nz>

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FRM413 : ANIMAL WELFARE IN THE FISH AND CRUSTACEAN INDUSTRY

by N. G. Gregory [a] and J. S. Lumsden [b]

[a] MIRINZ, PO Box 617, Hamilton; [b] Massey University, Palmerston North

This report is aimed at assisting the fisheries and aquaculture industry in recognising the animal welfare issues that exist within their areas of interest. It may help them in developing self-regulatory standards or Codes of Conduct. The report has been prepared at the request of the MAF, and it may be considered by government staff and the National Animal Welfare Advisory Committee who are charged with advising the Minister on animal welfare issues.

The report examines specific practices in the fisheries and aquaculture industries which have a bearing on fish and crustacean welfare. The information focuses on determining whether fish can feel pain, the sources of welfare compromise in industrial practice, and the interactions between welfare issues and product quality. The questions that have been considered include:

- can fish feel pain ?
- are there any commercial fisheries or fish farming practices which might compromise fish welfare ?
- are there relationships between potential welfare compromise and product quality, and if so do commercial benefits encourage or discourage practices which compromise fish welfare ?

This review does not consider the ethics of recreational angling. That subject has been reviewed by de Leeuw (1996). Nor does it consider in any depth the by-catch issues. Pertinent information on marine mammal by-catch can be found in Hofman (1995), and on fish by-catch in Alveson *et al.* (1994). Information on fish by-catch which is relevant to New Zealand can be found in Anon(1987), Hickford *et al.* (1997) and Livingston (1990).

Physiology of Pain in Fish

There are three ways of approaching the question whether fish can experience pain. The first is to establish whether or not fish possess the appropriate neurotransmitters, neurone types and brain structures which are known from work in other species to mediate or influence pain. This approach does not give a precise answer, but, if the known neural mediators of a potentially painful stimulus are absent it can be concluded that pain perception could not occur through these routes. The second approach is to give fish stimuli which we intuitively consider would be painful in other species, assess their physical responses, and determine whether those responses can be suppressed with analgesic drugs which in turn are blocked with analgesic inhibitors. A practical difficulty with this approach is in determining, beforehand, the appropriate doses of analgesic and anti-analgesic that could be effective in fish. A third approach is to condition a fish to a potentially painful stimulus and examine whether the fish shows aversion to the conditioned stimulus. A difficulty with this approach is in deciding whether the stimulus was painful or unpleasant. This can, however, be tested by examining whether the response is absent when the fish is pre-treated with an analgesic which specifically inhibits pain without affecting motor control.

In mammals there are two types of neurone which relay nociceptive signals to the brain; those with myelinated axons and large cell bodies (A fibres) and those which are unmyelinated (C fibres). During the evolution of vertebrates there has been a progression towards myelination of sensory neurones. This is important because it probably influences the type of pain that different species can experience. The initial sharp pain that occurs during an injury is mediated by the myelinated A fibres which have a rapid conduction velocity (about 11 $m.sec^{-1}$). Whereas, delayed aching pains are mediated by unmyelinated C fibres. Neurones in the skin and viscera which mediate pain signals connect synaptically with spinal neurones which ascend the spinal cord. The spinal neurones in the dorsal horn of the spinal cord are one of the first relay sites for a pain-provoking signal. The axons in the dorsal horn neurones are arranged in layers or laminae. In mammals the outermost laminae (lamina I and II) include unmyelinated and myelinated neurones which respond to algogenic stimuli and project to the thalamus. These laminae are two of the more important paths which convey potentially painful signals to the brain.

In lamprey, all peripheral nerve fibres are unmyelinated, and all sensory nerve endings have been described as free nerve endings in the skin (Martin and Wickelgren, 1971). However, elasmobranch species differ in the degree of myelination of their nerve fibres in the peripheral nervous system. Stingrays have virtually no unmyelinated fibres in the nerves of the outermost lamina of the dorsal horn, whereas in black-tip sharks about 16% of those neurones are unmyelinated (Snow *et al.*, 1993). It is possible that the limited number of unmyelinated neurones that were found in the black-tip sharks were in the process of myelination, in which case unmyelinated outer lamina neurones may be absent in the adult shark as well. The layer equivalent to lamina I is poorly represented in elasmobranchs, but its function may be served by one or more of the other laminae, and in particular by the substantia gelatinosa (Cameron *et al.*, 1990). Although elasmobranchs have relatively few unmyelinated preganglionic sensory neurones, they do have second order neurones within the dorsal horn which are either unmyelinated or finely myelinated. Those neurones are concentrated within the substantia gelatinosa layer within the dorsal horn (Cameron *et al.*, 1990). That layer is relatively large in elasmobranchs, and it corresponds to lamina II in mammals which is rich in C fibres and is partly responsible for mediating pain-provoking signals to the brain.

In mammals, unmyelinated neurones contain a wide variety of neuropeptides which act as neurotransmitters and neuromodulators. In stingrays, rays and black-tip sharks, substance P, serotonin, calcitonin gene-related peptide, neuropeptide Y and bombesin are present in the outer part of the substantia gelatinosa in the dorsal horn, and in the shovelnose ray met-enkephalin is concentrated in the lateral part of the substantia gelatinosa (Cameron *et al.*, 1990). This distribution shows similarities to that in the mammalian dorsal horn. So far, of these neurotransmitters, only substance P has been shown to be present in afferent neurones in the elasmobranch substantia gelatinosa (Ritchie and Leonard, 1983). In the absence of more detailed information on the neurotransmitters present in the afferent neurones, it is not possible to say which neurotransmitters are responsible for relaying nociceptive signals in elasmobranchs, but their presence would subsume the potential for that function.

The μ opioid receptor arose very early in evolution, probably before the appearance of vertebrates. One of its main functions in mammals is to suppress pain. It might be inferred that it probably fulfills the same role in lower vertebrates, but it is also possible that it evolved an antinociceptive function during the course of evolution. Teleost fish possess at least six different opioid receptor-like proteins. An example of how these have been demonstrated is as follows (Darlison *et al.*, 1997). DNA was isolated from the brain of a fish and was transfected into HEK 293 cells. The HEK 293 cells were maintained in culture and they produced receptors which had a high affinity for the μ opioid selective agonist DAMGO. In addition it was shown that the receptors had a high affinity for the nonselective opioid antagonist naloxone, whilst having negligible affinity for kappa and delta-opioid receptor selective agonists. Taken together this was sufficient evidence to demonstrate encoding for a specific μ opioid receptor.

In humans there are specific regions in the brain which can attenuate the perception of pain. These include the periaqueductal gray in the mesencephalon, specific relay nuclei in the thalamus, and the rostroventral medulla in the brainstem. The raphe nucleus in the rostroventral medulla activates axons which project to the dorsal horn of the spinal cord, where they inhibit the relaying of afferent nociceptive signals through a variety of neuropeptide receptors. One group of pain modulating neuropeptides is the enkephalins, which are opiate-like compounds. The enkephalins help to reduce pain perception and they appear to serve a number of other roles in reproduction, vision and chemosensory systems. Enkephalins have been discovered in a range of brain regions in teleost species, but as yet their presence in pain-related pathways has not been adequately tested. This area of neuroscience is complicated by the fact that we do not know the functional piscine homologs for the periaqueductal gray and the raphe nucleus. Attempts at locating enkephalin-containing cell bodies in the dorsal horn of lamprey and trout have been unsuccessful (Vecino *et al.*, 1992). This suggests that either descending inhibition of nociceptive stimuli is mediated by another neuropeptide or that this method of pain control does not exist in these fish.

A number of other fish species, including salmon, are known to synthesise and store ß-endorphins in their brains. The des-acetyl salmon S-endorphin has been shown to have analgesic effects when given to mice, but its analgesic potency is only half that of human ß-endorphin (Hammonds *et al.*, 1982).

LaChat (1996) argued that neuroanatomical evidence suggests that fish brains do not have structures comparable with the human neocortex, and so it is unlikely that fish can consciously experience pain stimuli. This assumes that the neocortex is essential for pain perception and that the equivalent structure in fish and birds, the telencephalon, does not and cannot participate in pain perception. The basis for that assumption is not clear. There is little doubt that the telencephalon has sensory delineation and is involved in higher functions such as sophisticated learning and thought processes. For example, Overmeir and Papini (1986) showed that avoidance learning in fish depended on a functional telencephalon, whereas simple escape behaviours and defense reactions were not impaired by ablation of the telencephalon. It is a *non sequitur* to argue that the absence of a true neocortex means that fish cannot perceive sensory and nociceptive stimuli.

Physical responses to potentially painful stimuli are often used as a means of identifying whether an animal can perceive pain. This approach, however, can have limitations if the stimulus provokes a spinal reflex or a subconscious brainstem reflex.

Some fish show sensitive spinal reflexes which could be confused with conscious behaviour. For example, in decapitated lampreys the dorsal fins move briskly to one side when the ventral abdominal skin on the same side is stroked. Similarly, pricking the skin below the dorsal fin with a needle, pinching the skin, or electrically stimulating the skin elicited the same fin reflex in the decerebrated fish (Birnberger and Rovainen, 1971). Similar responses have been described in higher fish species.

Dogfish which have their spinal cord transected swim continuously, in a way which resembles normal cruising swimming. In non-swimming decerebrate dogfish, swimming movements which last for several minutes can be induced by stroking the skin in a variety of places on the body. Similarly, electrical stimulation of the caudal fin can provoke swimming activity in quiescent decerebrate fish, and, when the current is applied to rhythmically active decerebrate dogfish, it perturbs the swimming (Paul and Roberts, 1984). This emphasises the need to examine behavioural responses to potentially painful stimuli which are shown not to be spinal reflexes, when asking the question whether fish can feel pain.

Fish show many physical responses to tactile and noxious stimuli which no doubt involve conscious perception. This has been shown in a number of experiments which involved a learning process in order to elicit a particular response. For example,

- in Japanese carp, applying a 50 msec 7 mA DC shock across the fish produced suppression of opercular (respiratory) activity when the fish was trained to expect the shock using a pre-shock light stimulus (Woodard, 1971).
- Paradise fish avoided a black compartment within their tank after they learnt that they experienced a mild electric shock when they were in the black compartment (Brookshire *et al.*, 1968). In addition they learnt how to activate an escape hatch in order to avoid the shock.
- In goldfish fear of an imminent electric shock can be blocked by pretreating the fish with the anterograde memory blocker MK801, which is an N-methyl-D-aspartic acid antagonist (Davis and Klinger, 1994). Similar effects have been observed in rats.

MK801 causes dissociation between the cue that elicits fear (conditioned stimulus) and the forthcoming potentially painful stimulus (unconditioned electric shock stimulus), rather than inhibiting identification of the conditioned stimulus.

• Not all fish are good at learning to avoid potentially painful stimuli. For example, Pinckney (1967) recognised two populations of goldfish; those which learnt how to avoid an electric shock which was preceded by a light being turned on, and those which were poor learners.

Jansen and Greene (1970) used an electric current applied immediately caudal to the dorsal fin in goldfish to provoke an agitated swimming response (ASR), which consisted of a sudden, pronounced increase in frequency and amplitude of fin and opercular movements. By gradually increasing the voltage, the threshold for the ASR was determined for each fish. On average the threshold was 4.75V. When morphine was added to the water, analgesia was achieved and the ASR at the threshold voltage was suppressed. The new voltage at which the ASR could be induced was higher than the voltage without morphine. Repeated electric currents in the no-morphine controls were not associated with a change in threshold stimulus. The only criticism that one could raise against this study is that it did not discount the possibility that morphine could have suppressed the motor execution of the response to the noxious stimulus, as distinct from a pain-evoked initiation of the motor response. Never-the-less, it strongly suggests that pharmacological suppression of pain pathways reduces the physical response to a potentially painful stimulus. It is one of the most important studies which suggests that fish can experience pain. Since that study, the analgesic effect of morphine in goldfish has been shown to be reversed by naloxone (Ehrensing, Michell and Kastin, 1982). Both drugs were injected intracranially in the space above the optic tectum, and the ASR was also used in assessing responsiveness to pain.

In many fish, pinching the fins can elicit an escape response, and this is often used as a guide to depth of anaesthesia during experimental surgery. Alternatively, insufficient anaesthesia can be gauged from the escape behaviour that occurs in response to a sudden light tap to the side of the head. The typical response is a rapid, contralateral bend of the body and tail that turns the fish away from the stimulus (Fetcho and O'Malley, 1995).

Tactile stimuli such as this are detected either by Merkel cells or free nerve endings in the epidermis. In the lamprey they innervate three types of sensory fibre within the spinal cord. There are two types of touch fibre, which respond to indentation of the skin, and a population of nociceptive fibres which respond to very strong deformation of the skin or to excessive heat (Martin and Wickelgren, 1971). This has been assumed to be good evidence that lamprey have nociceptors which are triggered by potentially painful stimuli and project a signal to the spinal cord.

In mammals, dental pain is frequently used as a model for understanding whether an animal or human is susceptible to pain. This is because, in the human, of all the senses that can emanate from the tooth, pain is the predominant sensation. Dental pain is either a sharp pain or an aching unpleasant pain. Byers (1984) reported that the same basic structure for nerve endings in the teeth exist in humans and fish, as well as a variety of other species. However, no-one has as yet used this as a model to test whether fish are responsive to pain.

Injury to peripheral nerves in the human often causes paraesthesias and pain. Such pain is probably due to axonal hyperexcitability within neuromas and at the ends of injured nerve fibres, which, in turn, are probably linked to a localised abundance of sodium channels at the demyelinated injured nerve surfaces. England *et al.* (1994) demonstrated that sodium channels accumulate at the tips of injured axons in the lateral line nerve of goldfish, and that this response could be used as a model for the mechanisms leading to nerve injury-induced pain in humans.

The gills of fish are very sensitive to mild stimuli. For example, stimulation of mechanoreceptors in the gill filaments of carp elicits coughing and expulsion reflexes (de

Graaf *et al.*, 1987). Mechanical interference with the gills during capture and killing would probably activate such receptors and lead to irritation. It is not known whether there are nociceptors in the gills.

Conclusions:

Fish peripheral nerves are morphologically and physiologically similar to human peripheral nerves. However, in some fish species the sensory nerves are predominantly myelinated. In elasmobranchs the dorsal horn of the spinal cord contains a large substantia gelatinosa which has a variety of neuropeptides that could act as neurotransmitters and neuromodulators. The neuroanatomical basis of pain perception within the fishes' brain is not understood, but it may involve the telencephalon. On the basis of the neuroanatomy and neurochemistry of all these structures there is no reason to rule out the possibility that fish can feel pain. The question that these findings raise is not "do fish feel pain ?". Instead, it is "what types of pain do fish experience ?"

It is not surprising that fish possess the peripheral anatomical and chemical prerequisites for pain perception. Simpler life forms, such as gastropods, also share these features, and they show nociceptive responses which are analogous to those in vertebrates (Kavaliers, 1989). For example snails show prompt aversion to heat by lifting the anterior portion of the foot, and this response is supressed by morphine. Naloxone suppresses and reverses the analgesic effect of morphine in land snails, and it promotes hyperalgesia in snails not treated with morphine. The equivalent experiments for fish have been conducted in the goldfish. When using an electric shock as the potentially painful stimulus, a pain response was demonstrated which was reduced by morphine, and that reduction was reversed by naloxone. This reinforces the neuroanatomical and neurochemical findings that fish can feel pain. There is, however, room for substantial improvement in our knowledge about pain perception in fish, and in particular we need to know more about which types of stimuli appear to provoke pain responses in fish.

Commercial Fisheries Practices

MARINE FISH

From the previous section of this paper it seems likely that fish are capable of experiencing pain. In which case, it is likely that any damage that occurs to the fish during fishing could cause suffering. Such damage is also important as a potential cause of downgrading and food wastage. The methods used for catching and killing fish affect their scales, skin and the quality of the meat. With some methods there is also wastage from harvesting by-catch , and in some sectors of the fishing industry, such as shrimp fishing in the tropics, only a small proportion of the catch (10 to 30%) may be used.

