Meat consumption from stranded whales and marine mammals in New Zealand: Public health and other issues

M W Cawthorn
Cawthorn & Associates
Marine Mammals/Fisheries Consultants
53 Motuhara Road
Plimmerton
Wellington

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Abstract

Interest in the use of stranded whales as a source of food and the use of seals for cultural purposes has been expressed to the Department of Conservation by Ngati Hawea and Ngai Tahu Maori respectively. The known and anecdotal history of consumption of whale and seal meat in New Zealand and elsewhere is briefly discussed. Comments on the palatibility of marine mammal meat and the use of whales and seals as food are presented. Post-stranding damage and carcass contamination result in unsuitability of meat for human consumption. Criteria for the assessment of meat quality from stranded animals are presented. The transmission of parasites, particularly *Anisakis* sp., and the cumulative effects of persistent pesticides and heavy metals from consumption of meat from species such as pilot whales is discussed. Meat collection and storage should be conducted under the same conditions and constraints applied to terrestrial mammals.

Summary

1. In 1995 DOC received expressions of interest in the taking of whale meat from stranded whales for human consumption and taking of seals for cultural purposes.

2. Stranded whales and seals ashore formed a valuable food resource for pre-European Maori and Moriori.

3. Maori and Moriori undertook seasonal harvests of sealions and fur seals.

4. Stranded whales were a serendipitous source of protein. However, when European whaling began in New Zealand more regular and plentiful supplies of whale meat became available.

5. There are inherent dangers to public health in the handling of meat from stranded whales and seals.

6. Palatability *per se* is totally variable and is influenced by such factors as preservation and processing methods.

7. Meat from baleen whales is highly nutritious and "healthier" than beef, being higher in protein, fatless and lower in both cholesterol and calories.

8. Meat from baleen whales is preferable to that of toothed whales.

9. Marine mammals carry high natural parasite burdens. Of these, *Anisakis* sp is implicated most frequently in pathogenic transmission to humans.

10. Toothed whales carry a greater contaminant load than baleen whales. Consumption of toothed whale meat and organs is not recommended. Similarly, the consumption of seal livers, kidneys and other organs is not recommended.

11. Criteria for assessment of suitability of whale meat for human consumption are presented.

12. When butchering and storing meat from marine mammals, the same processing hygiene and preservation standards used for terrestrial animal meat must apply.

1. Introduction

Hawke Bay is one of the prime whale stranding sites in New Zealand. This is largely a result of the combination of its geography, its proximity to deep water and coastal current movements. The bay is semicircular with two major promontories - Cape Kidnappers and the Mahia Peninsula - at the south western and north eastern ends respectively.

On the 30 March 1995, a 17 m male sperm whale stranded at Clifton, north of Napier. Mr Clinton Duffy of the Department of Conservation's (DOC) Napier office notified two kaumatua of the local Ngati Hawea and together they attended the stranding. During conversation with Mr Duffy, both the kaumatua expressed a strong interest in the possibility of eating meat from stranded whales. Similarly, Ms Karen Baird, of DOC's Dunedin office, has been dealing with queries from Ngai Tahu regarding the use of seals for cultural purposes.

The issues raised by these queries have both cultural and ecological implications. I have endeavoured to gather together in this report what little information exists on the use of marine mammals as food in the New Zealand context. As the taking of marine mammals by Moriori and Maori was on an opportunistic basis, few records exist.

Those accounts cited in this document were gathered by Europeans and, naturally, reflect a European bias in the notions of 'palatability'. In the absence of other data, I have resorted to northern hemisphere examples where the consumption of marine mammal meat is commonplace and any problems associated with either parasitism or contaminants are well understood.

The consumption of marine mammal meat is largely a forgotten practice in New Zealand and, apart from a few clandestine removals of meat from stranded whales, it is unlikely that whale meat in any quantity has been eaten by people since the closure of the last whaling station in 1964. To the best of my knowledge, there are no documented incidents of seal meat being eaten by New Zealanders since the beginning of the 20th century.

In pre-European New Zealand, seals and stranded whales provided a serendipitous source of protein for Maori, whose diet was largely vegetable based (N. Pollock pers.comm.). Seals also formed a valuable seasonal food resource for coastal Maori in many parts of the country.

Although stranded whales and seals ashore are a convenient source of meat there are inherent dangers involved in eating these animals. Whale strandings may be active or passive. Passive strandings are those where dead or moribund animals are cast ashore by wind or currents, or a combination of both. The causes of death are frequently unknown and animals are often in an advanced stage of decomposition. In active strandings, otherwise healthy animals will run ashore for a variety of reasons. Trauma and stress during and post-stranding induce irreversible pathological changes in tissues which begin to break down. Animals which are refloated after such stranding episodes will die. The meat quality is progressively and rapidly degrading before recovery begins.

This report includes some basic guidelines for departmental managers on the assessment of edibility of meat from stranded animals and the concomitant public health issues . I have not attempted to lay down any hard and fast rules for, where food is concerned, people will generally do as they wish. Nor have I touched upon the constraints of the Marine Mammals Protection Act 1978 which is beyond the scope of this report.

2. Palatability

The notion of 'palatability', that is, something which is agreeably pleasant to the taste, is entirely personal and so subjective it is almost impossible to describe. It varies greatly between and within races; it varies through time as fads and fashions dictate, and between individuals, giving rise to such pithy aphorisms as, 'one man's meat is another man's poison'. Other significant influences on palatability are religion, and technology as it applies to preservation and food processing methods. The Maori practice of rotting corn and rock lobster in fresh water before consumption (S. Rei pers. comm.) may seem repugnant to some but it is little different from the Icelandic practice of burying a shark in the beach and letting it decompose until the flesh is "cheese-like" before exhumation and consumption. Even hardy Icelandics admit that this requires an educated and disciplined palate (J. Sigurjonsson pers. comm.). The European practice of hanging game to enhance its flavour is similar. Brillat-Savarin, the French gastronome, is quoted as saying that "the pheasant does not reach its 'apogee of delicacy' until it begins to decompose" (Montagne 1938).

However, one influence can override all usual criteria of palatability and common sense and that is hunger.

