Toxic Menu

Contamination of Whale Meat and Impact on Consumers' Health

A review by Dr. Sandra Altherr and Sigrid Lüber

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Baird's beaked whale, hunted and consumed in Japan, despite high burdens of PCB and mercury
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Content

Glossary

AMAP	Arctic Monitoring and Assessment Programme
CHL	chlordanes
DDT	dichloro-diphenyl-trichlorethane
FAO	Food and Agriculture Organisation
INAC	Indian and Northern Affairs Canada
IWC	International Whaling Commission
JARPA	Japanese Whale Research Program under Special Permit in the Antarctic
JARPN	Japanese Whale Research Program under Special Permit in the western North Pacific
NCP	Northern Contaminants Program
PBDEs	polybrominated diphenyl ethers
PCBs	polychlorinated biphenyls
POPs	persistent organic pollutants
SC	Scientific Committee of the IWC
SOCER	State of the Cetacean Environment Report
TDI	Tolerable Daily Intake
WHO	World Health Organisation

1. Executive summary

At its 64th meeting in July 2012 the *International Whaling Commission* (IW) will decide on a Resolution regarding contaminant burden in whale products and associated health risks for consumers. This initiative is the logic consequence of accumulating alarming findings: In late 2011, scientists presented the outcome of five cohort studies at the Faroe Islands, showing the link between an increasing number of human diseases and contamination of whale products (Weihe & Grandjean 2012). Another recent cohort study in Nunavik, Canada, found a correlation between consumption of beluga meat and "*poor intellectual function and attention in schools*" (Nunavik Regional Board of Health 2011). Already in 2008, the Faroese health authorities recommended to their regional Government that pilot whale meat should no longer be used for human consumption (Weihe & Joensen 2008). However, the Faeroese Government just issued revised guidelines and only advised women planning pregnancy, being pregnant or breast-feeding to refrain from eating whale meat (Faeroese Food and Veterinary Authority 2011).

The serious impact on the consumers' health is not a new phenomenon: Already in 1996, alarming findings indicated a reduction of neuropsychological abilities in Faroese children due to a diet-based mercury exposure (Weihe *et al.* 1996). Studies in other regions, such as Arctic Canada, Greenland or Japan, also showed alarming pollution levels in whale products and associated human diseases, including Parkinson's disease (Wermuth *et al.* 2008, 2000), suppression of the immune systems (INAC 2003a), and increased respiratory infections in children (Van Oostdam *et al.* 2005).

Many governments have set safety limits for mercury in sea food. Officials in Canada, Japan, and Norway gave food advice for pregnant and nursing women, but not for other human population groups. However, the enormous risks from cetacean products can no longer be ignored. Climate change may even worsen the scenario by releasing chemicals from ice (SOCER 2005 and literature therein). The risks may even affect political economies: Scientists warn that neurological deficits, resulting from prenatal exposure to mercury, may weaken the national economy (Trasande *et al.* 2005).

In some geographic regions, people, such as the Inuit and the Chukotka, still depend on traditional food as an important part of their diet. Traditional food is important for their well-being and has a cultural function. Therefore, benefits of traditional foods must be weighed against health risks. Nevertheless, whale products are only one part of traditional food, and an increased consumption of less contaminated alternatives would help to avoid health risks for consumers (Deutch 2006; Johansen *et al*. 2004). In industrial nations with high living standards, whale meat is not a vital food component. In addition to the current political, cultural or animal welfare-motivated discussions on whaling, the health aspect needs be considered as a priority.

The IWC, the *World Health Organisation* (WHO), and consumer protection organisations should draw the conclusions from the scientific findings: They should urge whaling nations to assess and inform consumers of whale products on health risks. Aboriginal people should reduce the consumption of whale products. In societies with high living standards and sufficient food alternatives, however, a cessation of whale consumption is the only legitimate advice.

Remarks from the editors

Within the last decades, several international agreements have aimed to reduce the contamination levels of toxic substances. Indeed, the release of many chemicals into the environment has decreased, e.g. PCBs and mercury. Many substances, however, are persistent in the environment and even at low background levels can accumulate in long-living organisms, especially those at high-trophic levels such as toothed whales.