The fishing methods that will be considered in this report have been described in detail by Sainsbury (1971) and are grouped as follows:

- trawling
- purse seining
- gillnetting
- longlining
- trolling
- pole and line fishing
- harpooning
- jigging lines
- angling

In bottom otter **trawling** a large bag-shaped net is drawn along the seabed to scoop up fish on or near the bottom. The net has a wide open mouth and tapers to a quick-release closed end (cod-end). Wings extend from the mouth increasing the area swept by the net and they guide the fish towards the mouth. The wings are held outwards by otter boards, and opposing floats and weights keep the mouth of the bag open.
In **purse seining** a long net is set around a school of fish, the top of the net usually being at the water's surface. When the school is encircled, the bottom is pulled together to create an artificial enclosure which holds the catch. By drawing in the top lines the purse is made smaller until the fish are gathered alongside the vessel. The catch is removed from the net either with a fish pump, a net winch or by brailing with a scoop net.
The **gillnet** relies on fish swimming into a stationary net and becoming trapped by the gills and operculum as they try to swim through. In some versions there are several layers of net with different mesh sizes and the fish become entangled (tangle nets).
Longline and gillnet fishing are done with static gear which is usually anchored underwater and marked with bouys. With longlines, a line (often up to 60 km long) fitted with short lengths of line carrying baited hooks is set. The fish take the bait, become hooked and are brought aboard as the line is taken up. The length of time that a fish is held by a hook depends on how frequently the gear is hauled up.
In **trolling** a slow-moving vessel tows weighted lines each bearing a number of lures or baited hooks. The fish snap at the lures and after hooking themselves they are hauled in. The hooking of a fish is detected by a

jerk at the outrigger. In some systems the fish are gaffed to bring them aboard.
Pole and line fishing is arguably one of the most humane methods of catching a fish. When a school of fish is located they are brought to a feeding frenzy by scattering bait over the side of the vessel. A gang of pole fishermen, or mechanical poles, cast their lines and the fish snap at the splash of the hooks. On striking, the fisherman swings a fish onto the deck behind, and as the hook is barbless the fish disengages at the end of the swing and slides to a collecting area.
Harpooning has been used for large species such as swordfish. When the fish is struck and the harpoon takes hold, it is allowed to run until it tires itself out. It is then snubbed, secured in a sling and hoisted aboard.
Jigging lines are used in squid fisheries in Asia. Incandescent lamps are hung over the side of the vessel to attract the squid. The vessel is stabilised to dampen pitching thus minimising fouling of the fishing lines. The lines are weighted, they have coloured plastic lures with hooks and they are wound onto eliptical reels, so that when a line is wound in automatically it has a jerking or jigging motion. The squid attack the lures and hook themselves. With multiple jigging lines and strategically placed hand jigging lines, the squid can be brought into a feeding frenzy which greatly increases the catch.
In **angling** the fish are caught individually with a rod and line. The fish may be played whilst reeling in as part of a sporting contest for the enjoyment of the fisherman.

Catching a fish in a trawl net depends on guiding it to the mouth of the net, and then exhausting and overrunning it as the net is towed forwards. The fish are guided towards the mouth of the net in two ways. The bridle wires which stretch between the wings and the otter boards guide the fish towards the centre path of the net, and the wings of the net act as a funnel. The bridle wires are set at an angle to the towing path. As they move they create the illusion for a fish positioned on the nearside of a bridle that the wire is moving towards it. This makes the fish manoeuvre away from the wire and towards the central axis of the net.

Underwater filming of bottom trawling has shown that the fish swim in front of the mouth of the trawl net, and as they tire, they slow down, rise up from the seabed and enter the body of the net. Overrunning the fish depends on outlasting its stamina. Normally cod and haddock can swim for long periods, relying mainly on their dark muscle, when swimming at speeds which are up to twice their own body length per second. For a 50 cm fish this is up to 2 knots. Above that speed, the staying power or endurance is quite short. The 50 cm fish can sustain a speed which is greater than 2 knots for a distance which is equal to only about 500 body lengths (250 metres). At these faster speeds the fish relies on its anaerobic muscle system, which is powered by a limited reserve of glycogen. Endurance is limited by the supply of glycogen, and the time taken before a fish tires varies considerably with species. When the towing speed is 3 knots, haddock swim for no more than 2.5 minutes, whereas pollack keep going for about 15 minutes.

Mackerel often speed up and swim out of the net. Larger fish can sustain faster speeds and at the end of a tow those at the front of the mouth of the net swim away as the net slows down. A burst of faster towing speed towards the end of a tow helps to put these fish into the cod-end.

As the fish pass down the trawl net they come to a position where the net tapers to a funnel. At this point they become constricted and they start to panic. They swim with fast tail beating, and an erratic flick-glide action, often striking the net and colliding with each other whilst trying to maintain a position ahead of the funnel. Eventually the net overtakes them and they pass down to the cod-end whilst scraping and bumping against the net. By the time they reach the cod-end they have acquired skin and scale damage. As the cod-end fills with more fish there is an increase in turbulence within the net. This can cause the cod-end to twist on itself. After two or three such revolutions in the same direction, the entrance of the cod-end is sealed off and the fish become compressed. The compression causes additional skin and scale damage. After a time the net will untwist itself and return to its normal position.

Some of the fish die within the cod-end from compression. Death presumably occurs from compression of the opercula (gill covers) against the net and adjacent fish preventing breathing movements of the gills. The fish asphyxiate. Another possible cause of death in a minority of fish is failure in venous return to the heart due to pressure on the body at particular points. This would lead to reduced cardiac output and perfusion of the brain. The proportion of fish that are dead by the time they are hoisted on board varies considerably according to the size of the catch and the duration of the tow. The longer the towing period the more likely they will be dead; for example in one study a 2 hour trawl was associated with 29% mortality on raising the net whereas a 4 hour trawl resulted in 61% mortality (Hattula *et al,* 1995). High pressures are exerted on the fish when the nets are hoisted out of the water and this can cause intestinal contents to be expelled. These need to be washed off before the fish are packed and stowed.

There are regulations which govern the mesh size of the cod-ends of the trawl nets. These aim at allowing undersized fish to escape and hopefully survive. Smaller fish usually escape through the upper part of the cod-end, immediately in front of the bulk of the catch, however not all of them survive. Mortality amongst escapees from a herring trawl during the first 7 days following escape has varied between 30% and 72%. Small fish are more prone to dying after escape (Suuronen *et al,* 1996), and herring are probably more prone to dying than other species such as snapper. Death is thought to develop from skin injuries inflicted when the fish are in the net and from exhaustion.

In seine netting the fish are encircled and herded by ropes and a net at a relatively slow speed so as not to alarm the fish. The vessel then speeds up to 2 to 3 knots to outpace the fish as the circle is completed. In seine fishing the towing speeds are slower and so seine-caught fish often have less skin and scale damage than trawled fish. Monofilament gillnets cause considerable damage to skin and scales. As the fish struggle the net material cuts through the skin, and the net scuffs the surface of the skin. When the gillnet and fish are hauled in, the weight of the net does additional damage to the snared fish as they pass over a roller guide. As the fish and net land on the deck the fish are unmeshed, and, in the case of shark, the fish may be bled by cutting the throat. In some shark species delayed bleeding after death affects their quality through the accumulation of urea and ammonia in the flesh. Using nets with knotless mesh, and retrieving the nets at short intervals, help to minimise skin and scale damage during gillnet fishing. On some vessels a crew member may stand alongside the net roller to make sure that any fish that are not properly meshed do not escape. The loosely attached fish are gaffed with a handheld hook, and this causes additional damage to the product.

Net fishing causes more skin and scale damage than line fishing. This affects quality in two ways. Fish skin is normally covered with a layer of mucus which acts as a water-repellant and as a barrier to bacteria and other pathogens. Skin and scale damage allows easier entry of bacteria into the flesh which increases the risk of spoilage and off-odours, and it detracts from the appearance of the fish, spoiling its marketability. During troll fishing some species tend to roll and become entangled in the troll lines whilst they are towed by the hook and line. This is not particularly common, but when it occurs it causes skin and scale damage.

Depending on how the fish is hooked, trolling can be very stressful for the fish. Wertheimer *et al.* (1989) examined the results from three vessels which were trolling for chinook salmon off Alaska in 1987. The majority of the fish were hooked in or around their mouths, and a further 23% were hooked through an eye. Only 3% of the fish were dead when they were unhooked on the vessel, and most of these were hooked by the gills. In this study the fish that were alive were unhooked and held live in sea pens; 16% of them died within 4 to 6 days. Those that had been hooked by the gills, isthmus or eye had a reduced chance of survival. These results are important for two reasons. Firstly they show which parts of the fish are particularly sensitive to hook trauma in terms of the fish survival, and they indicate the likely capture mortality in fish that are released instead of being used for meat consumption. In fish, blood passes from the heart to the brain via the gills. If a fish is hooked by the gills and this interferes with blood flow to the brain, unconsciousness and death could be rapid. However, entanglement or hooking in the gills could be irritating as this region is sensitive to physical stimulation by even fine foreign objects such as weed.

The world's marine fish reserves have fallen dramatically during the 20th century. This is now being addressed by limiting the by-catch, by defining the size of target fish that can be taken and by setting quotas for particular species. These are prescribed either as legal requirements or as voluntary undertakings by the fisheries. In purse seine fishing if the average size in a catch is too small or if the total catch is too large for what is required, part or all of the catch may be slipped (released). In some fisheries there are regulations which limit either the number and tonnage of fish that can be landed, the length of the fishing season, or the size of each fish that can be marketed. Sublegal sized fish have to be returned to the ocean. These regulations and recommendations are based on the assumption that most fish that are returned will survive. In salmon troll fisheries, mortality during the first 4 to 6 days after being fished is 18% in sublegal sized fish which are returned to the water, and most of these deaths occur within 24 hours. Where trials have been done on the survival of fish that were caught by trolling or angling, mortality has been related to the severity of the exercise stress. Those fish that died during the recuperation period were the ones which developed the highest lactate levels. When muskellunge have been caught by angling and then released, 30% died after release. Those that died within 6 hours developed a severe acidosis and rises in plasma potassium levels. When salmon were caught by angling, the pH in the white muscle fell from 7.46 to 6.80. The struggle associated with playing the fish caused near depletion of muscle phosphocreatine and glycogen, and a marked reduction in ATP. Muscle lactate levels rose from about 1 µmol per g to 37 µmol per g, but plasma lactate only showed a small rise.

During angling, carp show the following behaviours once they are hooked: rapid darting movements, coughing and spitting, head shaking, fleeing, belching gas from the swim bladder, sinking, and lying on the bed of the tank. If, after hooking, the line is payed out and there is no line tension, the fish do not show escape behaviour. Instead, the main behaviours are coughing or spitting and head shaking, and they resume feeding within a few minutes. This implies that playing the fish is more aversive than hooking the mouth.

Two types of livebaiting are used in commercial hook and line fishing. Chumming is used for pelagic (near surface) species which need to be brought together or set into a feeding frenzy. The livebait is thrown into the water usually alongside the vessel. Typically the livebait remains motionless for several seconds upon hitting the water, and then it swims underneath the hull for protection. This brings the predatory fish nearer to the vessel where they are taken with hook and lure. After the initial catch the vessel is eased forward to flush out the livebait from under the hull and a second catch follows. The choice of livebait species is important. In pole and line fishing a species which jumps when attacked is better than one that dives. The other type of livebaiting is attaching a live fish to a hook to draw the target species. This method is commonly used in longline fishing and it has been condemned by some welfare protagonists. In the past the chief practical disadvantage has been the time involved in attaching the livebait to the hooks. This has been overcome with a semi-automatic machine which attaches the live fish as the line is payed out.

Bruising and mechanical damage occur in fish when they are pumped automatically from seine nets or from tanks, cages or ponds. Three types of fish pump are used; vacuum (and venturi), centrifugal (and turbine), and archimedean screw pumps. Transferring fish by turbine pump or brailing with a lift net causes more skin abrasions than using a vacuum pump (Grizzle *et al,* 1992). Vacuum and turbine pumps cause more broken dorsal and pectoral fins than lift nets.

Most fishing methods impose physiological and physical stress on the fish. When marine fish are caught by net or line they often show pronounced increases in plasma catecholamines, p_aCO_2, lactate, K^+, Na^+, creatine phosphokinase and cortisol. For example adrenaline, which is released from chromaffin tissue near the kidney, increases from less than 0.15 nM to 36 nM in the plasma when ludderick are gillnetted, and it can exceed 300 nM in blue mao mao which are caught and played on a line for about 10 minutes (Lowe and Wells, 1996). Adrenaline and physical activity both promote glycogen breakdown and the formation of acid as H^+ in muscle. Much of the acid is produced in the fishs' white muscle, and fish are capable of producing high levels of lactate in this muscle when exercise stressed. The protons that accompany lactate production in muscle are potentially harmful, and fish need to protect themselves with a buffering mechanism. This is provided by the imidazole group of L-hisitidine. Histidine, and its related derivative anserine, buffers the muscle by absorbing the protons. Anserine acts as a store of histidine which is made available during periods of activity. Athletic species such as tuna and marlin have large quantities of anserine in their white muscle.

Fish also have to protect themselves against the osmotic forces of their environment. The osmolarity of fish plasma is typically 300 to 400 mOsm per litre, whereas seawater has an osmolarity of 1000 mOsm. Marine fish expend energy in maintaining their body fluids in a hypotonic condition relative to the environment. This energy expenditure accounts for 15 to 20% of the fish's basal metabolic rate. When energy substrates are chanelled towards other functions, as occurs when fish are stressed, osmotic homeostasis may be lost, the fish lose body water and hence weight. There are a number of mechanisms involved in this weight loss. Normally, marine fish counteract the diffusion of water from body fluids to the hypertonic seawater medium by swallowing seawater and extracting the water component through the gut. Monovalent ions, principally Na^+ and Cl^-, are absorbed with the water. Excess chloride is excreted by the gills and sodium is exchanged across the gills in return for potassium. When fish are stressed, the release of adrenaline leads to constriction of intestinal sphincters causing a prompt decrease in water uptake by the gut. At the same time adrenergic receptors in the gills are activated which inhibit chloride excretion and Na^+-K^+ exchange at the gills. Water loss occurs across the gills through osmosis, and, as this is not adequately replaced by water absorption through the gut, weight loss follows. Freshwater fish experience similar problems but the osmotic gradient is in the opposite direction. The osmoregulatory disturbance created by hooking stress in freshwater rainbow trout is greatest at about 2 to 4 hours after the fish has been hooked and played, and it is exaggerated at high water temperatures. In marine fish which are caught and sold live these osmotic stresses can be countered by lowering the salinity of the water in the holding tanks. In freshwater fish the salinity should be raised slightly. Adjusting the osmolarity of the water may help reduce mortality in some species.

The loss of osmotic homeostasis during exercise stress can be lethal. As little as 6 minutes exercise to exhaustion has been known to kill 40% of trout (Wood *et al,* 1983). Death is not necessarily immediate. Typically, the fish lose balance 1 to 2 hours prior to death by rolling onto their backs, and their ventilation becomes rapid and shallow. Ventilation ceases before they develop a cardiac arrest. Another situation where stress is associated with suppressed respiration is tonic immobility. Some species go into an inactive catatonic state with subdued breathing movements when they are captured and restrained (Davie *et al*, 1993). In practice this reaction makes them easy to restrain and handle, especially for livebaiting.

Successful capture by trawling, harpooning and angling depends on exhausting the fish as they are caught. Gillnetting, longlining, trolling and some types of pole and line fishing also cause exhaustion through the high levels of activity and excitement. With all these methods the white muscle in the fish is almost depleted of glycogen by the time the fish is captured. The muscle may not be particularly acid, but it has high lactate levels. In fish most of the lactate that is produced from glycogen is retained in the muscle during a stressful episode, and it is eventually metabolised to CO_2 or back to glycogen. The H^+ produced with the lactate are released into the blood for excretion by the gills. For these reasons, in some species blood pH is more likely to reflect exercise stress than blood lactate.

Fish which are stressed during trawling develop high levels of glucose-6-phosphate and fructose-1,6,diphosphate in their meat in comparison with unstressed fish. This can influence the colour of the meat. Brown colours form during Maillard reactions between these compounds and amino groups during cooking. Dehydrated and dry-salted fish are particularly prone to these reactions which can be prevented either by the addition of sodium bisulphite or by soaking the meat in water before cooking.

If fish continuously exercise for several weeks before they are caught and killed, the haem pigments in the dark muscle are likely to be enriched. In particular the myoglobin levels are higher and the meat is darker in colour. This may detract from the fishs' value if the market expects a white meat.

The normal pH_{ult} of fishmeat is higher than in other meat species, and its exact value varies with species. In haddock it is between 6.3 and 6.6, whereas in cod it varies according to season, from 5.9 to 6.9. The pH is lowest in summer when the cod are feeding well, and it is highest in winter. One of the reasons the pH_{ult} is high in fish is that muscle glycogen is broken down by amylolysis besides producing lactic acid, and in some species lactic acid production is lower. In amylolysis glycogen is broken down to maltose and then glucose. The intermediate and final products in amylolysis are sweeter than those in the glycogenolytic pathway, and so fishmeat tends to be sweeter tasting than other meats.