2.1 SEALS AS FOOD

For New Zealand Maori generally and those in the south particularly, the sea was a principal source of food. Fish, crustacea and shellfish were the primary targets but small coastal marine mammals, such as Hector's dolphin (for which there are at least five Maori names) could have been taken in large beach-seines or by using small harpoons. Archaeological evidence and contemporary reports suggest that seals were very numerous and more widely distributed in pre-European time than at present and also formed an important seasonal source of protein.

Each year, the Rakiura Maori travelled to "... Lord's Harbour (River) to kill great quantities of hair seal (Hooker's sea lion) for the purposes of food" (Boultbee, in Stark 1986). These animals were most likely sub-adult and bachelor males which congregate at Lords River and Pegasus Bay on the eastern shore of Stewart Island during the winter.

Fortunately for mariners shipwrecked on the Auckland Islands in the 19th century, seals proved an accessible source of food and hides when nothing else was available.

On 3 January 1864, the schooner "Grafton" was wrecked in Carnley Harbour at the Auckland Islands. Her crew, led by Capt. Thomas Musgrave and the mate, Capt. F.E. Raynal, survived on the islands for 20 months before being rescued. During that time their principal source of food was Hooker's sea lions. As Musgrave recorded in his journal (written in sea lion blood):

> "We only eat the cow and calf tiger seals; the black seal is not good, and the bulls are all very rank. We killed a cow and her calf this morning; we got milk from the cow after she was killed, which is very rich and good, much better even than goats milk" (Musgrave 1866).

Despite the meat of the sea lions being roasted, boiled, salted and dried, Raynal described it as "... repugnant to us on account of its oily savour " (Raynal 1880).

Fur seals, which were a readily accessible source of transportable meat, were taken along the shores of both the North and South Islands. Fur seal fat was considered a delicacy in the south, as Joel Polack (1838) noted:

> "I have been assured, by many persons who have resided for years in the South Island, that the blubber of seals, killed full two months previously, was devoured by the natives with the greatest eagerness, and that many of them were not satisfied with emptying the lamps, but actually swallowed the fragrant wick."

At the prehistoric Mt. Camel site at the mouth of Houhora Harbour, a Maori settlement covered about 1.5 ha on a platform a little above high water mark. Shawcross undertook an economic analysis of 21,000 bones from fish, seal, dolphin, dog, rat and moa found at the site. In estimating energy from estimated meat weight, fish were by far the most numerous prey items, but seals provided the most meat. The remains of 43-48 seals yielded an estimated

2,838 kg of meat, and 8 dolphins gave 820 kg of meat (Bellwood 1978). It is likely that the marine mammals were taken elsewhere, butchered and the pieces then transported to the Mt. Camel site, which was apparently occupied during the summer season.

In the Chatham Islands, however, seals were vital to the very survival of the Moriori as Skinner and Baucke (1928) state, "... the seal, of both hair and fur, was of great value since it provided him with food, and its pelt, for protection during the winters of those inclement latitudes". Moriori tradition relates how the Chatham Islands were home to vast herds of fur seals and these animals were harvested as required.

Elsewhere, seals were eaten as a regular part of the diet. Among Antarctic sealers working in South Georgia, elephant seal noses (known as "snotters") and pressed tongues were considered delicacies (Mathews 1952). In Newfoundland, Labrador and Arctic Canada five species of Arctic seals and the Atlantic harp seals are taken in the winter months when the pack-ice is fast to the shore. Skins are used for clothing, the fat as fuel and meat for food. Meat, hearts, livers and flippers are all considered delicacies (MWC. pers obs., Ellis 1967).

2.2 WHALES AS FOOD

The pre-European Polynesians had no history of maritime whaling, that being the active pursuit and capture, in open seas, of large and medium-sized whales by harpooning, or other means. They relied instead on incidental catches and strandings. The reasons were that the canoes were unsuited to this type of fishery, whaling was too dangerous and fish were abundant and easy to catch using existing technology. Artefacts such as harpoon points and similar equipment suitable for large whaling are singularly lacking from the archaeological record. Small coastal dolphins were likely to have been taken as bycatch in large beach seines. In Melanesia and some parts of Polynesia, such as the Marquesas Islands in French Polynesia, dolphins were physically driven into the lagoons and killed on the beaches for food.

Throughout Polynesia, whale strandings had major significance as "gifts of the sea". In Kiribati, traditional dolphin "calling" was used to bring pods of small whales into the lagoons where they were assisted onto the beach. After the animals died they were butchered to feed the community (Grimble 1952). Large whales which stranded were highly prized as a serendipitous source of meat for the community.

In the Chatham Islands the Moriori exploited ". .. shellfish, moulting ducks, seals and carcasses of stranded whales" (Richards 1952). Skinner and Baucke (1928) detail the gathering and preparation of meat from pilot whales which, to this day, mass-strand in large numbers on the east coast of the Chatham Islands: "One yet other flesh food was the erratic ocean jetsam classed under the generic term rongomoan' (whales) which might include every sea mammal known to these meridians, but more exactly that commonly called "blackfish". No valid reason has yet been shown (why they strand) to meet on land a lingering and in death-groans painful death, till discovered by that human

scavenger, tchakat Mai-hor-r, who speedily hacked, with flint saws, the stranded creature into junks, and, after baking in stone ovens, buried the flesh in earthen pits till it defiled the atmosphere where it lay, and not till then considered ripe and edible."

"Women were not permitted to taste this k'ye arik' (royal food)" (Skinner and Baucke 1928).

In Australia, Aborigines also exploited strandings as a chance occurence of a large amount of edible protein. On 7 September 1790, "captain Nepean of the New South Wales corps ... and a party of men, went in a boat to Manly Cove, intending to land there, and walk on to Broken Bay. On drawing near the shore, a dead whale, in the most disgusting state of putrefaction, was seen lying on the beach, and at least two hundred Indians surrounding it, broiling the flesh on different fires, and feasting on it with the most extravagant marks of greediness and rapture"(Tench, Capt.W. 1793).

However, in the 18th century this reliance on strandings and natural events changed with the arrival in the South Pacific of European whalers. Because of the wasteful European practice of taking only blubber and baleen (whalebone) from right whales, and blubber and the heads (including the spermaceti case) only from sperm whales, then setting the carcasses adrift to eventually wash ashore, a much greater supply of whale meat became available to Maori.