The present report by no means wishes to release industrial countries from their responsibility: A top priority must be to further reduce environmental pollution. We clearly recognise the needs of several aboriginal tribes who heavily rely on traditional food from the sea. Nonetheless, the increasing number of alarming scientific studies should intensify a discussion on alternatives to highly contaminated whale meat. The issue of whaling is in many aspects politically motivated and emotionally influenced. The enormous health risk for consumers calls for political decisions on whaling activities based on objective and responsible grounds.

2. Contaminants and pathogens in whales

Cetaceans, especially toothed whales, are on the top of the marine food web. Their high trophic level, combined with their longevity, makes whales among those animals accumulating the highest levels of toxic substances. Blubber, liver and kidney are among the tissues with the highest pollutant load. The contamination level in whales differs geographically, which reflects different feeding strategies and degrees of pollution. Arctic toothed whales are especially vulnerable to chemical exposures due to their large amount of body fat. Most data exist on the impact of organochlorines and mercury. However, increasing scientific data on new contaminants and pathogens in whale products are available (see for example SOCER reports 2004, 2005, and 2008). The present report therefore only highlights the levels in cetaceans that are hunted and consumed by humans. Table 1 (Annex) gives an overview of contamination levels in toothed whales, table 2 (Annex) on the findings in baleen whales.

2.1. Heavy metals: mercury

Mercury toxicity – especially with the organic form methyl-mercury (Me-HG) – in marine mammals can cause weight loss, liver anomalies, prevalence of parasitic infections, pneumonia, and premature birth. Mercury concentrations increase with whale body size because this heavy metal is accumulated over the life time (Das *et al*. 2003).

In most cetacean species, highest mercury concentrations are found in the liver (see table 1 and 2, Annex). Mercury levels in **beluga** and **narwhal** of the Canadian Arctic are higher than in other marine mammals, such as walrus. In Canada, concentrations of up to 44.3 µg/g were found in liver of belugas, in narwhal even levels of up to 137 µg/g; in Greenland, mercury in liver reached levels of 73.3 µg/g (table 1, AMAP 2011), Annex. At the Faroe Islands, analysis of **long-finned pilot whales** revealed values of up to 179 µg/g in liver and 30 µg/g in blubber (Hoydal & Dam 2005; Weihe *et al*. 1996). Also in the western North Pacific, findings are alarming: In **sperm whale** liver, maximum levels of 130 µg/g were detected. Liver of **Risso's dolphins** contained up to 645 µg/g. In short-finned pilot whales, mercury content in liver peaked at 422 µg/g, in **striped dolphins** as high as 452 µg/g. The latter species also contained up to 1,980 µg/g in kidney and 153µg/g in lung (Endo *et al*. 2004).

In baleen whales, mercury burdens are lower, but in the Northwest Pacific levels of up to 13.7 µg/g (Endo *et al.* 2004) and 2 µg/g off Greenland and Norway (AMAP 2011) were found in the liver of **minke whales**. In **Bryde whales**, maximum levels described so far are 0.6 µg/g in kidney and 0.49 µg/g in liver (Yasunaga & Fujise 2009c). A maximum of 4.4 µg/g was found in liver and 2.3 µg/g in kidney of **gray whales** in Alaska (Varanasi *et al.* 1993).

In general, mercury levels have not significantly changed in recent decades, but varied geographically (INAC 2007). In some beluga populations (e.g. Beaufort Sea and western Hudson Bay), however, mercury has increased up to the fourfold between 1993 and 2003 (INAC 2003b). The long-term impacts of these mercury burdens, especially in combination with other toxic substances, on the health of toothed and baleen whales are still unknown.

2.2. Organochlorines: PCB, DDT, & CHL

Organochlorine compounds are lipophilic, i.e. soluble in fat, and therefore accumulate particularly in fatty tissue, such as blubber. Among the most toxic substances are PCBs (polychlorinated biphenyls), DDT (dichloro-diphenyl-trichlor-ethane) and CHL (Chlordane). PCB levels in some Arctic cetacean species, e.g. pilot and minke whales, belugas, narwhals, are reaching concentrations that may affect reproduction and induce immunosuppression (SOCER 2005, 2004 and literature therein; De Guise *et al.* 1995). Small cetaceans metabolise PCB only minimally compared to birds and terrestrial mammals (Borrell 1993).