Fish flavour can be influenced by the metabolism of nucleotides in the meat. During the early stages of storage AMP is deaminated to inosinic acid (IMP) which has the beneficial effect of intensifying the flavour of other compounds. As the fish ages further, IMP is converted to inosine which is flavourless and has no flavour-enhancing properties. Later still, inosine is broken down to ribose and hypoxanthine, and hypoxanthine has a bitter flavour. The production of hypoxanthine is probably the reason for the bitterness that occurs in cod which is held for long periods after death. There is no reason to suppose that the levels of IMP are influenced by catching stress; when IMP levels were compared in herring caught by trawling, gillnetting and trapnetting there were no differences.

Gaping is one of the most common quality problems with filleted fish (Love, 1988). It occurs when adjacent myotomes (muscle blocks) separate from each other. Gaps are created within the meat and the fillet is likely to fall to pieces. Gaping makes it difficult to skin the fish without breaking it, especially when using skinning machines. It also makes thin slicing of cured meats such as smoked salmon more difficult. The most effective ways of countering gaping and disintegration of a fish during cooking are to either cook it with the skin on or to coat it with a binder (e.g. batter) which holds the fillet together.

There are several factors which cause fish fillets to gape. One is weakening of the binding between the mycommata (connective tissue) and muscle fibres. The mycommata help to hold adjacent myotomes together. The other is excessive tension during rigor, which causes adjacent myotomes to shrink and the muscle tears itself to pieces. The likelihood of gaping occurring is increased if the freshly caught fish is allowed to warm up in the sun whilst on the deck. In the case of cod the muscle temperature has to increase above 17^{0}C, and for trout 26^{0}C, before gaping is more likely to occur. The higher temperatures have two effects. They increase muscle contraction as rigor sets in, and they reduce the strength of the mycommata. Heat-treated fish that develops gaping also tends to be tough and it loses fluid. An important practical recommendation is to chill fish rapidly in order to avoid gaping.

Gaping is not likely to occur in meat from stressed fish. Fish which are severely stressed during catching have low levels of muscle glycogen and ATP and so they will have insufficient energy to permit the vigorous contraction which causes the myotomes to tear apart. It is only fishmeat which is destined to have a low or intermediate pH_{ult} that has sufficient energy to experience this severe form of contraction, and because of this there is a negative relationship between gaping and pH_{ult}. Part of this relationship is also due to a direct effect of pH on the strength of the mycommata. Under acid conditions the connective tissue in the mycommata is physically weaker and the meat is more prone to developing gaping (Love *et al,* 1974).

In cod and farmed salmon the prevalence of gaping varies with season. It is more common in the warmer months. This can be due to inadequate chilling of the meat, but more frequently it is because the fish are eating more and their muscle glycogen and ATP levels are higher. This allows a stronger contraction during rigor and creates the acid conditions which causes weakening of the mycommata.

The seasonal variation in pH in cod also explains the seasonal variation in its mushiness. During early winter and spring when the fish are starving and the pH is high, the meat has a higher water holding capacity and moisture content and it is prone to being mushy. Such fish spoils more quickly when stored in an unfrozen state. Freezing helps to improve its texture by making it firmer. At the end of spring the fish pass abruptly from a period of semi-starvation to full feeding as they enter the summer feeding grounds.

This allows supercompensation of glycogen and glycogen storage capacity increases. The meat not only has a low pH but also contains more glycolytic intermediate compounds which help to make it sweeter.

The reason that freezing makes fishmeat firmer can be explained as follows. The water in fishmeat exists in two states; water which is bound to proteins in the meat and water which is unbound or 'free'. During freezing, water is forced from the proteins to join the column of ice which has been formed from free water. Once the protein-bound water has joined the free water, it will not return to its former place on the protein molecules when it is thawed. The protein fibres in thawed meat are less hydrated, they feel more fibrous and chewy and dry to the palate, and the meat is sometimes described as "raggy". In this way, short term freezing can be used to firm-up mushy high pH fishmeat. Freezing may have a detrimental toughening effect in low pH meat, which is likely to be firm anyway. The mechanisms which cause firmness in low pH fish are different from the toughening effect created by freezing, and the two are additive. Large cod are more likely to have a lower pH than small cod, especially when feed is available, and so where part of the catch is to be frozen and part iced, it is logical to freeze the smaller fish to reduce mushiness and avoid overall toughening. The toughening effect of freezing is species dependant; species such as cod and whiting are more prone to developing toughness than sole and halibut.

Burnt tuna is an interesting example of how exercise during catching affects meat quality. It shares many similarities to the PSE condition which occurs in pork (Watson *et al.*, 1992). High quality tuna should be translucent, red and firm. Burnt tuna is soft, it has a pale muddy brown colour, and a slightly sour taste. Although burnt tuna is edible, it is unacceptable for the sashimi trade (raw fish consumption). It is only evident when the fish are cut up, and it is customary for fishermen in Hawaii to give a rebate to wholesalers who discover the condition during butchery. It occurs in about 25% of tuna caught by commercial pole and line fishing, and it is common in sport-caught tuna. Longline tuna are less affected.

Tuna have remarkable athletic and line-fighting abilities. When alarmed they have been known to sustain speeds of 35 knots for over 5 minutes, and this produces large amounts of lactate in their white muscle. Some of the highest muscle lactate concentrations that have ever been recorded have been in tuna. Their unusually active muscle leads to muscle temperatures which can be more than 10^{o}C higher than other parts of the body. During line fishing, the longer the fish fights the line and the longer it takes to bring the fish in, the worse the burnt tuna condition (Cramer *et al,* 1981). Fish which fight the longest have particularly high muscle lactate levels and low muscle pHs at death. The combination of low pH and high temperature induces opacity and fluid leakage through denaturation of the sarcoplasmic and myofibrillar proteins respectively. Prompt chilling when the fish are caught may help to reduce but not eliminate the problem.

Highly active marine species also produce high levels of trimethylamine oxide in their meat, especially in fish living in cold waters. Trimethylamine oxide is an excretory product formed during detoxification of ammonia. It does not impart any flavour to the meat, but on storage, bacteria reduce it to trimethylamine which produces the characteristic fishy off-odours of spoiled fish.

Slime secretion continues for a number of days after slaughter, and this results in some weight loss. If the skin is removed and the fillets are stored in salt water, the meat gains weight by an osmotic effect created by Na^+ uptake. Na^+ uptake is inhibited for as long as the muscle ATP levels remain elevated. In exhausted fish the ATP level is reduced and Na^+ uptake starts sooner during the postmortem period. Muscle from exhausted fish which are skinned postmortem is likely to gain more weight by this process than muscle from unexhausted fish.

In some longline and trolling fisheries the fish have their brains spiked as soon as they are landed. A narrow-bladed knife is pushed through the top of the head into the brain and the blade is twisted. This reduces physical activity and hence the rate of ATP degradation in the muscle, and it delays the onset of rigor. Of commercial significance, it helps to extend the period of translucency of the chilled meat and delays the onset of opaqueness, but it is ineffective if the fish is severely stressed during capture.

Fish are not usually bled when they are slaughtered. However, trials with trout and catfish have shown that bleeding at slaughter reduces redness in the meat and the development of rancid odours in frozen fish. The iron in haem blood pigments acts as a pro-oxidant, accelerating the production of oxidative rancidity. The yield of blood during slaughter has been greatest when the tail is cut off at the caudal peduncle. Cutting the ventral aorta at the isthmus provides a satisfactory bleed out, whereas severing the spinal cord and dorsal aorta at the nape results in a poor bleed out. Some fisheries which specialise in smoked fish production routinely bleed the fish as soon as they are caught. Blood spots can be a problem in frozen tuna and carp. The severity of the spotting can be reduced but not eliminated by storing the fish in a chilled state for two or more days before freezing.

In benthic species (fish that live at low depths) which are physoclistous (have a closed swim bladder) there is a risk that the rapid change in pressure experienced as the fish are brought to the surface results in overinflation of the swim bladder. This is common in fish which are raised from 30 metres or more depth, and it is important in catch and release fishing as the chances of survival are greatly reduced. In extreme cases the build-up in pressure within the abdomen causes a prolapse; parts of the gut are forced out of the mouth and anus, the eyes may be forced from the orbits and there can be distortion of the scales and flesh.

Conclusions:

There are a number of practices during harvesting which are likely to cause pain and distress in marine fish. They include asphyxiation whilst compressed in a net or during emersion, exhaustion during the chase, compression during towing in a net and at lifting, pain from hooking, gaffing, abrasion against the net and impacts from fish pumps. In addition in some situations there could be pain, distress or discomfort from osmotic stressors, burst swim bladders, the stress of capture and during live-baiting.

A number of stress-associated practices can influence the quality of the product. Exhaustion during capture can lead to to the burnt tuna condition and reduced translucency in the meat, but it can benefit meat quality through reduced gaping and increased water uptake and yield. Bruising caused by fish pumps and skin or scale damage occuring in nets can lead to downgrading of product, as can gaffing. Skin and scale damage not only disfigures the product but can also encourage entry of spoilage micro-organisms.

Methods used for limiting the catch of small-sized fish are not always associated with a high survival rate in the fish which avoid capture.

CRUSTACEANS AND SQUID

Lobsters and crabs are caught in trap pots, by spearing, handheld scoop nets or by gloved hand and lantern. Spearing can result in a short storage life unless processing facilities are very close to the fishery. When lobsters and crabs are not processed immediately, they are often stored alive in tanks which are irrigated with sea water. When crabs are sold alive freshness is assessed from their vitality. This is determined as follows:

Lively -quite active when held by the carapace (back) with legs extended out horizontally

Weak - active only when pressure is applied to the apron. Periodic slight movement of the legs and mandibles when held by carapace

Critically weak - very heavy drooping of legs, mandibles and apron. No physical movement. Life only detectable by observing heart action (after removing carapace)

Dead - Distinguishable from critically weak crab by absence of heart action (after removing carapace)

Vitality provides the buyer with an indication of how well the live crab has been stored. In warm climates the crabs have to be stored in iced insulated containers to maintain a lively condition and freedom from bacterial proliferation.

Healthy crabs do not have a sterile haemolymph. Instead they harbour low levels of bacterial infection (about 14 cfu/ml haemolymph). Crabs caught in pots and confined to the pots for as long as 24 hours have similar bacterial counts in their haemolymph, but crabs subjected to the stresses of commercial capture, handling and transport are likely to be more heavily infected. This may be due to the injuries that occur during commercial handling. It has been suggested that the bacterial contamination may contribute to the risk of *Vibrio* poisoning amongst crabmeat consumers.

Claw loss is quite common in lobsters caught in traps. In one study in Canada, 19% of the lobsters had a missing claw. Up to 11% of the lobsters were also wounded in another part of the body. Not all this damage occurred during handling; some occurred in lobster grounds where Irish moss had been harvested from the seabed using drag rakes. Needless-to-say the damage reduced the marketability of the lobsters.

Crabs and lobsters may be killed by pegging (pithing), boiling, freezing or during evisceration and dressing. The stage at which an animal loses sentience during these killing procedures has not been examined in any detail. On some vessels crabs are killed on the deck. In Asian fisheries the pegged crab is often cut along the ventral midline and meat is cut out from each half. In other fisheries, the carapace is removed by striking the anterior projection against the edge of the processing table, prising the body in half, removing the gut and gills with a rotating nylon brush and then packing the two halves which still contain the meat into a basket net which is subsequently lowered into a cooking vat. The method used for killing lobsters can affect the flavour of its meat. When lobsters are killed by pegging (slicing through the carapace just behind the eyes) without being boiled, IMP will form in the tailmeat from AMP after about two days when stored at $0^{0}C$. Inosine starts to form between three and seven days postmortem, and hypoxanthine at seven to nine days. If instead, the lobsters are boiled alive, the enzymes responsible for these conversions are denatured. This results in lower levels of the flavour-enhancing IMP as well as lower levels of the bitter compound hypoxanthine.

New Zealand crayfish are usually exported live. For this reason it is important to ensure that they are handled appropriately with limited osmotic stress and autotomy. Crayfish that are killed for the domestic market are either chilled before the tailmeat is removed, or the tailmeat is cut away using a mounted static knife from the unchilled animal. The fore end is still active after cutting out the tailmeat when crays are not chilled. Killing crays in freshwater (drowning) is not considered humane, but is used in some fisheries in New Zealand.

Some species of prawn and shrimp are thin shelled and fragile (e.g. Royal red prawns), and require careful handling to avoid stress-induced discolourations. Melanosis (black spot) quickly develops when they are removed from the sea. This is caused by the enzyme dopa oxidase which produces the black pigment melanin, particularly at high temperatures. In warm conditions, the prawns need to be sorted and chilled quickly. Sodium bisulphite is sometimes used for delaying blackspot formation in ice-stored shrimps and prawns.

Eyestalk ablation is practiced in breeding stock in farmed crustacea (especially prawns and shrimps). The eyestalks are essential for vision, and they secrete a number of hormones, one of which inhibits reproduction. By cutting off the eyestalks the inhibitor is removed and the females will mate repeatedly and lay successive batches of eggs until they die. In males, ablation induces precocious moulting and reproduction. Male prawns (*Macrobrachium rosenbergii*) die within 48 days of bilateral eyestalk ablation, but if only one eyestalk is removed they survive considerably longer. Although the animals are blinded they are able to feed, and in fact their appetite and growth rate are increased following eyestalk removal. Removing a single eyestalk is more difficult and takes longer than cutting off both together.

Squid are caught by trawling, basnig nets, purse seining, round haul seining, scoopnets and jigging lines. Trawling takes most of the catch, but jigging is more common in municipal fisheries. The main edible parts in a squid are its mantle and tentacles. The tentacles in particular are damaged when jigging lines are used. Normally, the squid strikes its prey with its tentacles in a rapid lunging motion which draws the prey to its arms. Squid meat is mainly cream coloured and any bruising caused by the hooks strongly discolours the meat, even when it is processed by blanching and retorting.

Conclusions:

The main welfare concerns with crustacea are stress-associated autotomy, the killing methods that are used and the conditions provided during live export. Further information on commercial practices, and the nature of the welfare impositions that they might create, is needed before constructive comments can be made which could help the crustacean fishing industry.

FISH FARMING

Fish that are farmed in coastal floating cages or freshwater ponds experience a variety of different stresses. These include:

- overcrowding
- predation
- increased prevalence of disease
- failure to migrate in mature stock
- cage noise
- inability to swim to deeper water during storms
- abrasion against the cage walls
- handling stresses
- cannibalism

Overcrowding in cages or ponds can lead to elevated plasma cortisol and catecholamine levels, greater scale loss and entry of pathogens, and decreased sodium possibly resulting from damage to the gills. At high stocking densities it is the subordinate fish which are likely to become most stressed. Recommended stocking rates have been 15 kg/m^3 for salmon and less than 30 kg/m^3 for trout (Farm Animal Welfare Council, 1996). In some salmon farms the stocking density is as high as 40 kg/m^3. Controlling disease outbreaks can be difficult at the higher stocking rates.

A major expense in farming fish is the cost of the feed. Two strategies are used for minimising this cost; ensuring that feed is not wasted and maximising feed conversion efficiency (growth per unit weight of feed consumed). In salmon and trout farming feed wastage is controlled by giving the fish a pelleted feed which is slow to sink. This is done by impregnating the pellet with air when it is manufactured in the mill. The fish have more time to eat the pellets if they sink slowly and so less is wasted on the estuary or pond bed. Growth rate and feed conversion efficiency are maximised by including high levels of fat in the pelleted feed. This acts as a concentrated source of energy and it helps to slow the sink rate, and hence the bottom wastage, of the feed Over the years the fat content of salmon and trout feeds has increased from 10 to 30%, whilst the more expensive protein content has been kept constant at about 45%. The faster growth rates benefit the fish farmer, but this is offset by adverse effects on the appearance and eating quality of the product. Fish reared on high fat pellets have more oily flesh. This is thought to create a fatty mouth feel when the meat is eaten, it is associated with more gaping on storing, there can be poorer uniformity in the colour of smoked salmon and there may be oil separation in vacuum packaged product. The flavour of the meat is not necessarily affected. In trout farms these quality problems are managed by forcing the fish to metabolise surplus fat in the muscle before they are slaughtered. This is done in two ways. Firstly by fasting the trout for one to four weeks before catching. In addition to this they may be penned in a fast-flowing current to provoke muscular exercise. Fish such as trout are adapted to short bursts of activity rather than sustained continuous activity. In this respect these treatments are severe, but they need to be severe in order to achieve the aim of reducing fat levels in the muscle. During fasting the level of monunsaturated fatty acids decreases more than the polyunsaturated fatty acids, and there are reductions in flavour and juiciness. Some salmon farms use a low fat finishing ration which from a welfare perspective is a more acceptable option.

At feeding time the fish compete for feed, and the smaller fish may be intimidated by the larger ones. Over time the sizes diverge and if they are not periodically graded and sorted into cages or ponds according to size, there is a risk of cannibalism. The smaller fish are attacked by the larger fish, and the early signs of cannibalism are loss of tail fins in the smaller stock. To reduce aggression and competition at feeding time, the feed should be distributed evenly and widely.