In 1827 John Boultbee observed:" As we were pulling along shore on our way, we saw a number of wild looking fellows on a rocky beach cutting a whale into junks and carrying it away, they were as greasy and dirty as might be expected from the nature of their employment. It seems the Lynx had been to those parts, and struck several whales which got away, and this was one of them" (Boultbee in Stark 1986).

Twelve years later, in 1839, Ernst Dieffenbach was observing whaling operations at Te Awaiti in Tory Channel. He noted: "As soon as the process of cutting was over, the natives, who had come with their canoes from the Sound, cut off large pieces of flesh which they carried off to feast upon" (Dieffenbach 1843). Removal of meat for local consumption became a common practice at bay whaling stations around New Zealand.

Polack (1838) notes: "The cetaceous fishes, especially the whale, are accounted a luxury by these people, who vie with certain northern nations in their unqualified admiration of train-oil (whale oil) and other abominable rancidities. Many a battle has been fought by hostile gourmands for the carcass of a whale thrown on shore long after its death.

When I was resident at Hokianga, a large whale without its head (the body cut adrift by some whalemen) was thrown on the southern shore of that river. The resident tribe determined to devour the fish amongst themselves without admitting their neighbour to a just share;... and the people of the opposite banks soon became acquainted with the fact; but a composition was entered into by the belligerents, and they mutually gastronomised on the fish in amity, contending only, with their usual determination, which party could devour the largest quantity."

Whaling was introduced to Tonga in the early 19th century byAmerican whalers and methods continued unchanged until 1978. Using European boats and hand-harpoons the Tongans took humpback whales and their calves in the lagoons on the western side of the archipelago. The whales were towed to a part of the reef accessible from the shore, where they were butchered and the meat sold by the whalers to an eager public. Whale meat was highly prized and the whalers had considerable mana, or prestige, within society.

Historically, in areas where climate does not permit intensive pastoral farming, people such as the Chatham Island Moriori, Icelanders, Greenlanders, Faeroese, Norwegians and Eskimos have all had to depend on sea foods generally and whale meat in particular as an especially important source of protein. All these people consider whale meat to be a nutritionally valuable delicacy.

In Japan, whale meat has been part of the ethnic dietary tradition for at least

1000 years. The tradition of using whale products is evidenced by the reference to whale-hunters found in the Manyoshu, the earliest collection of Japanese poems (AD 360-759) (Misaki/ICR 1996).

In a recently published account of the social anthropology of whaling in Japan, Kalland and Moeran (1992) noted: "In about 1497, whale meat received an"honourable mention" in a famous cook book published during the Muromachi Period. In 1832 a special whale cookery book, *Geiniku chomiho*, was published in Kyushu, and this divided the whale into 70 named parts, each with detailed information about methods of cooking and nutritive value". The book includes information on skin, blubber, meat, cartilage, flukes, intestine and genital organs.

Organised bay-whaling in Japan began during the Edo period in the 17th century with net-whaling starting around 1650. Captured whales were towed ashore and hauled from the water to be worked up. The meat, bones, blubber, tongue, ventral grooves, entrails and reproductive organs were all removed according to a prescribed procedure and processed in specific buildings. Throughout the entire process hygiene was particularly important. In Japan, all parts of the meat, blubber and offals were eaten, in contrast to the wasteful European practice of discarding the carcass after taking blubber for oil and baleen ("whalebone"). In Japan the oil was used for soap and lamps and also mixed with vinegar for use as a pesticide on rice paddy fields. Bones were crushed as fertiliser. Sinews were used as musical instrument strings. Baleen was made into fans, lantern handles, fishing rods, plates and puppets. Entrails were used for soups. Heart membranes were fashioned into drumheads. Medicines were made from selected internal organs and the penises were dried and pulverised as a tonic for revitalising whalers.

To the Japanese, the land mammals were regarded as 'four legged creatures' and, as such, were prohibited food under the dietary constraints of Buddhism. Beef entered the national diet as a regular item only during the Meiji Restoration in the late 1800s.

In France in the Middle Ages, whale meat, under the name *crapois* or Lenten bacon, was sold on meatless days and formed the staple diet of the poor. The

meat was not highly esteemed but the tongue, usually salted, was considered 'tender and delicious'. One gastronome described the flavour of whale meat, served in a Parisian restaurant as *Escalope of whale a la Valois*, as follows: "Boil a piece of lean beef in water which has been used to wash a not too fresh mackerel and you will have a dish similar to that served to me" (Montagne 1938).

During the Second World War, whale meat from the British Antarctic whaling fleets was canned and sold to a generally unenthusiastic British public. The usual complaint was that it had a "fishy" flavour and was tough when cooked. This was a result of two factors. First, unlike the Japanese, the British whalers had little experience in handling whale meat for human consumption and second, there was no long term experience in the preparation of whale meat for the table. Properly seasoned and prepared, whale meat has little or no smell, is extremely tender but will quickly toughen if overcooked.

3. Palatability of different tissue types

The meat from baleen whales, particularly the rorquals (blue, fin, sei, Bryde and minke whales), is a red meat the same colour as fresh, top-grade beef steak. It is tender and soft in texture, contains virtually no fat and is high in omega-3 oils which are now widely recognised as being very beneficial. Whale meat has a very low cholesterol content and contains about 127 calories per 1008, compared with beef at 209 calories, per 1008 and pork at 346 calories per 100g (Tables 1, 2. Japan Whaling Assn.).

The prime meat cuts are the 'back meat' (back steaks) taken from the nape of the neck to the dorsal fin and the 'tail meat' (posterior epaxial muscles) taken from the dorsal surface between the dorsal fin and the tail flukes. The meat from the ventral grooves is best pickled in brine and smoked as 'bacon'.

Meat from minke whales, taken in a small type coastal whaling operation in north western Norway, is currently sold over the counter in shops in Lofoten and Tromso for about the same price as prime beef steak.