Physical injury to farmed fish can be an important welfare problem as well as causing downgrading. For example, considerable damage and losses have occurred from predation. In Europe the main predators on fish farms are seals, otters, mink, herons, cormorants, shags and other seabirds. The primary control objectives should be physical exclusion or scaring. Destruction of a predator will not be effective if its place is taken by another of the same species. In salmon, injuries to the snout and fins are caused by damage from the cage walls. They can be controlled to some extent by using cage nets with a small mesh size or nets that have been treated to reduce abbrasiveness, but small mesh sizes have the disadvantage of reduced water flow and the need for more frequent cleaning.

The following risks occur when fish are handled:

- inadequate oxygenation when removed from the water
- inadequate oxygenation when crowded together
- death in association with exercise and stress
- mechanical damage from pumps, nets, vaccination tables and grading equipment
- infections developing from fin, skin and scale damage

If fish are severely stressed during the handling that precedes stunning they develop rigor more rapidly and the rigor is stronger. The rapid, strong contractions result in disruption of the muscle structure and produce a softer meat (Sigholt *et al.*, 1997). It can also have a lower water holding capacity.

Concern for the methods of slaughter of 'higher' vertebrates, such as domestic farm animals and poultry has received a significant amount of attention and some concerted experimental research. However, detailed examination of sensibility at slaughter is a largely ignored topic in fish. Meat and product appearance have, not surprisingly, been the primary concern of producers and as yet fish welfare has received little thought from the public. With the exception of West Germany, there has been no legislation specifically governing the methods used to harvest and slaughter fish from aquaculture operations. A proposed FAO guideline on ethics for fisheries covers many issues, including environmental concerns but fails to mention fish welfare at harvest (Anon, 1997). Similarly, in an extensive five article series on legal issues for the North American aquaculture industry there is not a single mention of fish welfare issues (Anon, 1997). Fortunately, with many aquaculture species there should be little conflict between harvest procedures which are humane and also derive an appealing product. Each slaughter procedure should be evaluated experimentally to determine its effectiveness, and preferably repeated for each major group of species. Species differences can critically influence the effectiveness and acceptability of a particular slaughter method. Four groups of fish will be considered here; salmonids (*Oncorhynchus*) and eels (*Anguilla*), as these are the most applicable for New Zealand, and catfish/carp, representing species raised semi-intensively and the most numerous finfish speices cultured.

The procedures used to gather farmed fish for slaughter depend on the type of system used and this is also dependant on the region/country concerned and the species in question. The majority of salmonids are raised in freshwater raceways or marine cages, eels are primarily raised in a variety of land-based freshwater systems including tanks and ponds, while the majority of catfish and carp are raised in earthen ponds (Busch, 1985; Beveridge, 1987; Varadi, 1995). Fish for harvest are usually not fed for a period of time to clean out the gastrointestinal tract; 24 hours is sufficient. Salmonids in raceways are slowly crowded to one end via a grate and then, in small sized operations dip netted, or in a larger operation moved via one of several types of pescalators or nets. Crowding fish can cause abrasions and carcass damage, and it is stressful. These pescalators are usually vacuum or water pumps, or a mechanical system of elevators or screw augers which raise the fish into a container. These systems are limited by the size of the fish and they are useful for 'pan-sized' product. They can sometimes cause abrasions and scale damage and fish are occasionally crushed depending on the system used, but proper operation can eliminate these problems and with proper use they are usually gentler than nets (Varadi, 1985). Cage cultured fish are seine-netted and then brail or dip netted into a stun tank. Pond cultured species are generally gathered by seine netting or a modification of a netting procedure dependant on the size, shape and depth of the pond. The fish can be netted out or once they are crowded into a small area they can be moved with other types of nets or pumps. Netting catfish is a particular problem as the spines of the pectoral fins get caught. These spines are a notable problem as they traumatise other fish and the net operators. Some fish have to be removed from the nets by clipping the spines (Busch, 1985). Fish can be slaughtered on site and then packed in ice, or in some species (e.g. carp, catfish and sometimes eels) they are trucked live at high densities to a processing plant or directly to a market. High density transport of fish leads to physical trauma, stress and water quality degradation (Busch, 1985; Varadi, 1995). Handling stress, particularly in fish which are transported live, requires careful consideration, not only for effects on carcass quality but also for the welfare of the fish. Each type of net, for example, may provoke different types of stress and varying degrees of carcass damage (Hopkins and Cech, 1992). It is important to note that there are very clear differences between wild fish and those which have been partly domesticated and that after several generations fish will adapt to many management practices (Mazur and Iwama, 1993; Pottinger et al., 1994).

The main killing methods used for farmed fish are:

- concussion with a priest (small club)
- CO_2 stunning followed by exsanguination
- overdosing with iso-eugenol
- emersion
- exsanguination without prior stunning
- electrical stunning/electrocution

In general, slaughter procedures are dictated by local and international market demands. Factors which play a part in deciding which procedures are used include distance from the market, size of animal at harvest, the number of fish harvested, the type of holding facility the fish are derived from, and the inherent qualities of the particular species. Acceptable methods from a welfare perspective have to conform to market expectations. From the welfare perspective they should render the animal instantaneously insensible and involve a minimum of pain and/or stress before or during the procedure (Anon, 1993).

Eels, including the two New Zealand species, are harvested from the wild, held and shipped live to market, or caught as elvers and raised until harvested. In New Zealand, eels are caught by individual fishermen using a variety of methods, but are usually netted. They are then transported, often without water to a wholesale facility where they are held for a period to clean out their gastrointestinal tracts, graded and then exported live. The mortality rate experienced during these procedures is likely to be low but it can be significant. For example, eels have been seen (by J.L.) dying whilst in the wholesale facilities, and linked to this some eels are purchased in a poor condition with abrasions, fin loss, wounds and bacterial septicaemias.

Eels are either sold live individually or killed for the customer at the point of sale, or they are killed wholesale for smoking and brining. They are not considered to be fresh and palatable for the customer unless they are killed shortly before consumption or they are processed immediately after death for smoking. On some occasions they are frozen alive for bulk sale. When sold as individuals, they are rendered 'insensible' by a cut which transects the spinal cord caudal to the brain. This reduces movement, and allows easier evisceration and skinning. Before cooking the eel is decapitated. A considerable period of time can elapse between spinal transection and decapitation since it is commonly held that spinal transection alone kills the eel.

Since the brain is not ablated by transection of the spinal cord it seems unlikely that the animal is rendered insensible. In fact, eels in which a spinal transection was performed, followed by repositioning of the wound with skin sutures, were shown to completely recover in 6 weeks (Flight and Verheijen, 1993). Similarly, complete recovery following spinal transection has been demonstrated for a number of teleost species (Berstein and Gelderd, 1964; Coggeshell et al., 1982).

Decapitation, as mentioned previously, follows spinal transection with disposal of the heads. The state of the head of the fish has not received further consideration. However, the 'isolated head perfusion technique' has been widely used in experimental work on fish because it represents the closest thing to a whole fish. It has been used in particular in studies on gill function (Daxboeck et al., 1982). Decapitated eels consistently showed signs of life (respiration, opening mouth, twisting of the shortened body, and pectoral fin movement) for up to eight hours. Those kept moist out of water lasted the longest while those kept under water died relatively quickly (after approximately 30 minutes) probably from the severe osmotic effects of an open wound in the water (Verheijen and Flight, 1997).

Eels that are to be used for smoking are deslimed (stimulation of mucus in goblet cells) by adding them in large numbers to large vats with dry salt for 30 minutes followed by the addition of water to form a brine in which the eels slowly ceased all movements over a period of approximately 30 minutes, at which point they were considered to be dead. Before movement ceases the eels thrash and writhe but movement sharply decreases and many eels stop moving by the end of the dry phase. Movement may re-occur after the addition of water but it is usually uncoordinated and by the end of the wet phase it has ceased. Experimental reproduction of this method with removal of eels from a brining tank and placement in tap water produced purposeful movement and activity (shelter seeking) in all of the experimental eels. These eels were essentially in osmotic shock, and all died within 18 hours (Verheijen and Flight, 1997). These authors also noted that animals which had their brains destroyed immediately before brining seemed to deslime appropriately, questioning the need for using the procedure on live eels. Failure to remove the slime results in white discolouration of the skin in the smoked product, and it is claimed to affect the flavour of the meat. Part of the perceived off-flavour may, however, be due to the fact that non-deslimed eels are often sold whole with their viscera present. Muddy flavours can be transferred to the meat if evisceration is delayed. In some countries live eels are deslimed using ammonium hydroxide. The eels are first weakened by holding them out of water for 12 hours. When placed in a tank of 6% ammonium hydroxide they take on average 16 minutes to die, and they show pronounced writhing in the intervening period. At this concentration the smoked meat contains small amounts of ammonia (about 25 mg/100 g) and this is not usually sufficient to affect its taste or smell. Ammonium hydroxide is an irritant for fish. It is NH_3 rather than NH_4^+ which is toxic, and the equilibrium between the two is temperature and pH-dependant. From the welfare perspective there is a need for replacing this and the salt desliming method with a postmortem desliming system.

A variety of methods are used for harvesting salmonids. Anoxia alone, on ice, or in an ice/water slurry is a commonly used method, particularly in large cage culture operations. Anoxia alone does not meet the requirement that the method should induce immediate insensibility, and brain responsiveness persists for some time. It has been found, using visual evoked potentials (VERs), stimulated by a strobe light and recorded with implanted optic lobe electrodes, that brain responsiveness remained detectable for up to 10 minutes after removal from the water (Kestin et al., 1991).

Several other points should be made regarding this study. Part of the difficulty in evaluating the ability of the brain to respond to the activation of primary sensory pathways (including pain) is the subjective nature of many of the criteria that are used. The methods that have been used include the spontaneous electroencephalogram, reflex physical activities, cardiac pain reflexes, behavioural studies and assessment of averaged evoked responses in the brain. Of these criteria, cardiac pain reflexes are not applicable to fish and all but the last are subjective and open to alternative interpretation.

The eel studies mentioned previously provided very convincing and dramatic evidence, but the interpretation that can be placed on spontaneous physical activity is limited. For example, the studies by Kestin et al. (1991) clearly illustrated that determining the cessation of an animal's movement is an insensitive technique considering that anoxic rainbow trout continued to express detectable movements for up to 198 minutes whereas the VERs disappeared in less than 10 minutes. Those studies also demonstrated that lowering the temperature of the fish during anoxia increased the time over which the VERs and movement were detectable (Kestin et al., 1991). The use of ice and ice/water tanks would therefore increase the length of time that conscious fish could experience discomfort and pain.

Cerebral concussion is a good method for quick and effective destruction of the brain in salmonids. Trout correctly struck just caudal to the eyes over the cranium almost immediately lost their VERs (Kestin, 1993). This method is used because it is cheap, quick and reliable, however it is not a practical method in operations where large numbers of fish are harvested. One of its commercial advantages is that it reduces physical activity and hence skin and scale damage. The low levels of physical activity are associated with reduced levels of lactic acid during the early postmortem period (Azam *et al,* 1989). The blow should be aimed at the head in a restrained fish. Striking a freely moving fish is likely to bruise the edible parts as well as cause suffering. Restraint is sometimes achieved by holding the fish by the tail with the fingers pressing on the lateral line and the fish resting on a sheepskin.

Most of the standard chemical anaesthetic agents are not approved for use in fish for human consumption except for tricaine methansulfonate (MS-222), however it has a 21 day withdrawal period and therefore is not used for harvesting market fish. A very promising product derived from cloves, iso-eugenol (marketed as Aqui-S), is used in Australasia for preslaughter sedation and increasingly around the world as an anaesthetic (D. MacPhee, Shurgain Foods, New Brunswick, Canada, personal communication) and appears to be very effective at reducing or eliminating the struggling usually experienced during the induction of hypoxia. Aqui-S is being used experimentally in New Brunswick and Maine to sedate fish before they are brailed into stun tanks.

Carbon dioxide and sodium bicarbonate are used in some countries for preslaughter stunning salmon (Anon, 1993; Schnick et al., 1986), however they can cause irritation during induction and the loss of VERs can take up to 5 minutes when they are held at 14^{0}C (Kestin, 1993). Carbon dioxide in ice water is the most common method employed in the Tasmanian salmon industry although asphyxiation is still probably common (B. Munday, University of Tasmania, personal communication). Salmon killed by carbon dioxide followed by bleeding enter rigor quicker than fish stunned by concussion. Carbon dioxide causes more physical activity and so muscle ATP is depleted sooner, allowing rigor to occur earlier. The increased physical activity with carbon dioxide is thought to be a sign of irritation in the fish. They jump and swim actively presumably in an attempt to escape before losing consciousness at 30 and 60 seconds after tipping them into the CO_2-enriched water. There is concern that carbon dioxide is not an acceptable method from the welfare perspective, and some farms have stopped using it because the increased activity causes too much skin damage. The gills in uncooked salmon that have been stunned with carbon dioxide are prone to premature browning, and this can give a false impression that the fish have been stored for a long period. If salmon are kept in stagnant water in a holding pen for 10 minutes before CO_2 stunning, the additional stress of overcrowding provokes vigorous muscular activity and accelerated rigor once they are dead. The muscle structure becomes disrupted and meat texture can be unacceptably soft (Sigholt *et al.*, 1997). In eels, CO_2 stunning can be associated with a lower water holding capacity in the meat, and in carp there can be a more intense rigor, in comparison with electrical stunning, concussion stunning or severing the spinal cord (Marx *et al.*, 1997).

Exsanguination is the most common method employed in the Norwegian salmon industry and on the Atlantic coast in Canada but a variety of methods are used to handle and sedate the fish before they are killed. The fish are killed by manually slicing the gill arches on one side and the fish is then sluiced into a 'bleed-out tank' containing salt water and ice. On the Atlantic coast of North America the fish are brailed into a stun tank before being handled manually. Fish in the stun tank are exposed to ice cold seawater, with or without bubbled carbon dioxide (D. MacPhee, personal communication).

Applying an electric current, with or without chilling, has been widely tested as a method of immobilizing fish at slaughter (Gunstrom and Bethers, 1985; Kestin, 1993; Orsi and Short, 1987; Redman et al., 1998; Varadi, 1995). It has been used for euthanasia, electrofishing (Sharber and Carothers, 1988) and for immobilizong wild fish for tagging or egg collection where chemical anaesthesia was impractical (Gunstom and Bethers, 1985; Orsi and Short, 1987). It can also be used for spawning food fish without incurring anaesthetic withdrawal times and it does not have any undue effect on the eggs (Redman et al., 1998). It is used sporadically as a method of stunning harvested caged salmon in the Canadian west coast industry (V. Ostland, University of Guelph, Canada, personal communication), in Scotland (Kestin, 1993), and is used to stun carp before processing (Varadi, 1995). The effect and length of action depends on the methodology employed. The use of an alternating current can result in widespread carcass haemorrhages and spinal injuries which are unacceptable (Sharber and Carothers, 1988; Walker et al., 1994), while pulsed direct currents produce a more predictable effect and they do not cause carcass damage at lower currents (Kestin, 1993; Redman et al., 1988). The voltage required varies with the species, length of the fish, apparatus, and of course with the desired effect. Short-term immobilization with recovery in one or two minutes is produced by low currents (60V or 300mA for 1 to 10 seconds) while higher currents (>600mA for as short as 1 second) prevent recovery. Currents above 300mA immediately ablate VERs while even at 1.5A the heart remains beating and some movements are visible (Kestin, 1993) which again emphasizes the importance of the criteria used to define an effective stun. An important practical advantage with this method is the capability of immobilizing large numbers of market sized fish quickly and effectively, and it can be adapted to a range of handling and harvesting procedures. Some processors use an electric current to immobilise or stun the eels, whilst kabyaki manufacturers are said to skin the eels live. This is done by quickly pinning the head to a board, slitting down the side of the back and removing the guts and backbone.

Conclusions:

The main welfare concerns in the aquaculture and eel industries are to do with specific management practices. These include the killing methods used for fish, preslaughter desliming methods for eels, overcrowding by the time the fish reach slaughter weight, cannibalism due to inadequate grading, and handling stress and damage. Many of these features are linked with good (or poor) practice and so it should be possible for the industry to ensure that they can be controlled. However, some assistance or guidance may be appropriate with respect to stocking densities, slaughter methods and preslaughter desliming.

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SURVEY OF METHODS USED FOR KILLING ROCK LOBSTERS IN NEW ZEALAND

Introduction

The methods used for killing rock lobsters in New Zealand have received some adverse publicity in recent years. The Ministry of Agriculture and Forestry decided that this issue should be addressed and they asked MIRINZ to conduct a survey which:

- Determines the methods used for killing rock lobsters in restaurants
- Determines the methods that are used and are recommended for killing rock lobsters by seafood shop owners
- Provides suggestions on which killing methods are appropriate and which are inappropriate.