The meat from toothed whales is dark in colour because of the increased myoglobin content, is oily and has a stronger flavour than that of baleen whales. Of all the toothed whales, pilot whales are most frequently taken for human food and form a regular dietary item in the Faroe Islands, where they are taken in a traditional, albeit controversial, drive fishery. Pilot whales are also caught for human consumption in Japan, and, only 25-30 years ago, pilot whale meat was sold over the counter in Newfoundland as "Ocean Steak", or seasoned, smoked and dried like beef jerky. Sperm whale meat is taken for human consumption in some parts of the world, but the oil content is very high with a definite laxative quality.

4. Post-stranding damage and decomposition of carcasses

Before any material is removed from any stranded dead animal the carcass must be evaluated to determine its "freshness" and suitability for consumption. It must always be remembered that marine mammals maintain their normal body temperature (about 36°C) through efficient insulation, either from blubber, thick fur, or a combination of both. Transfer of excess body heat to the water is via an arterial/venous blood counter-current heat exchange system in flukes and flippers requiring a water flow over the skin to eliminate excess heat. This insulation and temperature regulation system is normally so efficient that, out of water, the animal cannot eliminate body heat in the usual manner and will literally "cook" from the inside out.

Rates of decomposition are influenced by body temperature in a robust animal with thick blubber, and by environmental temperature in lean animals. Large animals retain heat longer than smaller ones.

Whales - except the right whales - sink on death, then surface and float days or weeks later when buoyed up by gases from decomposition. They will float ashore outwardly unchanged but well decomposed internally.

Small whales, such as dolphins and porpoises, may have been attacked when still alive by gulls, which open up eyes and penetrate the skin and blubber of the mouth and body openings. A reliable sign of a whale having died at sea and drifted into coastal water, where it may have lain on the bottom before floating ashore, is sealice damage. These ubiquitous parasitic copepods can do substantial damage to carcasses, particularly around the eyes, mouth, tongue and orifices. Stranded animals may be lacerated and cut by rocks. Their outward condition is therefore not a good indication of their internal state.

Skin, mucous membranes and eyes dry rapidly following beaching and are, therefore, a poor indicator of general state.

Bloating is an obvious sign that the carcass is not fresh. Signs of decomposition are protruding tongues and penises. In females, nipples may be everted and tight.

Seals which die at sea may also drift ashore, buoyed up by the gases of decomposition. Following bloating, the fur or hair will slip, leaving patches of bare, greasy skin. Birds will attack the eyes and open the body in the axillae (armpits) where the skin is thinnest, and around the navel and anus.

Blubber of fresh carcasses is firm, white and moderately oily. With time blood from the underlying tissues will infiltrate the blubber turning it pinkish. The oil will then begin to separate from the blubber tissue.

The only reliable approach to determination of "freshness" is internal examination.

Fresh muscle is dark red and firm, with easily recognised fibre bundles which separate readily. As the carcass decomposes, muscles become soft, pale, translucent and pasty. Fibre bundles lose definition.

Decomposition rates may be increased by the animal's terminal condition such as infection with elevated temperature (fever) or bacterial infection. Because blood promotes the process of decomposition, animals which bleed to death are slower to decompose than those not bled.

Marine mammals have elevated levels of haemoglobin and myoglobin, the oxygen binding elements in blood and muscle respectively. These, in contact with tissues, accelerate decomposition. Adrenal glands, liver, spleen, brain and kidney all decompose rapidly, while heart and lungs may remain in reasonable condition for two or three days.

Two examples of the rates of decomposition of large whales in different environments serve to illustrate how rapid the process can be. In the Antarctic, a British veterinarian and whaling inspector observed that a catch of fin whales was flensed about 14-16 hours after being taken."The meat was wet and mushy and entering rapidly into the state of decomposition" (Cockrill 1955). It is worth noting this was after the whales had been towed to the factory ship in rough Antarctic seas in water of -1°C to 5°C. A similar observation was recorded by the British marine mammal biologist Nigel Bonner, who worked at the whaling station at South Georgia in the 1950s. He describes the state of the meat of whales which had an extended post mortem time between shooting and processing as "...falling in dark brown tatters from the bone; if I put my hand into the reeking meat it would be hot to the touch. ...At all events, the heat generated by decomposition, unable to escape through the blubber, had cooked the meat, despite its being surrounded by icy water" (Bonner 1980).

In the Perano's whaling operation at Tory Channel, and similar operations in Nova Scotia, Newfoundland and western Norway, it was standard practice to open the abdomen of all whales taken as soon as they were secured to the catcher boat. This permitted cooling by sea water as the animals were being towed to the whaling station for processing. Twelve hours was considered the maximum post mortem time before decomposition began to affect meat and oil quality (MWC pers. obs.).

5. Suitability of stranded marine mammal meat for human consumption

Despite the uncertainties inherent in determining the stage of decomposition of stranded carcasses, a system is required to define the quality of the meat and other tissues. The following is a modified version of part of the code system established by the Smithsonian Institution's Scientific Event Alert

Network (Geraci and Lounsbury 1993) in which carcasses are assigned to one of five categories based on specific characteristics. Note: there are inherent dangers in eating any meat other than that from very fresh carcasses.

5.1 ASSESSMENT CRITERIA

1. Live Animals

2. Euthanased Animals (Edible)

3. Fresh Stranded Animals (Edible)
   Normal appearance, little scavenger damage, fresh smell, minimal drying and wrinkling of skin, eyes and mucous membranes, eyes clear, carcass not bloated, tongue, penis and nipples internal, blubber firm and white, muscles firm and dark red, well defined, blood cells not haemolysed can be settled, serum clear, gut with little or no gas, viscera intact and well defined.

4. Fair (Muscle tissue, edible only after cooking at very high temperature)
   Decomposing but organs intact. Bloating (tongue and penis out), skin cracked and sloughing, scavenger damage, characteristic mild odour, mucous membranes dry, eyes sunken/ missing, blubber blood-tinged oily, muscles soft and poorly defined, blood haemolysed uniformly dark red, viscera soft/friable mottled but still intact, gut dilated with gas.

5. Advanced Decomposition (Inedible)
   Carcass intact but collapsing/ed, skin sloughing, epidermis of cetaceans may be entirely absent, often severe scavenger damage, strong odour, blubber soft often with pockets of gas and pooled oil, muscles liquifying easily torn and falling from bones, blood thin and black, viscera identifiable but friable easily torn, gut gas-filled taut. Gas infiltration of tissues, muscle mass hot to touch, tissues "fizzy" with escaping gas. Blood tinged fluids will ooze from the mouth and anus.