This report describes the findings from that survey, which included premises in Auckland and the Bay of Plenty.

Methodology

Twelve restaurants, three seafood shops, and four exporters which killed rock lobsters for consumption within New Zealand were invited to take part in the survey. Five of the restaurants and one sea food shop, either refused to take part in the survey or refused to provide information relating to the killing methods.

The survey was conducted as a face-to-face interview, either with the chef, manager or proprietor of the premises, or, as a telephone interview in the case of the lobster exporters. At the restaurants, it was usually the chef who killed the rock lobsters. However, the chef was not always responsible for the purchase and care of the rock lobsters before slaughter.

The purpose of the interview was explained at the beginning of the interview. The interviewees were aware of the publicity and sensitivity associated with the practice, but they were assured that information relating to individual premises was confidential and that they would not be discussed by name.

Results

The restaurants usually bought-in live rock lobsters four times a week in lots varying from 3 to 60 animals. Some restaurants made a speciality of rock lobsters meals, and they would put through about 100 rock lobsters a week, but in busy periods it could be as many as 300. Some restaurants had display tanks of live rock lobsters, and customers could choose the animal they wanted to eat. It was more common for the customer to order the dish, live-animal-unseen.

The restaurant proprietors often collected the rock lobsters from a seafood wholesaler or retailer, but in some instances the rock lobsters were delivered by the wholesaler. They were usually transported loose in bins or styrofoam boxes with either a dry straw overlay or a lining of damp newspaper. They may or may not have been transported in a container that was chilled with an ice bottle. Some restaurants preferred the damp newspaper as it kept the rock lobsters moist and appeared to enhance their freshness. Live rock lobsters that were sent to Auckland from the South Island, were usually packed in ice and straw.

Not all rock lobsters were kept on display. Some were kept in the kitchen or food storage area. Those that were kept on display were usually maintained in seawater tanks, and the water was aerated, filtered and usually kept at 11 to 14 °C. The tanks were typically bare, without any vegetation or stones.

Eight procedures were used on a routine basis when killing rock lobsters in the restaurants and seafood shops. They included:

Chilling

Methods used in the Seafood and Restaurant Industries:

Restaurants which did not have live holding tanks usually bought lobsters in every 1-2 days. In that situation the lobsters were stored live in a chilled state until they were needed. Chilling was done by placing the lobster in either an ice slurry (fresh or salt water), a chiller, or a refrigerator. The lobsters were killed as soon as an order for a lobster meal was received.

Most restaurateurs considered that lobsters should not be kept for more than 3 days in a chilled state. If lobsters were to be kept live for longer than this, live storage tanks would be preferred.

In restaurants which had live lobsters on display in tanks, the lobsters were not chilled prior to slaughter. Chilling would take too long whilst a customer was waiting.

All but one of the lobster retailers chilled the lobsters. They used an ice slurry or large chiller/freezer before tailing or cooking. They generally considered chilling to be a humane method, as opposed to no chilling.

Welfare appraisal:

The immersion of crustaceans including rock lobsters into an ice-sea water slurry is one of the preferred methods for inducing torpor before slaughter. Crustaceans can sense changes in temperature, but they become torpid quite rapidly when placed in an ice slurry. Time to loss of movement is slower when they are placed in a container within a chiller or refrigerator. It is clear that the rate of chilling is an important factor in determining the suitability of this method.
Chilling in an ice slurry for 20 minutes is an approved method for killing rock lobster, in the New Zealand Fishing Industry Agreed Implementation standards.

Freezing

Methods used in the Seafood and Restaurant Industries:

Live rock lobsters are sometimes placed in freezers to either freeze to death, or to chill as a prior step to slaughter or cooking. This method was not used widely because most restaurants preferred to serve unfrozen rock lobsters, and because they had limited freezer space. The method tended to be used when there was surplus stock.

Welfare appraisal:
Essentially the same as for chilling. In this case the lobsters would first become torpid from chilling and then freeze to death.

<u>*Drowning*</u>
Methods used in the Seafood and Restaurant Industries:
Lobsters are put into a container of fresh water and usually weighted down to stop escape, as this method is often associated with struggling. This method was used where a large number of rock lobsters have to be killed rapidly. It was also the preferred method amongst some seafood retailers where the rock lobsters were sold dead instead of alive. This was because it allowed the body to be sold whole, without any blemishes or puncture wounds. This method was said to produce a flaccid rigor, which was not always favoured.

Welfare appraisal:
Rock lobsters are a marine species and while many people believe that lobsters drown in freshwater, it is likely that the severe osmotic stress is the primary cause of death, rather than asphyxia. Osmotic stress is looked upon as an unpleasant experience for the animal.

<u>*Boiling*</u>
Methods used in the Seafood and Restaurant Industries:
The live rock lobsters are placed in boiling water. This method was not used widely because the limbs are prone to falling off. The cephalothorax (fore-half) is often used as a decoration/garnish accompanying the meat, and a full complement of limbs is preferred. Some restaurant proprietors considered that boiling live made the meat tougher, and that the appearance of the meat was less appealing as it lacked freshness.

Welfare appraisal:
The loss of limbs from boiling the lobster alive could be due to autotomy. In other situations, the lobster actively severs its limbs as part of an escape response. This may suggest that while death is rapid it is not instantaneous, and there may be an intervening escape response.

<u>*Head spiking*</u>
Methods used in the Seafood and Restaurant Industries:
A knife was inserted into the head between the eyes. This method was not widely used as a sole means of killing the lobster. Often it was used in conjunction with splitting.

Welfare appraisal:
In the rock lobster there are two chains of ganglia with interconnecting nerves which run down the length of its body. The cerebral ganglia is located in the approximate area where spiking is done. There are other significant nerve centres which are not destroyed during spiking. Their role in sustaining perception after spiking the cerebral ganglia is not understood. It requires some skill to perform spiking effectively.

Chest spiking

Methods used in the Seafood and Restaurant Industries:

A knife was inserted into the chest along the mid-line, and was followed by splitting. One premises favoured this method because it was associated with less leg loss in comparison with splitting without chest spiking. This method may also reduce limb activity.

Welfare appraisal:

Unknown

Splitting

Methods used in the Seafood and Restaurant Industries:

This method was done with and without prior head spiking. A knife was introduced through the carapace and drawn down the length of the body whilst restraining the rock lobsters belly downwards on a flat surface. This split the animal longitudinally into two pieces. The rock lobsters may or may not have been chilled when this was done. It was associated with less activity after cutting in comparison with tailing, and so the parts of the body were easier to control. Prior head spiking or chilling helped to reduce the physical activity during and following splitting.

Welfare appraisal:

This is similar to head spiking, but is a more comprehensive way of destroying the nervous system.

Tailing

Methods used in the Seafood and Restaurant Industries:

A transverse cut was made across the body between the cephalothorax and the abdomen. This type of cut was easier to perform than an uninterrupted split, but splitting was favoured for cooked rock lobster meals where the meat was served in the shell.

Welfare appraisal:

A transverse cut does very little to destroy the nervous system of the lobster and death is probably caused by blood loss. The limited interference with the nervous system means that the animal could remain conscious for sometime if it had not been chilled beforehand.

The type of cuts used in head spiking, chest spiking, tailing and splitting are shown in the accompanying figure.

When retailers gave advice on how to kill rock lobsters to customers, they usually recommended drowning.

Table 1 shows the sequence of procedures that were used when the lobsters were being killed at the 14 premises. For example, at the second restaurant shown in the 9th row of the table, the live lobsters were stored in a refrigerator and they were split with a knife as soon as there was an order. In two restaurants more than one method was used, depending on how the product was going to be served or whether there was a large order as an advanced booking.

Table 1. Sequence of procedures used when killing rock lobsters

Premises	Chilled	Drowned	Boiled	Head spike	Chest spike	Split	Tailed
Retailer	1						
Retailer	1	1					
Retailer	1						
Retailer	1						
Retailer	1	1					
Retailer		1					
Retailer	Refused to take part in the survey						
Restaurant	1	1			2	3	
Restaurant	1					2	
Restaurant						2	1
Restaurant	1					3	2
Restaurant				1		2	
Restaurant			1				
Restaurant		1					
Restaurant				1		2	
Restaurant	Refused to answer questions on killing methods						
Restaurant	Refused to take part in the survey						
Restaurant	Refused to take part in the survey						
Restaurant	Refused to take part in the survey						
Restaurant	Refused to take part in the survey						

Discussion

In general, people involved with killing lobsters were reluctant to take part in the survey. Restaurant proprietors seemed to want to continue the practice, but were not always prepared to discuss the killing methods, even though it was explained that the purpose of the survey was to help the restaurant and retail food industry

The procedures used when killing lobsters were: chilling, freezing, drowning, boiling, head spiking, chest spiking, splitting and tailing. Freezing and boiling were not in general use as they were associated with inferior product quality. Most lobsters were split longitudinally to present the meat, and they may or may not have been chilled, given a head or chest spike, or tailed before splitting.

Table 2 summarises the methods according to their likely acceptability in terms of lobster welfare. It is assumed that chilling has an anaesthetic-like effect on lobsters, and so, once the animal has been properly chilled, and provided it is not re-warmed, the method of slaughter becomes less important from the welfare perspective.

Where chilling is not used, tailing was considered the least acceptable killing method. This is because it causes less disruption of the nervous system, and so consciousness is likely to persist for longer. Tailing without chilling was not used widely. It is unclear whether head or chest spiking causes immediate insensibility in lobsters which are not chilled, and so we are not in a position to recommend or discourage this method.

Table 2. Likely welfare acceptability of methods

Method		Most Acceptable	Intermediate Acceptability	Least Acceptable	Don't Know
Chilling (in combination with spiking, splitting or tailing)	Seawater/ice slurry	√			
	Freshwater/ice slurry		√		
	Freezer	√			
	Refrigerator/Chiller	√*			
Freezing		√			
Drowning				√	
Boiling				√	
Head spiking	Without chilling				√
Chest spiking	Without chilling				√
Splitting	Without chilling		√		
Tailing	Without chilling			√	

* this assumes that the lobsters are chilled effectively (less than 4 °C)

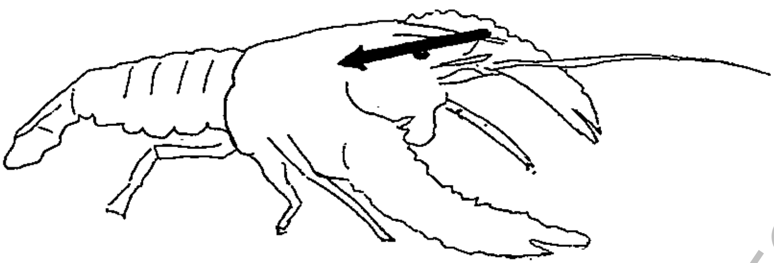
Some methods of slaughter are better suited to particular types of cuisine than others. For example, the method that is used can depend on whether the meat is to be presented as sashimi or as cooked meat within a half carapace. In addition, some outlets require physical activity in the meat or body of the animal when it is being killed. This indicates that the animal was vigorous and probably healthy up to the time of death, and this is considered synonymous with freshness. It was our impression that the attitudes associated with those traditional requirements did not always consider the needs for humane slaughter of sentient animals.

Taking these points together it is concluded that the preferred method from an animal welfare perspective involves chilling before killing. An alternative may be splitting an unchilled lobster, provided it is performed by a skilled operator. Chilling is not always a practical procedure for lobsters that are taken directly from a live display tank for killing. This could be overcome by using tanks for display only, and killing rock lobsters from a reserve of chilled stock.

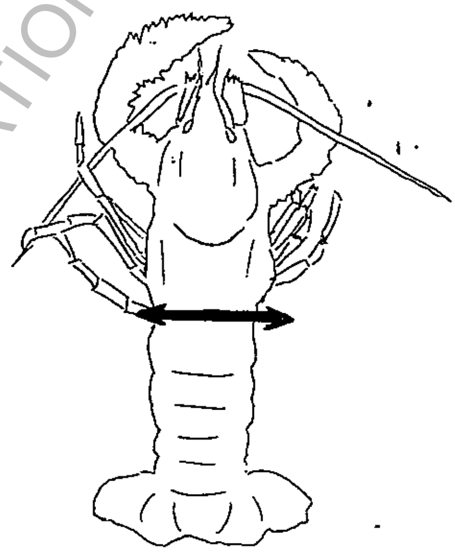
Addendum

The observations during this survey indicated that the recommended method for killing rock lobsters which has been put forward by the New Zealand Fishing Industry Agreed Implementation Standards (IAIS) could be reviewed. In IAIS 003.4: Live Eels and Rock Lobsters Circular 1995 Issue 1: May 1995, it states that tailing without chilling is an acceptable method of killing lobsters. Tailing without chilling has received adverse publicity in recent years, and it was our conclusion that it is one of the least acceptable methods from an animal welfare perspective. When we asked licensees of fish premises about tailing, most thought that chilling before tailing should be required. In addition, only one premises in this survey tailed without chilling.

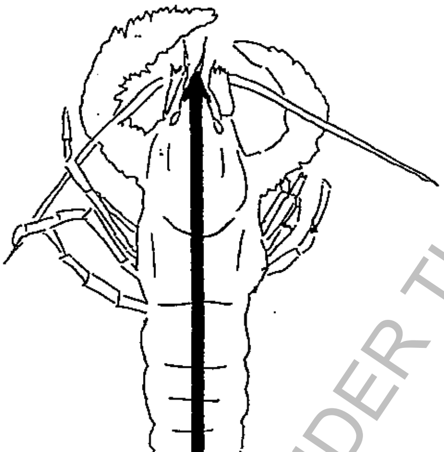
Head Spiking



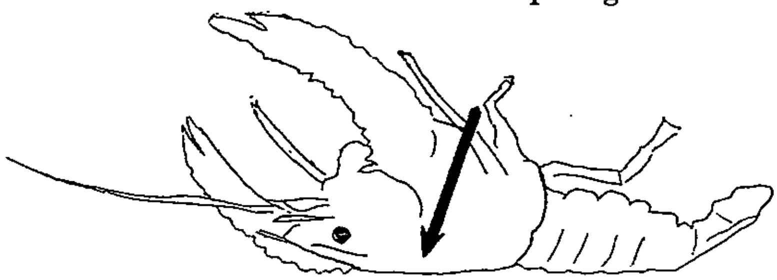
Tailing



Splitting



Chest Spiking



SUBMISSION

BY THE

Royal New Zealand Society for the Prevention of Cruelty to Animals Inc.

ON

The humane killing of aquatic invertebrates

1st May 2017

Table of Contents

Introduction

The following submission is made on behalf of The Royal New Zealand Society for the Prevention of Cruelty to Animals (RNZSPCA).

The RNZSPCA is the preeminent animal welfare and advocacy organisation in New Zealand. We have been in existence for over 130 years with a supporter base representing many tens of thousands of New Zealanders across the nation.

The organisation includes 46 Animal Welfare Centres across New Zealand and over 80 inspectors appointed under the Animal Welfare Act 1999.

The RNZSPCA welcomes the opportunity to make a submission on the humane killing of aquatic invertebrates (including crustaceans)

RNZSPCA position

The RNZSPCA believes that aquatic invertebrates (which include crabs, rock lobsters and crayfish) farmed or caught for food should be treated humanely at all times. Therefore, the animal must not be caused any pain or distress during killing and only methods that humanely render the animal insensible before the animal is killed should be used.

The current techniques generally used to stun and/or kill aquatic invertebrates including freezing, boiling, gassing with carbon dioxide, or "drowning" in fresh water are inhumane and cause considerable pain and distress to the animal. In addition, there is a lack of evidence that chilling in air or on ice renders crustaceans insensible without distress. Our organisation considers it vital to utilise up to date scientific information and technologies that can provide a humane death to these animals.

In addition, the RNZSPCA opposes the selling and transportation of live aquatic invertebrates to be killed in people's homes as the standard methods for transporting aquatic invertebrates and the limited slaughter methods available in most homes are likely to cause the animals to suffer.

Literature review and assessment

Background

There is extensive and robust evidence to demonstrate the sentience of aquatic invertebrates; these animals have been shown to experience both positive and negative emotions, including pain and distress (Yue, 2008; Elwood & Adams, 2015; Elwood et al., 2015; Vervaecke et al., 2015). Treatment of aquatic invertebrates should reflect this and be as humane as possible. Therefore, whenever possible, precautions should be taken against causing aquatic invertebrates pain and distress.

Invertebrates, including aquatic invertebrates such as crustaceans, do not have a centralised nervous system. Therefore, these animals are not killed immediately if only one discrete area, such as the brain, is destroyed. Methods of killing and/or stunning aquatic invertebrates that were once thought to be humane have now been shown to cause distress and/or pain to the animals.

Humane killing of aquatic invertebrates

Aquatic invertebrates do not have a centralised nervous system, and so they do not die immediately upon destruction of the brain (Neil, 2010). Therefore, in order to ensure a humane death for the animal, immediate interruption of the animal's entire nervous system function is necessary to effectively stun or kill the aquatic invertebrate (Mood, 2014). It is difficult to physically destroy the nervous system of aquatic invertebrates quickly and effectively as many species have a diffuse nervous system (Gardner, 2004; Yue, 2008).

To achieve this a 2-step procedure similar to that recommended for euthanasia of aquatic invertebrates should be utilised; first the aquatic invertebrate should be humanely rendered insensible and only then should the animal be mechanically killed with a method that irreparably mutilates the brain or major ganglia (American Veterinary Medical Association, 2013).

Rendering the aquatic invertebrate insensible

The only method that has been proven to result in the immediate loss of consciousness (within one second) of aquatic invertebrates is the use of a humane electrical stunning device (such as the Crustastun™) (Neil, 2010; Neil, 2012; Neil & Thompson, 2012; Fregin & Bickmeyer, 2016).

Research also suggests that a suitable and appropriately used food-grade anaesthetic (such as AQUI-S, a clove oil-based product that has been approved for use in New Zealand (AQUI-S, n.d.)) can be used to humanely render the animal unconscious before killing, although this may take several minutes it does not cause distress (Gardner, 1997). This product does not affect the safety of the aquatic invertebrate for human consumption since AQUI-S is of food-grade and can be consumed by humans without ill effects. This product can be administered by immersion of the aquatic invertebrate in a suitable dilution of the product in either salt or fresh water depending on the species of aquatic invertebrate (i.e. fresh water aquatic invertebrates should be aneasthetised in fresh water and salt water aquatic invertebrates in salt water to prevent osmotic shock and distress). Immersion has found to be an effective route of administration to aquatic invertebrates of such products for anaesthesia and euthanasia purposes (Murray, 2006a; Murray, 2006b; Waterstrat & Pinkham, 2005).

Aquatic invertebrates should never be gutted, filleted, frozen or subjected to any other form of processing whilst still conscious. It is not humane to boil aquatic invertebrates alive (The Panel on Animal Health and Welfare, 2005). In addition, boiling, gassing with carbon dioxide, or “drowning” in fresh water are not considered to be humane methods of stunning or killing aquatic invertebrates (Gardner, 1997; Roth & Øines, 2010).

Although chilling in air or on ice has previously been recommended as a humane method of stunning aquatic invertebrates, an increasing body of evidence suggests that this is not a humane. Chilling has been criticised as it exposes the animal to conditions it was normally avoid because they cause discomfort and in addition chilling is slow and inconsistent (Gardner, 2004). Chilling aquatic invertebrates in air is likely to cause additional stress through exposure to air, which has been demonstrated to be stressful to crabs and lobsters through measurements of physiological and immune responses during live transport (Fotedar & Evans, 2011).

The previous suggestions that chilling is an effective method of rendering an aquatic invertebrate insensible is based on the animals that have been subjected to chilling not showing behavioural signs of distress, such as thrashing and autotomy, rather than physiological indicators of distress (Yue, 2008). Recent evidence demonstrates that the nervous system of crustaceans continues to function even at extremely low temperatures (Tang et al., 2010; Marder, 2011, Tang et al., 2012). It can be inferred that chilling only reduces the animal's basal metabolic rate and induces a state of stiffness that is similar to paralysis but the animals are still able to compute sensory information (Fregin & Bickmeyer, 2016).

Chilling on ice has been shown to be ineffective in stunning edible crab and Australian giant crab (temperate species) (Gardner, 1997; Roth & Øines, 2010). Recent research on crayfish and lobster demonstrated that chilling was ineffective at providing effective anaesthesia for crayfish; responses to external stimuli were still detectable after chilling (Fregin & Bickmeyer, 2016). The welfare effect of chilling on aquatic invertebrates is also important in transport, since most crustaceans destined for live markets are chilled prior to transport (Fotedar & Evans, 2011).

It is particularly important that aquatic invertebrates are not chilled and then boiled as research has shown that the animals remain conscious during boiling for at least 3 minutes (Roth & Øines, 2010).

Humanely killing the insensible aquatic invertebrate

Once the aquatic invertebrate has been rendered insensible, a mechanical method of killing that destroys the animal's chain of ganglia (their central nervous system) needs to immediately follow (Mood, 2014). This method will differ depending on the species of aquatic invertebrate:

- Crabs: The two main nerve centres of the animal must be destroyed. Both are located on the central line of the body, one at the front of the animal under a shallow depression in the shell and the other towards the rear of the animal (this nerve centre may have a small hole over it). The destruction of the nerve centres can be achieve by lifting the tail flap of the crab and inserting a knife, or pithing instrument, completely through the hind nerve centre, then rapidly through the front nerve centre through the shallow depression at the front of the body, or the top shell of the crab can be removed and both front and hind nerve centres rapidly destroyed using a knife or pithing instrument.

- Rock lobster and crayfish: Lobsters and crayfish have a chain of nerve centres (ganglia) running down the midline of their body. These nerve centres should be destroyed by rapidly cutting through the midline of the animal longitudinally with a large sharp knife. This should take 10 seconds or less.

  (Johnston & Jungalwalla n.d.; Tuckwell, 2006)

A humane electrical stunning device or anaesthetic can also be used to humanely kill the aquatic invertebrates outright if used for long enough and at a high enough voltage/concentration. A suitable and appropriately used food-grade anaesthetic (such as AQUI-S) can also be used to kill the animal if used at a high enough concentration and for sufficient time. However, in most cases it is preferable to stun and then effectively kill the animal mechanically once it is unconscious (Roth & Grimsbø, 2013; Sparrey, 2005).

In addition, recent evidence suggests that crayfish and lobster still show a central nervous system electrophysiological response to boiling (although only minor response) after effective stunning (Fregin & Bickmeyer, 2016). This indicates that the animals should be mechanically killed before boiling, even if they have been stunned appropriately.

The evidence suggests that most commercial methods of killing aquatic invertebrates will cause considerable suffering to the animals. Spiking, splitting and high pressure killing of conscious animals provide a much shorter slaughter process so may seem to be less inhumane. However, since they are neither immediate nor likely to be distress-free (Mood, 2014), these methods are not considered humane and the RNZSPCA does not advocate their use.

Conclusion

The RNZSPCA agrees that crabs, rock lobsters and crayfish should all be required to be humanely rendered insensible prior to being killed. In fact, the Society would contend that the regulation should extend to all aquatic invertebrates and fish, not just crabs, rock lobsters and crayfish.

The RNZSPCA is concerned that the proposed regulation that includes the provision that crabs, rock lobsters and crayfish must be 'chilled to 4°C or less, or be electrically stunned, or be otherwise rendered insensible before being killed' includes a method (chilling) that is slow, inconsistent and may cause distress to the animal. In addition, the inclusion of 'otherwise rendered insensible' is non-specific and does not require that this method should be humane. The most humane method available is appropriate electrical stunning and this should be used in preference to other methods. An alternative method that may be more practical and accessible for small operations or non-commercial slaughter of aquatic invertebrates is use of the food-grade anaesthetic AQUI-S. This product is already being used in aquaculture and in export of lobsters from New Zealand, is readily available and practical to use and inexpensive. Further details can be provided if desired.

The RNZSPCA urges the New Zealand government to modify the proposed regulation to ensure that ineffective stunning methods that will cause the suffering of aquatic invertebrates are not included. Only methods known to be humane should be included for rendering the animals insensible before killing; these are limited to appropriate electrical stunning (using a Crustastun device) or anaethetising using AQUI-S. In addition, the regulation should include acceptable species specific methods of killing of insensible aquatic invertebrates. In order to cover the possibility that other humane methods of stunning and killing may become available over time, SPCA®

the following could also be included in the regulation: *other methods of stunning and killing can be used for aquatic invertebrates if there is independent evidence that the method kills or renders the animal insensible in a distress and pain-free manner demonstrated on the species it will be used on and based on the measurement of physiological and immune responses rather than solely behavioural indicators.*

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Comments on RNZSPCA's submission – Humane Killing of Crustaceans

Literature Review & Assessment

Agree with the RNZSPCA in this section. NAWAC and MPI also consider certain aquatic invertebrates to be sentient. They are included as 'animals' in the Act and therefore a humane death is required, which can be achieved by a 2-step process of causing the animal to be insensible and then killing the animal.

Rendering the aquatic invertebrate insensible

Most points in this section are supported by MPI and NAWAC's previous work, and do not conflict with the proposed regulation, with the exception of the RNZSPCA's recommendation that chilling should be removed as an option for making the animal insensible.

The Minimum Standard 22(e) Commercial Slaughter Code of Welfare states that before being killed, crabs, rock lobsters and crayfish have to be chilled to 4 degrees or less, electrically stunned, or otherwise insensible before they are killed.

> Minimum Standard 22(e)
>
> Crabs, rock lobsters and crayfish must either:
>
> (i) have been chilled to 4 ^{o}C or less at the time they are killed; or
> (ii) have been electrically stunned before they are killed; or
> (iii) be otherwise insensible before they are killed.

The Minimum Standard is supported by a paper cited in the code report which states that chilling helps to reduce nerve function and metabolic activity (Lowe and Gregory, 1999) and an operational research report (Lowe and Gregory, 1998)

The Animal Health and Welfare S (AHAW) Panel of the European Food Safety Authority (Anonymous 2005) and the RSPCA Australia consider the following methods to be acceptable:

- CrustastunTM (electrical stunning in water bath)
- Chilling in an ice slurry not recommended for temperate marine species that are adapted to colder temperatures)
- Chilling in air (for large crustaceans adapted to very cold temperatures)

RSPCA Australia notes that further research is needed to fully understand the effects of different chilling methods on crustacean welfare.

AQUI-S (isoeuganol) is excluded from the above list due to concerns that it is not food grade, but the product is approved within New Zealand for use in food fish[1]. AQUI-S is generally supported as an effective method to induce insensibility or death, depending on dose (Gardner, 1997; Fishcount UK).

An HSUS report (Yue 2008) states that chilling is commonly believed to be effective based on behavioural signs, but that the amount of time required to render crustaceans insensible varies "depending on size, species, metabolic state, and the rate of chilling". Gardner (1997 & 2004) states that chilling appears to be very effective and few signs of distress are shown, but the technique is

[1] http://www.aqui-s.com/78-aqui-s/24-joomla

slow and inconsistent. For example, in one experiment Australian Giant Crabs (*Pseudocarcinus gigas*) were unaffected after 14 hours in 5°C and 2°C degree temperatures, and only experienced mild paralysis at -1.5^{o}C (Gardner 1997). In another species (*Cancer pagarus*) it took 10 minutes for crabs to begin to lose behavioural responses at 0°C, but freezer temperatures of -37^{o} led to autotomy (dropping limbs), a sign of distress, at some stage before death occurred in 30-40 minutes (Roth & Oines).

The papers cited by RNZSPCA to show that the nervous systems of crustaceans can still function at low temperatures (Tang et al., 2010; Marder, 2011; Tang et al., 2012) support the idea that crustaceans *already adapted to low temperatures* may react differently to cooler temperatures, as suggested by the Australia RSPCA guidelines ("Chilling in ice slurry not recommended for temperate marine species that are adapted to colder temperatures").

The authors in one paper cited by the RNZSPCA recorded nerve responsiveness to external stimuli even after chilling although no behavioural responses were displayed (Fregin and Bickmeyer, 2016)., It is also true that nociceptive signals can be detected via EEG in unconscious mammals and humans (Murrell & Johnson 2006).Further, the species used were not from New Zealand, and the authors noted that other species adapted to different temperatures may react differently. The study is recent and I cannot find other studies that have repeated the process that support the findings.

Humanely killing the insensible aquatic invertebrate

Agree with the SPCA's points in this section.

However, the proposed regulation is not intended to regulate killing methods. It solely describes a requirement to make the animal insensible.

Conclusion

The RNZSPCA submitted that chilling crustaceans is not humane – however, chilling could be included in a regulation if it allows for different temperatures and chilling times for different species. For example, the regulation could simply require insensibility (potential signs of insensibility are described in the code of welfare and listed in Appendix 1). This outcome-based wording can be supported by the code of welfare and guidance, for example the general information section for Minimum Standard 22 states that live crustaceans that are chilled 'eventually' become insensible and explains that live crustaceans that are reduced in temperature *until no movement occurs on handling* can be further processed.

The RNZSPCA points out that chilling and then boiling is unacceptable, which is supported by the literature. If chilling is kept in the regulation then we recommend it needs to be specified that any killing method done after chilling should be quick (e.g. pithing, spiking, splitting) and not involve warming up the crustacean.

Effective chilling techniques vary according to species and their adaptations. There is only limited evidence to support that crustaceans continue to feel pain while chilled. However, it will be difficult to specify a specific temperature or amount of time to chill a crustacean that is universally effective for all species covered by animal welfare regulations.

APPENDIX 1: Potential signs of insensibility

The following signs of insensibility and stress have been suggested by the RSPCA Australia, and others could also be considered (below).

Signs of insensibility

- no resistance to handling – for example, the abdomen or tail can be easily extended or manipulated, and the outer mouthparts can be moved without resistance
- no control of limb movement
- no eye reactions when the shell is tapped
- no reaction when touched around the mouthparts.

Sign of stress

- thrashing
- autotomy (casting off body parts, such as limbs)

There are several criteria for assessing insensibility/death in decapod crustaceans that have been used in research, which may also be useful in a commercial setting.

Cowing et al (2015) took full anaesthesia to be present when there was no response to stimuli (these included touching a plastic pipette to the rostrum and antennae) when the animal was placed in lateral recumbency. Any animal showing responses to stimulation or righting attempts when placed into lateral recumbency, would, by extrapolation, still be alive and sensible. In addition to touching the rostrum and antennae, the test procedure could be extended to include a greater number of test responses. For example, Simon et al (2016) considered the absence of appendage movements and mandibular movements as a sign of death, while Harris and Ulmestrand (2004) categorised lobsters as moribund/dead when the animals did not show any reflexes (including leg motion, leg retraction and maxilliped motion) nor any scaphognatite activity. In addition, some of the reflex actions suggested by Stoner (2012) for the assessment of vitality in lobsters may be useful for assessing sensibility, or lack thereof. These include leg retraction, leg extension, pleopod motion, mouth closure, antenna response, eye turgor, eye retraction and chela closure.

Indeed, Roth and Øines (2010) suggest that, as decapods have limited peripheral neurons for synaptic responses between sensory and motor fibres and synapses are mostly located centrally in the CNS (citing Laverack 1988), there is reason to believe that a physical response towards tactile stimuli is a reliable indicator of intact ganglia rather than merely a reflex. This would support the use of reflex responses in the assessment of sensibility/death in crustaceans.

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NZ ROCK LOBSTER INDUSTRY COUNCIL

Ka whakapai te kai o te moana

PRIVATE BAG 24-901 WELLINGTON 6142
64 4 385 4005 PHONE
64 4 385 2727 FAX
lobster@seafood.co.nz

Proposed Animal Welfare Regulations (Care and Conduct and Painful Procedures)

18th May 2016

Summary

The NZ RLIC recommends that:

Generally

(1) That regulations pertaining to rock lobsters (*Jasus edwardsii* and *Sagmariasus verreauxi*) do not impede or compromise industry best practice in relation to the catching, handling and transportation of live rock lobsters to domestic and/or export markets.

(2) That the Section 12 Regulatory Proposal referenced to the current Commercial Slaughter Code of Welfare 2010 be amended as follows:

Crabs, rock lobsters, and crayfish that are not immediately destroyed at time of capture must be rendered insensible before being killed.

(3) That the proposed references to ways in which crabs, rock lobsters and crayfish can be rendered insensible be removed from regulation.

(4) That clarity be given to the species description in regulations. Rock lobsters are not 'crayfish' and nor are 'crayfish' rock lobsters. It is not clear that the Code or the proposed regulations distinguish between them. If the reference is to freshwater crayfish (koura/marron) then that should be clarified.

Introduction

1. The NZ Rock Lobster Industry Council (NZ RLIC) welcomes the opportunity to submit on the *Proposed Animal Welfare Regulations (Care and Conduct and Painful Procedures).*

2. The NZ RLIC is an umbrella organisation for the nine commercial stakeholder organisations, known as CRAMACs, operating in each of the nine rock lobster (CRA) management areas of New Zealand. CRAMAC membership comprises CRA quota owners, processors, exporters, and fishermen in each region. All nine CRAMACs hold a significant majority mandate of CRA quota shares owned.

3. New Zealand produces 2800 tonnes and exports approximately 2600 tonnes of rock lobsters in every season. Currently, annual export receipts are valued in excess of $300 million.