6. Mummified or Skeletal (Inedible)
   Skin may be draped over skeletal remains, any tissues desiccated.

6. Toxic effects of vitamin A from seal liver

Ill-effects from eating the livers of several Arctic carnivores, such as polar bear, wolf, husky Arctic fox and bearded seal have apparently been known to Eskimos from the earliest times (Southcott et al. 1974). King (1983) cites comments from the accounts of Loaysa and Alcazaber, written in 1526 and 1535 respectively, referring to the southern sealion Otaria: "In Loaysa's voyage and again in that of Alcazabar it is stated that the liver is more or less

poisonous. "Most of us who ate it suffered from the head to the feet", and "the livers of these seals is so poisonous that they give fevers and headache to everyone who eat them, and presently all the hair on their bodies falls off and some die"."

To date, neither New Zealand fur seal (*Arctocephalus forsteri*) nor New Zealand sealion (*Phocarctos hookeri*) livers have been analysed for vitamin A content. However, analysis of Australian fur seal (*A.p. doriferus*) liver indicates that there is more vitamin A in the livers of the older animals, and a single meal of about 500 g could be toxic (Southcott et al. 1974). Cleland and Southcott (1969) noted "Shipwrecked sailors have become ill after eating livers of *Neophoca* (Australian sea lion)".Although neither of these species occurs in New Zealand, they are physiologically very similar to New Zealand fur seals and sealions and it is probable that both these species have similar vitamin A values in their livers.

As seals age, their livers tend to become darker in colour and stronger smelling than those of pups and juveniles (0-3 years). Pup livers are similar in appearance to sheep livers selected for human consumption as 'lamb's fry'. Southcott et al. (1974) note that "Selection of seal livers on the criterion of paleness might, however, increase the probability of ingestion of a toxic amount of vitamin A, since a direct correlation between paleness and high vitamin A content has been shown for the northern fur seal, *Callorhinus ursinus*."

The symptoms of hypervitaminosis are drowsiness, headache, nausea and/or vomiting, peeling of the skin and possible hair loss. Depending on the quantity of liver consumed, the condition can range from severe to fatal.

7. Transmission of pathogens to humans

Notwithstanding the palatability of different parts of marine mammals there are some very real problems associated with the consumption of meat and organs from top level predators. Almost all marine mammal carcasses contain parasites. Most of these have little effect on the host, provided its nutritional demands are being met. Some have significant value as geographical markers. Others, however, have the potential to cause serious illness to the host, especially if it becomes stressed or debilitated, and could ultimately be fatal. Stranded marine mammals are frequently discovered with apparently high parasite loads. It is possible that in these cases the causes of the strandings were physical debilitation, illness and stress, or old age. In all of these one would expect to find an elevated parasite load.

Baleen whales appear to harbour fewer parasites than toothed whales. However, one parasite in particular, the round worm *Anisakis* sp., found in the stomachs of fin, sei, humpback and minke whales, is readily transmitted to humans. *Lecithodesmus goliath* found in the bile ducts of fin and sei whales,

often in surprisingly high densities, is one of the largest of the liver flukes, but is not known to infest humans. The toothed whales are known to host almost two times as many parasites as the baleen whales, including a number of gut parasites, including the round worms, which are potentially harmful to humans.

Seals, in common with other marine mammals, inevitably contain a variety of internal parasites (Table 3). Conspicuous among these are the nematodes (roundworms) that live in the stomach, lungs and other viscera; the cestodes (tapeworms) and acanthocephalans (hookworms) which are usually found further down the gut. Most obvious are the plerocercoids of the tapeworm *Phyllobothrium* sp. These creamy-white sacs, about 6 mm-10 mm in diameter, embedded in the blubber and mammary tissues of females, are commonly known as 'blubber cysts' and are the first parasites one finds on opening the belly of adult sealions, fur seals, small toothed whales and dolphins. Of the roundworms, two species are most prevalent in New Zealand marine mammals. They are *Anisakis* sp. and *Terranova* sp. The intermediate hosts of *Anisakis* sp. are squids and fish, the favoured food of fur seals and sealions. *Anisakis* sp is remarkably resistant and readily infests humans, especially after they have consumed raw or partially cooked tissues of fish and squid.

Over recent years there has been a rapid rise in the popularity of eating raw seafoods, prepared in the Japanese style as sushi and sashimi. Over 50 species of helminth parasites have been implicated in producing zoonotic infections arising from the consumption of raw seafoods, including whale meats. Of all these infections, the most frequently associated parasites are the *Anisakis* spp. type nematodes, which burrow into the stomach wall and cause ulcerative degeneration. It should be noted, however, that *Anisakis* spp. infection of humans who have eaten whale meat is rare and is most likely a result of either the consumption of intestine - as is common in Japan - or by combining whale meat with raw fish in the same meal.

Both whales and seals harbour a number of pathogens, particularly viruses, bacteria and fungi, which can be readily transferred to humans by ingestion of tissues, directly through breaks in the skin or via exhaled aerosols. Among these are the brucella bacteria, previously unknown in marine mammals, which have only recently been isolated from harbour seals, harbour porpoises and common dolphins in the Northern Hemisphere. One of the brucella bacteria (*Brucella abortus*) is responsible for abortion of foetuses in domestic stock. Research to determine the prevalence and significance of brucella infection both in other marine species and in other geographical areas is now being planned. Brucellosis is recognised as an important zoonotic infection of man, infection occurring via the oral or ocular route following ingestion of infected milk or the handling of infected discharges and foetuses (Ross et al. 1996). It is now clear that the agents causing two very troublesome infections, "spekk finger" and "seal finger" are probably endemic in seals and whales throughout the world. Both these infections follow a regular course specific to the disease. The first line of prevention is careful attention to hygiene and treatment of cuts and scratches, no matter how trivial, which have been in contact with tissues of whales or seals. If infection develops, "seal finger" responds to tetracycline, while "spekk finger" from whales will respond to penicillin. If left untreated, the chronic infection can result in permanent disability (Cawthorn 1994).

8. Contaminants in marine mammals

Numerous studies have been published showing the presence of pesticides and heavy metals in the blubber, muscle, liver and brain of many cetacean species. As analytical methods have improved and animals have been sampled over wider regions, ever increasing quantities of trace elements and chlorinated hydrocarbons have been found. There are no areas of the world, even the remote Arctic and Antarctic, that do not possess traces of hydrocarbon derived from industrial or agricultural activities (Evans 1987). Determining the most significant contaminants in the tissues of marine mammals is not easy. One reason is that a number of trace elements, at least, occur naturally in the sea and food items. Those known to be toxic include the insect pesticides DDT (and its derivatives) and dieldrin, the polychlorinated biphenyls (PCBs), and the trace elements, otherwise known as heavy metals, such as mercury, lead, zinc, cadmium and copper. DDT, dieldrin and the PCBs are virtually insoluble in water but are soluble in fats so they can become concentrated in tissues such as blubber where they will persist for long periods in an inactive state. Applied over the land these compounds are transported by wind and water to the sea. Once in the sea these toxins are progressively accumulated as they pass through the food chain. Marine mammals, as top predators, are most vulnerable to the toxic effects at high concentrations. When heavy metals enter the sea they form either inorganic or organic complexes. It is in the latter form that they are ingested by marine mammals. Mercury, cadmium, arsenic and copper have little affinity for fats and usually enter organs, especially the liver and kidneys, rather than blubber.

In the traditional Faroese pilot whale drive fishery, the "Grind", between 500 and 3,000 pilot whales are taken annually. Pilot whales, being near the apex of the marine food chain, bioaccumulate organochlorines and mercury in their blubber, muscles and organs: Tissues from these animals are widely consumed by many of the islands' population of 45,000. In a comparative study of human tissues sampled from the Norwegian and Faroe populations, it was found that median levels of mercury in kidney and liver of Faroese Islanders were approximately ten times higher than in residents of Bergen, Norway. This difference was attributed to the high (82-555 g per week, mean 257 g) consumption of pilot whale tissues by the Faroese (Simmonds et al. 1994).

19th century records of the Moriori of the Chatham Islands contain many references to the large scale consumption of pilot whales by these people, for whom marine mammals formed a principal part of their diet. Recent analyses of mercury levels in prehistoric bone samples from Moriori suggested that their dependence on pilot whale meat resulted in very high levels of bioaccumulated mercury, particularly in high status males (Foss Leach pers. comm., Skinner and Baucke 1928).

In New Zealand a long history of pastoral farming encouraged the use of insecticides and herbicides, both of which have found their way into the coastal marine environment via wind and water runoff from the land. High levels of

DDT have been found in the blubber of common dolphins, Hector's dolphins and dusky dolphins (Evans 1987). Unpublished assays of blubber of Hector's dolphins show levels of DDT as high as 53 ppm and PCBs to 10.2 ppm (E.Slooten pers.comm.). Levels are generally lower in sperm whales and baleen whales, typically ranging between 0.1 and 10.0 ppm for both DDT and PCBs (Evans 1987). In the blubber these contaminants are probably fairly innocuous; however, if they were mobilised from the blubber during food shortages or lactation they could have cumulative side effects.

In a recent study of toxic contaminants in marine mammals in Australia, Kemper et al. (1994) report the findings of analyses for heavy metal and organochlorine levels in tissues from whales, dugongs and seals. The most consistently analysed metals were lead, mercury and cadmium. Liver and kidney levels ranged from <1-3 ppm; levels in bone were 0-418 ppm, with most less than 10 ppm. Mercury levels in a large sample of sperm whale muscle were <12.2ppm. Mercury levels in the small number of samples from other species were 0.51-143 ppm (kidney), 1.52-479 ppm (liver) and <0.1-36 ppm (muscle). Cadmium levels in liver and kidney were extremely variable. Levels greater than 10 ppm were recorded in many species and were especially high in leopard seals, dugongs, straptooth and false killer whales. Adult bottlenose dolphins inhabiting the inshore gulfs of South Australia had considerably higher levels of cadmium compared with other regions. Information on organochlorine levels is sparse and suggests low levels compared to other parts of the world. Total DDT was highest (28.4ppm) in a neonatal killer whale. Some high levels of DDT were recorded in bottlenose dolphins, common dolphins and Australian fur seals. PCBs ranged from <0.05-3.87 ppm.

Very few data have been collected from pinnipeds in New Zealand. Tissue samples from four Hooker's sealions, taken as by-catch in the trawl squid fishery, were analysed for persistent pesticides and heavy metals by Dr W.Locke, MAF Analytical Laboratory, Wallaceville. PCBs in blubber were at trace levels only and DDT levels were 4.75 ppm. Heavy metals were more apparent. Mercury concentrations in liver ranged from 11.2 ppm - 63.5 ppm, averaging 36.4 ppm, compared with about 0.32 ppm in muscle tissue. As might be expected, there were elevated levels in a young, emaciated sealion which had 53.4 ppm mercury in its liver and 105.8 ppm cadmium in its kidney tissue (MWC unpub. data).

9. Butchering and meat storage

Butchering, or *flensing* (to use the correct term) of large whales on a beach may, at first sight, be a rather daunting task, particularly when you are confronted with a 16 m - 20 m long mass of animal. However, provided you have the right knives, some long-handled hooks and four or five people to help, the job, done the right way, is not nearly as difficult as it may seem to the uninitiated. If you have a bucket or container, fill this with sea water to keep you and your knives clean. Wear gloves and protective clothing. Stranded whales are usually lying on their side. The first job is to remove the blubber

to expose the back meat. Make one long cut,through the blubber to the muscle, along the mid-flank from the insertion of the flipper to a point halfway between the dorsal fin and the tail fluke. Then, make two or three evenly spaced vertical cuts downward from the first cut and across the back to as close to beach level as you can. Here you may need some traction. Cut two slots through the blubber, thread a rope through the two slots and get the helpers to pull hard and steadily as you cut downward to drop the blubber flat onto the beach. KEEP IT CLEAN.