4. The rock lobster industry has a strong interest in animal welfare – the value of the industry is based on producing the highest quality product for domestic and export markets. It is important to the industry that regulations replacing the long established Welfare Codes do not impede or compromise industry best practice in the capture, handling, holding and transportation of rock lobsters.

5. The NZ RLIC has constrained this submission to Part B of the MPI Discussion Paper 2016/12, specifically the proposed wording:

10.2(12) Crabs, rock lobster, and crayfish – Insensible before being killed.

"Crabs, rock lobster, and crayfish that are captured but not imminently destroyed, must be chilled to 4 deg. C or less, or be electrically stunned, or be otherwise rendered insensible before being killed".

6. Given that the proposal in the Discussion Paper is only a description of the intent of the regulation and not necessarily the final text, the NZ RLIC considers that the wording can be simplified in order to best achieve the intended welfare objective. The current Code of Welfare provides specific guidance as to how the primary objective might be achieved but it is not necessary in our view for the regulation to specify the means by which lobsters can be rendered insensible.

7. We request that in drafting the final regulation that the scope and intent is clear and unambiguous – that the regulation should only apply to crabs rock lobsters, and crayfish that have been held alive in captivity prior to being killed for further processing or consumption.

8. Our recommended wording for 10.2(12) is as follows:

Crabs, rock lobsters, and crayfish that are not immediately destroyed at time of capture must be rendered insensible before being killed.

9. That wording gets to the heart of the welfare issue. It does not matter what means are used, the baseline requirement is that subsequent to being landed, lobsters are rendered insensible before being killed. The inherent flex bility as to method ensures that already-established slaughter protocols can be maintained and that deviation from industry best practice can be prosecuted if required.

Yours sincerely

NZ Rock Lobster Industry Council

Daryl R Sykes

Executive Officer

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

This article is also available for download as a PDF - RSPCA Humane killing of crustaceans

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Crustaceans show responses consistent with signs of pain and distress.[1 6] **They also have the cognitive capacity to remember, and learn to avoid, unpleasant stimuli.**[7 9] **As a result, RSPCA Australia considers that crustaceans should be captured, handled, transported, stored and killed humanely. This applies to all crustaceans, including crayfish, lobsters, crabs, Moreton Bay bugs and yabbies, whether the animal is to be eaten raw (sashimi) or cooked.**

Killing involves loss of sensibility (ability to feel pain), followed by death. For killing to be humane, either:

- the animal experiences an immediate loss of sensibility, or
- if loss of sensibility is not immediate, insensibility is induced without discomfort or pain.

Insensibility should persist until death intervenes.

A variety of methods are used to capture, hold, kill and process crustaceans. The methods used depend on the species involved, the scale of the processing operation (commercial or noncommercial) and the end product. In each case, crustaceans should be killed by the most humane method.

The legal status of crustaceans in Australia varies between different states and territories. In New South Wales, Victoria, the Northern Territory and the Australian Capital Territory, crustaceans are protected under the relevant animal welfare legislation (in some states, this only applies to crustaceans intended for human consumption). Penalties may apply if crustaceans are not treated humanely.

Skills and experience required

RSPCA Australia does not recommend that live crustaceans for human consumption are made available for purchase by the general public. Instead, they should be humanely killed by trained and competent personnel before purchase.

Training should include how to:

- appropriately handle and care for live crustaceans to minimise stress and suffering

- induce insensibility
- recognise signs of insensibility
- recognise signs of stress
- apply the method of killing
- operate and maintain any equipment involved in the killing process.

Signs of insensibility

Signs of insensibility vary from species to species but generally include:[10]

- no resistance to handling – for example, the abdomen or tail can be easily extended or manipulated, and the outer mouthparts can be moved without resistance
- no control of limb movement
- no eye reactions when the shell is tapped
- no reaction when touched around the mouthparts.

Signs of stress

Signs of stress include:

- thrashing
- autotomy (casting off of body parts, such as limbs).

Acceptable stunning and killing methods

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

Method	Suitable for	Comments
Stage 1: stunning		
Crustastun (electrical stunning in a water bath)	All species	Requires specialised equipment
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 Not recommended for temperate marine species that are adapted to colder temperatures
Chilling in air	Large crustaceans that are adapted to very cold temperatures	

Method	Suitable for	Comments
Stage 2: mechanical killing		
Splitting	Lobsters and similarly shaped species	
Spiking	Crabs	

Stunning methods

Crustaceans must not be subjected to mechanical killing without first being rendered insensible using one of the following methods.

Electrical stunning

With sufficient electrical current, crustaceans can be rendered insensible within 1 second of current being applied – that is, an immediate loss of sensibility.[11]

Only purpose-built electrical stunning equipment (the Crustastun) should be used, in accordance with the manufacturer's instructions.[10] Failure to adequately electrically stun may have serious welfare consequences, including a high rate of autotomy.

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.[3]

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.[12] 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.[13]

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.[14] Insensibility occurs more quickly in an ice slurry than in air at similar temperatures because water absorbs heat much faster than air.[3,15,16]

A saltwater ice slurry must be used for all marine species. Marine crustaceans should never be placed in a freshwater ice slurry because 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.[3,12] 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.[3]

Procedure: *chilling in an ice slurry*

1. Fill an insulated container (such as an esky) with crushed ice, and then add water; for marine species, add salt water, at the salinity (salt concentration) of sea water.

2. Make sure that:

- the ratio of ice to water (salt water for marine species) is 3:1 – this will give a consistency of wet cement and a temperature of about –1 °C
- enough ice is available to maintain the correct temperature throughout the chilling process.

3. Place the crustaceans in the ice slurry. Regularly check them for signs of insensibility (see 'Signs of insensibility'). The time required to induce insensibility will depend on the species, the size of the animals and their metabolic state. For many species, at least 20 minutes is required.
4. Once the crustaceans are showing signs of insensibility, mechanically kill them as soon as possible to ensure that they do not recover.

Chilling in air

Large crustaceans that are adapted to very cold temperatures may be stunned by chilling in air. Chilling in air takes longer than chilling in an ice slurry because of the slower rate of heat transfer to air than to water.[3,14,17]

Procedure: *chilling in air*

1. Place the crustaceans in a freezer. Regularly check them for signs of insensibility (see 'Signs of insensibility'). The time required to induce insensibility will depend on the species, the size of the animals and their metabolic state.
2. Once the crustaceans are showing signs of insensibility, mechanically kill them as soon as possible to ensure that they do not recover.

Mechanical killing methods

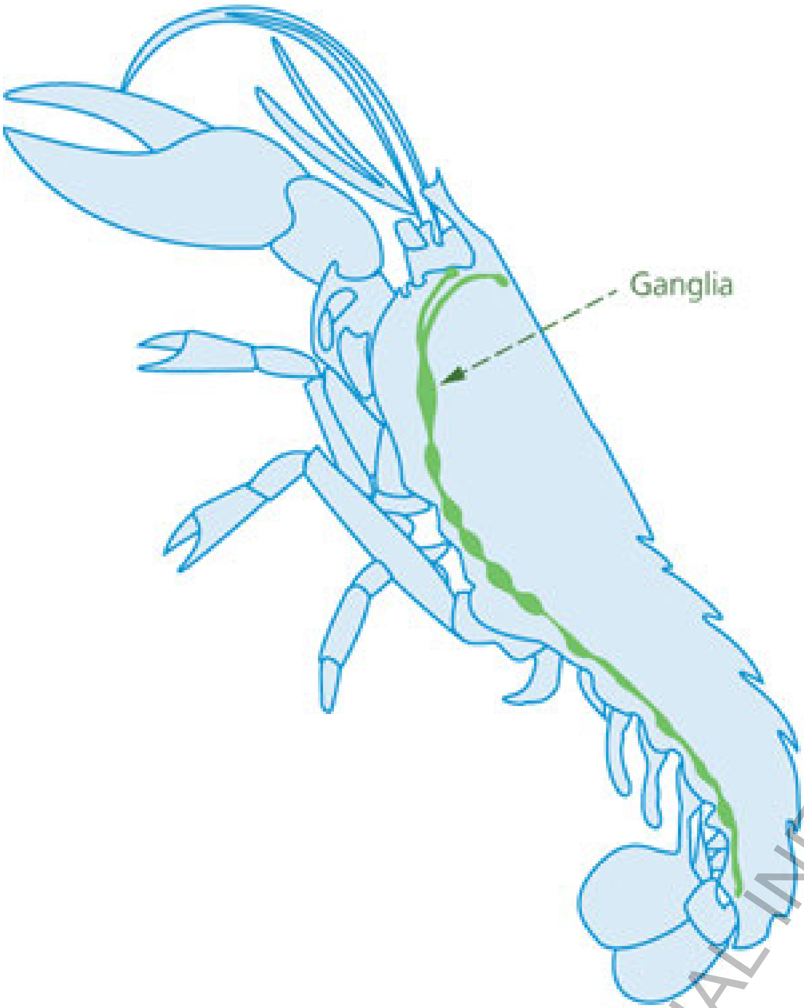
Once crustaceans are stunned and are showing signs of insensibility, they should be mechanically killed as soon as possible to ensure that they do not recover.[16]

Crustaceans have multiple nerve centres (ganglia). Humane killing requires rapid destruction of all the nerve centres. It is not possible to kill crustaceans quickly by destroying just a single central location (unlike in vertebrates).

Splitting

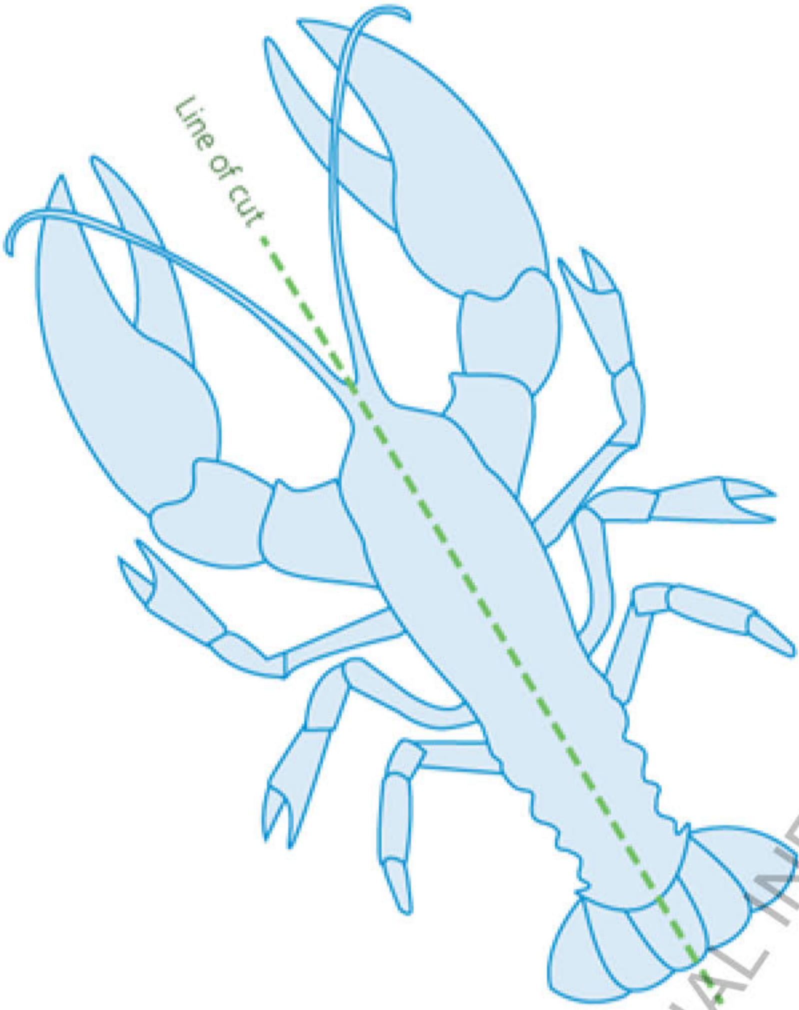
Splitting is suitable for lobsters and similarly shaped species. Lobsters have a chain of nerve centres running down their central length (ventral longitudinal midline) (Figure 1). All the nerve centres are beneath the longitudinal midline on the animal's undersurface, except the first nerve centre, the supraoesophageal ganglion, which is located at the top end of the chain and is reached through the head rather than the undersurface.[10,14]

Figure 1 Cross-section view of lobster, showing internal ganglia



Splitting involves rapidly cutting through the centre-line of the head, thorax (chest) and abdomen with a large, sharp knife. Cutting must occur along the longitudinal midline (lengthways) to destroy all the nerve centres (Figure 2).

Figure 2 View of lobster from above (or below), showing line of cut for lobster splitting



Procedure: *splitting*

1. Once the lobster is insensible, place it on a flat, nonslip surface, on its back, with claws tied to expose the undersurface clearly (only tie the legs after the lobster is insensible).[10,14]

2. Hold the lobster around the top of its head with firm pressure. Note the longitudinal midline on the lobster's undersurface.

3. Use a large, sharp knife (preferably as long and deep as the lobster – for example, a French cook's knife) for the cuts, and a mallet to force the knife quickly through the animal. Keeping the knife oriented with the midline, place the knife on the head beneath the mouth parts. Cut through the head at this point to pierce and destroy the first nerve centre (supraoesophageal ganglion).

4. Next, cut along the longitudinal midline on the undersurface to pierce and destroy the rest of the chain of nerve centres in two stages, starting near the junction of the abdomen and the thorax. Direct the first cut straight towards the head, and the second backwards, towards the tail (Figure 2).

5. After cutting in half lengthways through the longitudinal midline, rapidly remove the chain of nerve centres at the front end (chest and head) of the lobster (see Figure 1).

6. Complete the cutting procedure in less than 10 seconds.

Lie the obster f at on its back and cut through the mid ine with a arge, sharp knife.

(Image:Scott Phi ips, Fine Cooking Magazine, © 2009 The Taunton Press Inc, www.finecooking.com)

Spiking

Spiking is suitable for crabs. Crabs have two main nerve centres. One is located at the front of the animal, under a shallow depression. The other lies towards the rear of the animal and may have a small hole positioned over it (Figures 3 and 4).[10,14]

Figure 3 Topside of crab, showing internal ganglia (nerve centres)

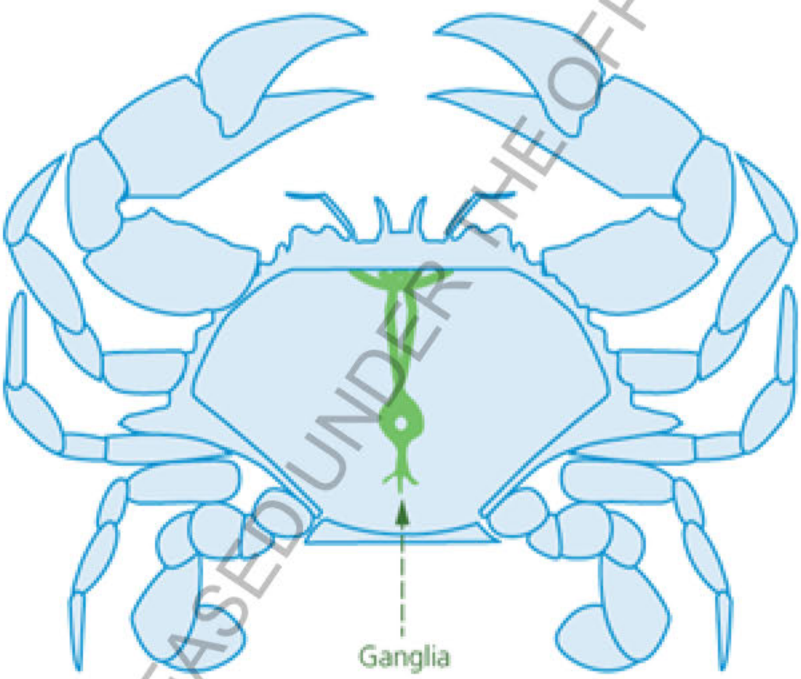
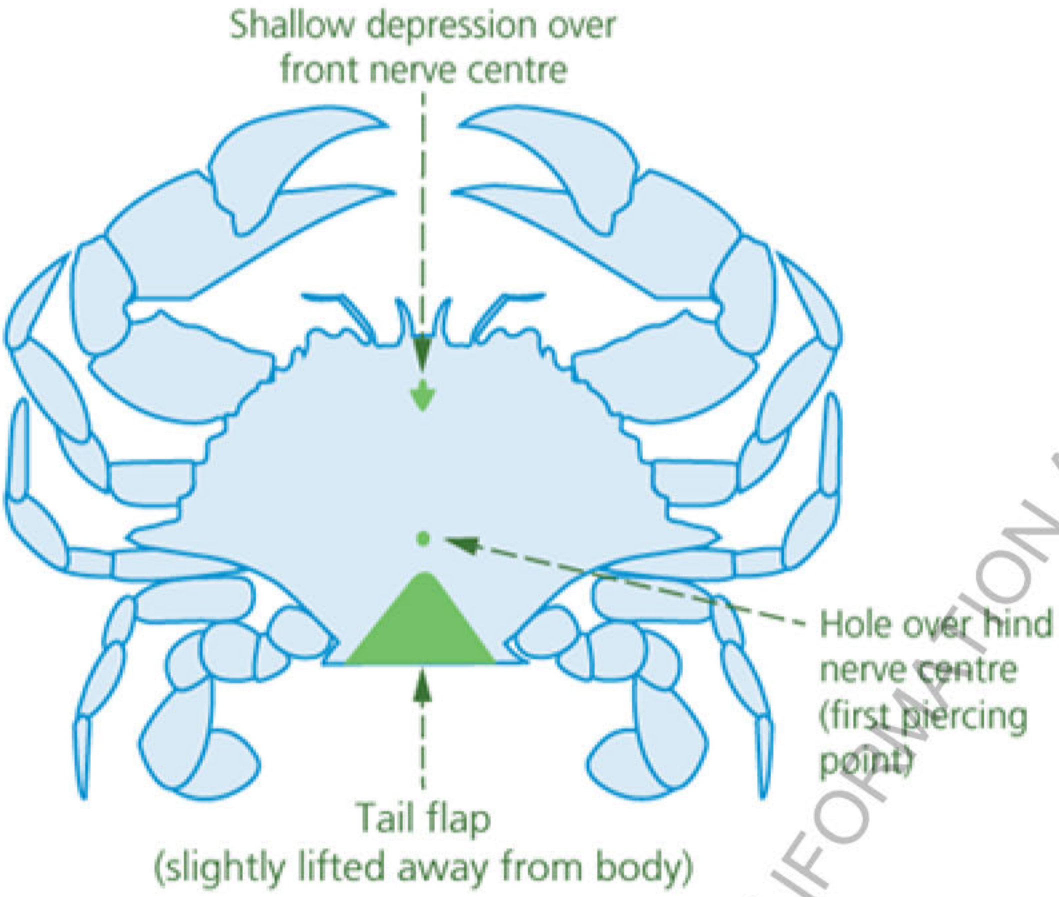


Figure 4 Underside of crab, showing reference points for spiking



Crabs can be killed by rapid destruction of both nerve centres by piercing both ganglia from the underside of the crab with a pointed spike (e.g. a thick, pointed pithing instrument, an awl or a sharp-pointed knife).