Return to the first cut along the flank, cut through the back muscle down to the backbone and make vertical cuts down to the dorsal spines of the backbone cutting the meat into manageable blocks. Once again, get the helpers to pull the blocks of meat away as you cut downward dropping the meat onto the CLEAN blubber on the beach. Transfer the meat onto clean plastic sheets for removal and cool down as soon as possible. Repeat the procedure when taking meat from the underside (belly).

Be careful not to pierce the stomach or intestines. IF THE GUT CONTENTS SHOULD CONTAMINATE THE MEAT, DISCARD THE MEAT IMMEDIATELY!

If collecting the meat from seals, the back meat, shoulder muscles and pectoral muscles across the chest are the best cuts. The same emphasis on cleanliness and hygiene applies. When cutting open any marine mammals it is always advisable to wear waterproof protective clothing and a pair of strong waterproof gloves.

Storage of marine mammal meat should be under exactly the same criteria as meat from land animals such as cattle and sheep. High standards of hygiene are vital. Meat must be kept chilled or frozen at the same temperature as beef.

10. Conclusions

Historically, marine mammals have been exploited either directly by hunting or indirectly from strandings for food, fuel and clothing for thousands of years in the northern hemisphere. It is probably safe to assume marine mammals have been exploited for food by Aborigines in Australia for at least 40,000 years (R. Warneke pers. comm.) and probably for the last 700 years or so by Maori in New Zealand. The regular consumption of whale meat in this country waned at the end of the 19th century and ended in about 1960 with the collapse of the commercial humpback whale fishery.

The Moriori and Maori seasonally exploited fur seals and sealions for food and clothing but, apart from the accounts of shipwrecked sailors, there are no records of seal meat being eaten after about 1907. The Maori predilection for fur seal fat cited by Polack (1838) is an understandable response by people on a very low fat diet. Fat provides instant calories and would satisfy short term energy requirements. However, in the process of eating blubber it is

possible Maori unwittingly consumed large quantities of encysted parasites with unknown consequences.

Fur seal meat is apparently less palatable than sealion meat although both have a strong fish-oil odour. Elsewhere in the world, seal meat is regularly eaten, with the consumers facing the constant problem of ingestion of zoonotic organisms such as *Trichinella*, *Leptospira*, *Brucella*, *Anisakis* and *Contracaecum*. Some seal species accumulate vitamin A in their livers, and consumers must be aware of the potentially lethal effects of vitaminosis from eating seal livers.

Baleen whale meat is undeniably palatable and highly nutritious with a significantly lower parasite burden than toothed whales.

The oils contained in the tissues of sperm whales are, when refined, similar in nature to industrial oils and impart an unpleasant flavour to the dark, strong-smelling meat. They also have a laxative effect on humans and dogs when consumed (MWC pers.obs.). The meat of sperm whales is not recommended for human consumption.

Pilot whale meat is widely consumed in the northern hemisphere, usually as part of a traditional diet. Recent research has shown that pilot whales accumulate organochlorines and heavy metals at rates exceeding many other species. These bioaccumulate in humans with detrimental effects if the intake of pilot whale meat is high enough. Pilot whale meat and organs are not recommended for human consumption.

Seal meat is eaten in many northern hemisphere countries and certainly constituted an important part of the diet of Maori and Moriori. Apart from the possibility of transmission of zoonotic organisms through improper preparation before eating, the consumption of livers should be avoided because of their potential toxicity to humans.

If whale meat is going to be collected for human consumption it is advisable that, given the rapidity of decomposition, meat is taken only from those animals which come ashore alive and are rapidly euthanased. Meat must be collected with all the care and attention to hygiene which attends the butchering and storage of meat from cattle and other terrestrial animals for human consumption. It should be noted that freezing will probably kill most of the intestinal and other metazoan parasites. However, it is most unlikely that bacteria and viruses will be rendered harmless by freezing, boiling, frying, roasting and baking. The only way to destroy these organisms is by pressure cooking (autoclaving) at high temperature and pressure. Consumers should be aware of the potential problems of bioaccumulated toxins, parasite burden and the effects on the human digestive system of some of the waxy oils contained in the tissues of toothed whales.

People should be aware that there are some pathogens in both whales and seals which, if not fatal, can cause considerable distress if contracted. They are the mycobacteria and the infective agents causing the conditions known as "spekk finger" and "seal finger". Protective clothing should be worn when butchering these animals and a high standard of hygiene maintained at all times.

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13. Appendices

Table 1. Vitamin A Content : Whale meat, Beef, Pork.

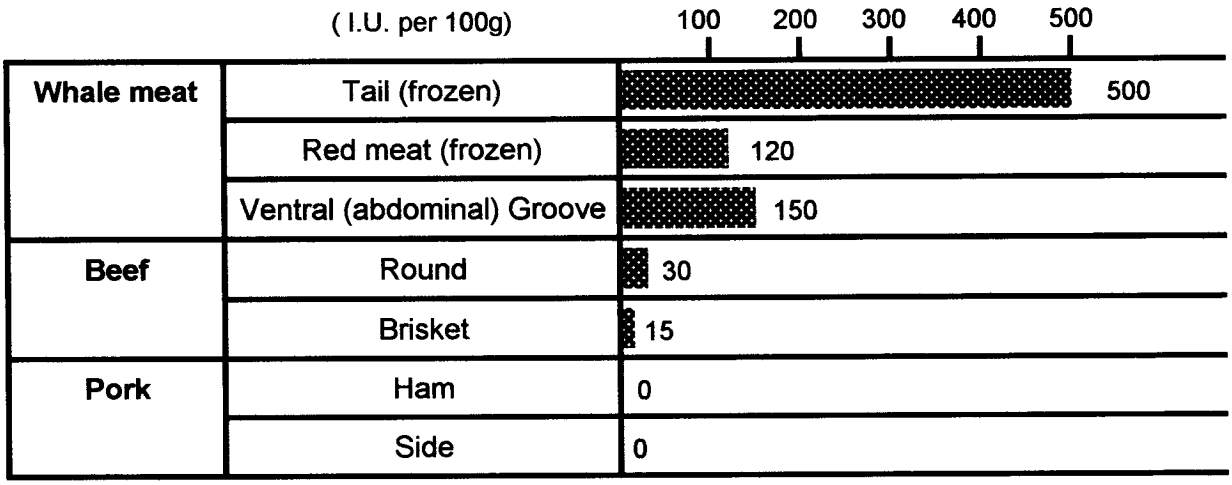

Table 2. Comparison of Cholesterol Content: Whale Meat, Beef, Pork, Fish.

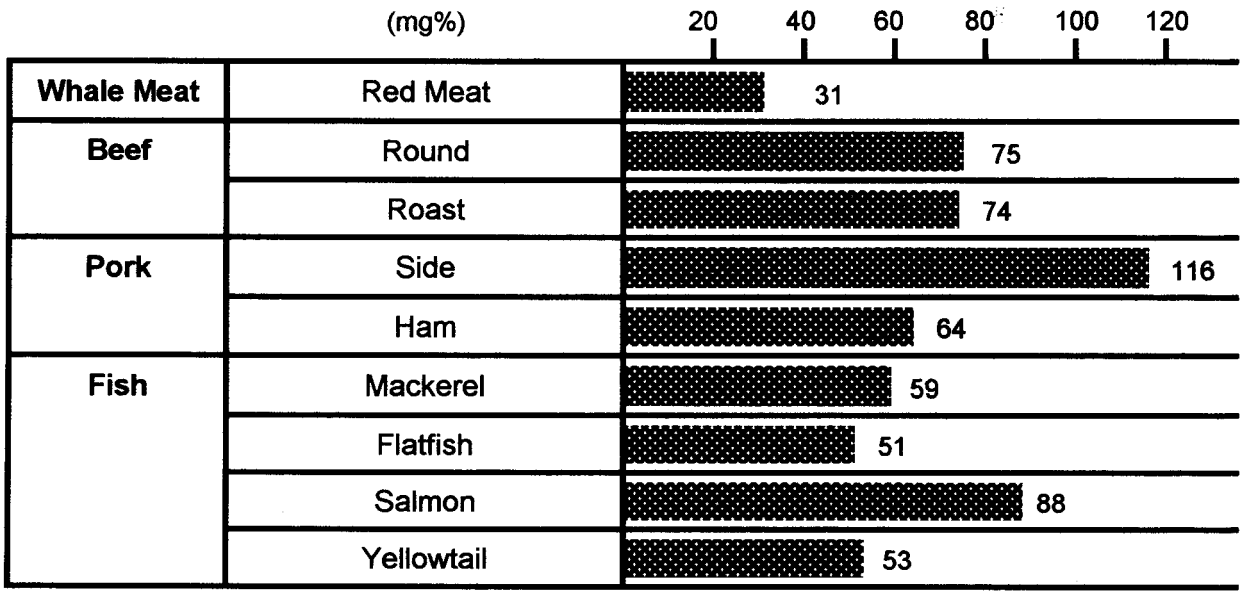

TABLE 3.

Organ	Skin	Naso-Pharynx	Lungs Trachea	Stomach	Intestine	Liver – Gall Bl.	Heart	Muscle Fascia	Mammaries
TRUE SEALS	A	J	B	C D E	F P S G	H	I	F	F
EARED SEALS	L	K	K R	E F D	N G O P	Q		I	F

SEALS - PARASITES

PARASITE SPECIES LIST:

A *Echinopthirius* sp.
B. *Othoostrongylus* sp.
C. *Anisakis* sp.
D. *Terranova* sp.
E *Contracaecum* sp.
F. *Diphyllobothrium* sp.
G. *Cryptocotyle* sp.
H *Orthosplanchnus* sp.
L *Dipetalonema* sp.
J. *Halarachne* sp.
K. *Orthohalarachne* sp.
L *Antarctophthirius* sp.
M. *Diplogonoporus* sp.
N. *Pricetrema* sp.
O. *Uncinaria* sp.
E *Corynosoma* sp.
Q. *Zalophotrema* sp.
R. *Parafilaroides* sp.
S. *Phocitrema* sp.

TABLE 4. PARASITES - WHALES

ORGAN	BALEEN WHALES	TOOTHED WHALES
Skin	C D E F H	C T
Blubber	U	U
Teeth		E
Cranial sinuses		M N B
U-G system	B	B
Stomach	A	A O P
Abdominal cavity and mesenteries		Q
Intestine	I J K	R S
Mammaries	U	B U
Liver Pancreas Bile ducts	L	V W
Respiratory Tract		N X
Brain		M

PARASITE SPECIES LIST

A *Anisakis* sp.
B. *Crassicauda* sp.
C. *Cyamis* sp.
D. *Penella* sp.
E *Conchoderma* sp.
F. *Coronula* sp.
G. *Nevicola* sp.
H. *Cocconeis* sp.
I *Ogmogaster* sp.
J. *Bolbosoma* sp.
K *Diplogonoporus* sp.
L *Lecithodesmus* sp.
M. *Nasitrema* sp.
O. *Braunina* sp.
P *Contracaecum* sp.
Q. *Monorygma* sp.
R *Tetrabotbrium* sp.
S. *Corynosoma* sp.
T *Xenobalanus* sp.
U. *Phyllobothrium* sp.
V *Oschmarinella* sp.
W *Campula* sp.
X *Halocercus* sp.

[NOTE:The following two tables are a guide only based on the author's changing tastes over time.]

TABLE 5. PALATABILITY OF WHALE MEAT BY SPECIES (0 =Least, 5= Most)

Species	Oiliness	Fishy Flavour	Colour (Dark-Light)	Palatability
Blue	2-3	2	3	3
Fin	2	2	3	4
Sei	2	2-3	3	4
Humpback	2-3	3	3	3-4
Minke	2	2	3	3-5
Right	2-3	3	3	3-4
Sperm	4-5	4	1-2	1-2
Killer	3-4	3-4	2-3	2-3
Pilot	3	3-4	2-3	3
Dolphin	3	3	3	3

TABLE 6. PALATABILITY OF DIFFERENT TISSUES (O=Least, 5=Most)

	Back Muscle	Tail Meat	Ventral Grooves	Tongue	Heart	Intestine	Liver	Testis	Blubber
Baleen	5	5	3-4	2	4	2	2	2	3
Toothed	2	2	-	2	3-4	2	1	1	3