Spiking must not be performed on lobsters because they have a long chain of nerve centres.

Procedure: *spiking*

1. Once the crab is insensible, place it on its back on a flat, nonslip surface.[10,14]

2. Lift the abdominal flap (tail flap) and insert a pointed spike such as an awl or sharp-pointed knife all the way through the rear nerve centre. Insert through the hole over the rear nerve centre at an angle of 85° to the horizontal (see Figures 4 and 5).

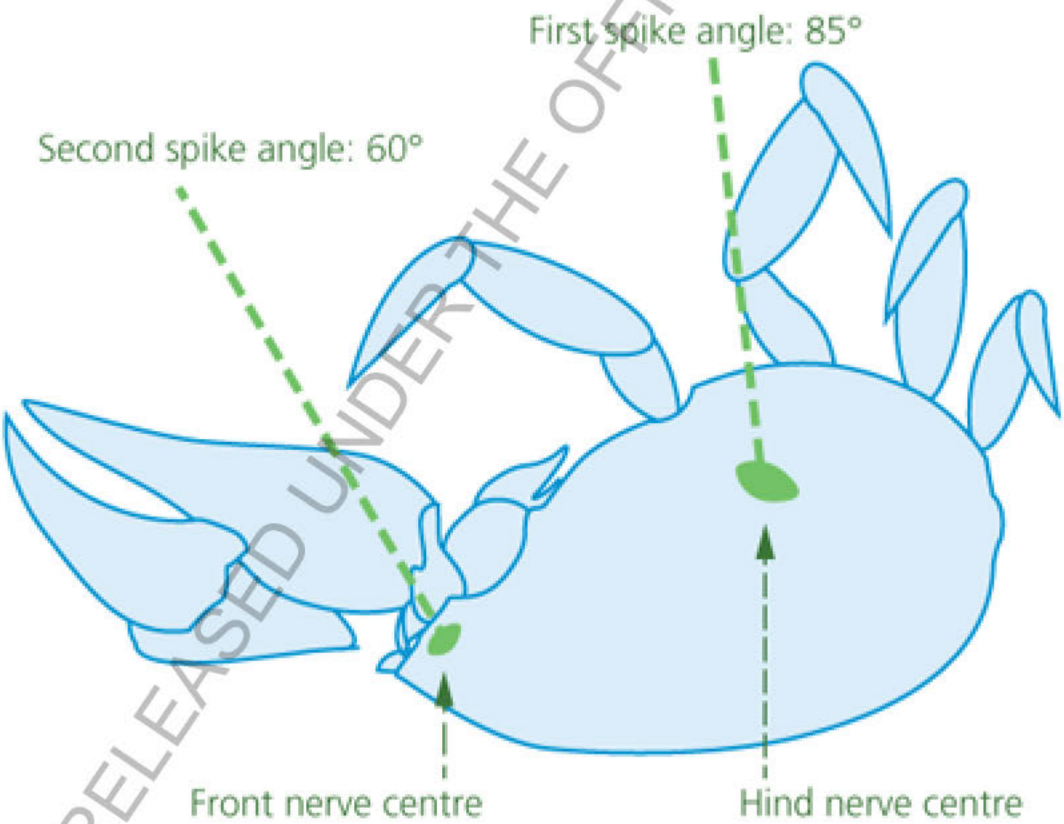
3. Repeat this process through the front nerve centre. Insert the spike through the shallow depression at the front of the body at an angle of 60° to the horizontal (see Figures 4 and 5).

4. Complete the spiking procedure in less than 10 seconds.

Lie the crab on its back and pierce it with a sharp, pointed object such as a knife.

(Image: www.fishfi es.com.au)

Figure 5 Cross-section view of crab, showing angles for spiking



Unacceptable killing methods

The following methods of processing crustaceans must not be used because they cause an unacceptable degree of pain and suffering to the animal:[10,14]

- Separating the abdomen (tailpiece) from the thorax – that is, tailing – or removing tissue, flesh or limbs while the animal is still alive (including when it is insensible) and before destroying the front and rear nerve centres (crabs) or chain of nerve centres (lobsters).
- Cutting crustaceans into sections while the animal is still alive (even when it is insensible) and before destroying the nerve centres.
- Placing live crustaceans (including when insensible) into hot or boiling water before destroying the nerve centres.
- Placing live marine crustaceans (including when insensible) in fresh water. Marine crustaceans suffer and die from severe osmotic shock when placed in fresh water.
- Microwaving live crustaceans (including when insensible).
- Removing crustaceans from the water and allowing them to die from lack of oxygen as a result of desiccation of their gill tissue.
- Placing crustaceans in a container of water without adequate aeration, causing death from lack of oxygen.
- Exposing crustaceans to caustic chemicals.
- Causing traumatic injury without first inducing insensibility and destroying the nerve centres.
- Serving any dish involving a live crustacean for consumption.

Anaesthetic agents

Anaesthetic agents (AQUI-S and clove oil) are not included as acceptable methods for the humane killing of crustaceans because it is not yet known whether they are safe for human consumption.

Glossary

Term	Definition
abdomen	The part of the crustacean's body between the thorax and the tail; in crabs, the abdomen is very small.
autotomy	The casting off by an animal of a part of its body, when under threat – for example, limbs, in the case of crustaceans.
crustacean	Aquatic arthropods with a segmented body, an exoskeleton and jointed, paired limbs; they include rocklobsters, crabs, Moreton Bay bugs, freshwater crayfish (such as yabbies) and prawns.
ganglion	Nerve centres (plural: ganglia).
humane killing	Killing that involves either immediate loss of

Term	Definition
	sensibility or induction of insensibility without discomfort or pain, followed by death while the animal is insensible.
osmotic shock	Drawing of water into a crustacean's body cells via osmosis, causing the cells to rupture (which is likely to cause suffering).
pain	An unpleasant sensation and feeling associated with actual or potential tissue damage.
sensibility	An animal's ability to feel pain.
stress	An organism's attempt to maintain homeostasis in response to environmental challenge.
stunning	Induction of insensibility.
thorax	The middle section of the body of a crustacean; fused with the head in most larger crustacean species.
torpor	A state of mental and motor inactivity with partial or total insensibility.

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Humane killing > Killing animals for food > What is the most humane way to kill crustaceans for human consumption?

http://kb.rspca.org.au/entry/625/

Analysis post pre-consultation workshops

The original 87 matters have been organised by species or activity (eg transport, commercial slaughter etc). For each group, the matters are being organised under the four categories outlined below. Where appropriate, comments on feasibility, problems, additional information needs, impacts / unintended consequences are included. Where necessary a recommendation(s) in also included.

	Matter	**Comment** (including feasibility, problems, additional information needs, impacts / unintended consequences, and recommendation-where necessary)
	OK to proceed as drafted	
	Ok to proceed but minor changes required	
	Regulations unnecessary/unworkable	
	Further work required / decision required	

This approach has been trialled (but not completed) for dogs (see below). The template and matters for the other groups are included within this document but have not been completed yet.

Contents

[Not relevant to request]

Commercial slaughter

	Matter	**Comment** (including feasibility, problems, additional information needs, impacts / unintended consequences / recommendation- where necessary)
	OK to proceed as drafted	
71	**Commercial slaughter** - Eels must be insensible for the duration of desliming or killed prior to desliming.	Confirms current transition to prohibition (Dec 2015). No indications of non-compliance. **Recommend** Proceed.
72	**Commercial slaughter** - Crabs, rock lobsters, and crayfish must be chilled, electrically stunned, or otherwise rendered insensible before being killed.	• Fine for commercial premises. Had comment to extend to all other areas e.g. restaurants. • How would this affect fishing and how do regulations interact with the hunting and fishing exemptions in the Act?

		Recommend Proceed for commercial slaughter premises.
	Ok to proceed but minor changes required	
	Regulations unnecessary/ unworkable	
	Further work required / decision required	

[Not relevant to request]

Animal Welfare Matters: Overview and Recommendations

This document provides an overview of pre-consultation discussion with stakeholders and a recommended approach for each of the 87 matters.

The original 87 matters have been organised by species or activity (eg transport, commercial slaughter etc). For each group, the matters are being organised under the four categories outlined below.

	Matter	**Comment** (including feasibility, problems, additional information needs, impacts / unintended consequences, and recommendation-where necessary)
	OK to proceed as drafted	
	Ok to proceed but minor changes required	
	Further work required / decision required	
	Regulations unnecessary/unworkable or better addressed in tranche 2	

The number alongside each matter in the following tables reflects the number allocated to each procedure on the master list of 87 matters. As the matters are discussed by species or activity the numbering is not consecutive and some matters will be discussed more than once. Where a matter is discussed multiple times it will have the same number associated with it eg disbudding for cattle and sheep.

Contents

Commercial slaughter

	Matter	**Comment** (including feasibility, problems, additional information needs, impacts / unintended consequences / recommendation- where necessary)
	OK to proceed as drafted	
71	**Commercial slaughter** - Eels must be insensible for the duration of desliming or killed prior to desliming.	Confirms current transition to prohibition (Dec 2015). No indications of non-compliance. **Recommendation** Proceed.
72	**Commercial slaughter** - Crabs, rock lobsters, and crayfish must be chilled, electrically stunned, or otherwise rendered insensible before being killed.	• Fine for commercial premises. Had comment to extend to all other areas e.g. restaurants. • Hunting and fishing provision will apply for recreational catches. **Recommendation** Proceed.
74	**Commercial slaughter** - Facilities where animals are held for more than 4 hours must allow all animals to move freely, stand up and lie down.	• Stakeholders may contest based on evidence of a problem, parity, and science. **Recommendation**

[Not relevant to request]

12. Crabs, rock lobster, crayfish and freshwater crayfish (koura)	
Proposed rule	Crabs, rock lobsters, crayfish and freshwater crayfish (koura) that are not immediately killed at time of capture must be rendered insensible before being killed.
Penalty	A person who contravenes this regulation commits an offence and is liable on conviction to a fine not exceeding $5,000 for an individual, and $25,000 for a body corporate.
Defences	Existing provisions in the Animal Welfare Act 1999 provide that it is a defence if the defendan took all reasonable steps to comply or the offending took place in circumstances of stress or emergency, and was necessary for the preservation, protection or maintenance of human life I is unlikely that these defences would ever apply to this rule
Rationale	<u>Rule</u> Crabs, rock lobster crayfish and koura are classified as sentient creatures under the Act The pain and distress associated with slaughter can be minimized by rendering them insen ible before being killed This regulation applies to both commercially farmed and wild-caught crabs, rock lobsters (crayfish) and freshwater crayfish (Koura) It does not apply to crabs, rock lobsters (crayfish) or freshwater crayfish (Koura) that are caught and immediately killed at the point of capture The rule does not specify the means by which crabs, rock lobster, crayfish and koura must be rendered insensible, allowing for innovation and for operators to select an option that suits their business model so long as it achieves the outcome of the egulation Minimum standards 22e in the commercial slaughter code will be retained along with further guidance material on effective methods <u>Penalty</u> The degree of premeditation in failing to have acceptab e killing protocols in place, and the need to drive behavior change in a commercial environment means it is appropriate that it be a prosecutable offence rather than an infringement A fine not exceeding $5,000 for an individual, and $25,000 for a body corporate is appropriate. •
Impact	This regulation applies to both comme cially farmed and wild-caught crabs, rock lobsters (crayfish) and freshwater crayfish (Koura) It does not apply to crabs, rock lobsters (crayfish) or freshwater crayfish (Koura) that are caught and immediately killed at the point of capture
Mitigation	Consultation with industry on appropriate time frame for implementing changes, and acceptable methods or rendering in ensible is needed
Commencement	Pencil in 6 months, pending MPI''s ability to enforce immediately and the need to discuss with the seafood sector
Changes to MS	***Ms Amends*** *Commercial Slaughter Code of Welfare MS22e*

Commented [PB42]: All well and good, but how do we decide what methods are effective/acceptable?

Commented [PB43]: Need to consult on what impact will be on commercial processors

	Crabs, rock lobsters and crayfish must either: *(i) have been chilled to 4 ^{0}C or less at the time they are killed; or* *(ii) have been electrically stunned before they are killed; or* *(iii) be otherwise insensible before they are killed.* *Refer to the reg. Retain the MS to act as guidance to the reg. Will also edit the general information section with more information to support users.*

[Not relevant to request]

No	Proposal	Animal Welfare Benefit[1]	Policy/ R&A priority	VS priority	Compliance priority	SPCA priority	NZVA priority	Nita (Dairy NZ)	SAFE suggestions
[Not relevant to request]	[redacted]	[redacted]	[redacted]		[redacted]	[redacted]	[redacted]	[redacted]	
	[redacted]	[redacted]	[redacted]		[redacted]	[redacted]		[redacted]	
12	Crabs, rock lobster and crayfish – insensible before being killed	High	Progress to achieve welfare gains. Current interpretation issues with industry have recently become apparent for a minority of lobster processed. Sorting these out and putting		2019	2017		N/A	

No	Proposal	Animal Welfare Benefit[1]	Policy/ R&A priority	VS priority	Compliance priority	SPCA priority	NZVA priority	Nita (Dairy NZ)	SAFE suggestions
			these in regulation will clarify the situation. Also clarify that restaurants must render insensible before cooking.						
[Not relevant to request] [redacted]	[redacted]	[redacted]	[redacted]		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]		[redacted]	[redacted]		[redacted]	
[redacted]	[redacted]	[redacted]	[redacted]		[redacted]	[redacted]		[redacted]	

AW Compliance for OIA18-0215
Complaints relating to Rock Lobster or Crayfish
for the 5 year period 1 January 2013 to 31 December 2017

ID	Provincial Region	Source	Grade	Complaint	Complaint Synopsis	Outcome	Status
10524	Auckland	Public	3	Ill Treatment	Live crayfish served in restaurant - unsure how it was dispatched, possibly inhumane	Education Letter	Closed
11049	Gisborne	Public	3	Ill Treatment	Crayfish placed alive in boiling water	Education Letter	Closed
1257	Christchurch	Public	3	Unhygienic Living Conditions	Crayfish overcrowded and in dirty tank at seafood restaurant	No Animal Welfare Issue (Complaint Unsubstantiated)	Closed
1679	Auckland	Public	3	Ill Treatment	Crayfish not insensible before being killed	No Animal Welfare Issue (Complaint Unsubstantiated)	Closed