Highest **PCB** levels so far detected in cetaceans are 30 µg/g in pilot whale blubber at the Faroe Islands (Weihe *et al.* 1996), 18.7 µg/g in minke whale blubber from Norway (Hassauer *et al.* 2002), and 17.8 µg/g in Dall's por-

Humpback Whale ©NOAA

poise blubber (Subramaniam *et al.* 1987). Johansen *et al.* (2004) emphasize the very high PCB concentrations in blubber of both beluga and narwhal.

Maximum **DDT** concentrations so far were found in blubber from Northwest Atlantic humpback whales (23.1 µg/g), Japanese striped dolphins (17.1 µg/g), from sperm whales in the Caribbean (15.5µg/g, Simmonds & Johnston 1994), and in muscle from Greenlandic minke whales (14.8 µg/g, Hassauer *et al*. 2002).

To date, highest **chlordane**-burdens are known from blubber from beluga (5.97 µg/g, Stern *et al.* 2005) and narwhal (2.6 µg/g, INAC 2003b) off Canada. Chlordane levels in both species from Greenland are also very high (Johansen *et al.* 2004).

Generally, contamination levels are highest in adult males, but levels vary significantly in animals from different areas: Among minke whales in the North Atlantic and European Arctic, levels of PCB, DDT and CHL in blubber generally increased from west to east, and were especially high near the Lofoten for PCB and DDT, and near Spitsbergen and the Barents Sea for CHL (Hobbs *et al*. 2003; Kleivane & Skaare 1998).

Belugas and narwhals off Greenland have very high PCB concentrations in blubber, whereas muscle, liver, kidney, and skin showed low to medium levels. For blubber of both species, CHL level is also very high, and in liver, kidney, muscle and skin still reach high levels (Johansen *et al*. 2004, for details see section 3.3.1).

Due to their lower trophic level, Arctic bowhead whales have lower organochlorine levels than other cetaceans (SOCER 2005 and literature therein). Liver of adult males contained significantly higher levels of PCB and DDT, compared to females (for details see table 2, Annex), whereas chlordanes were lower in males (O'Hara *et al*. 1999). In bowhead whales from Beaufort-Chukchi, levels in blubber reached 0.54 µg/g lw for PCB, 0.44 µg/g for DDT, and 0.26 µg/g for chlordane (Hoekstra *et al*. 2003).

Even in the Antarctic, bio-magnification of contaminants has recently been described: Persistent organic pollutants levels of up to 160-fold relative to their krill prey have been found in seals (SOCER 2005 and literature therein) and similar accumulation can be assumed for cetaceans. PCBs, DDTs, CHLs and other substances were detected in all the blubber samples of Antarctic minke whales taken in JARPA (table 2, Annex, Yasunaga *et al*. 2005).

Melting ice passes contaminants into the oceans. Accordingly, scientists fear that climate change could accelerate the input of PCBs into the Arctic marine food web, which would aggravate the contamination level in Arctic cetaceans (SOCER 2005 and literature therein).

2.3. Other Persistent Organic Pollutants: PBDE & Co.

Recently, new classes of persistent organic pollutants (POPs) have been increasingly found in cetaceans. For example, since the mid 1980s a significant rise of **polybrominated substances** (PBDEs) has been observed in belugas and North Atlantic harbour porpoises (Beineke 2003). In southeast Baffin, levels of some PBDE substances have increased up to 30fold (INAC 2003b). In muscle of North Atlantic minke whales, PBDE concentrations reach up to 4.9 µg/kg, in blubber even up to 573.7 µg/kg (Hassauer *et al.* 2002). In blubber of long-finned pilot whales, values of up to 3.2 µg/g lipid have been found (Lindström *et al*. 1999).

PBDEs are used as flame-retardants and are known to have immune-toxic and endocrine-disrupting effects. They can cause neurological and developmental abnormalities and may change reproductive success. There is also evidence that PBDEs are more toxic when combined with PCBs. So far, PBDE levels in whale tissues have been comparably low, but, contrary to PCBs, the concentrations of PBDEs are increasing in the environment, and it is feared that "***PBDEs may surpass PCBs in a few decades to become the most prevalent organohalogen compound***" (SOCER 2005 and literature therein; INAC 2003b).

Fluorinated substances have been found in pilot whales from the Faroe Islands, in northern minke whales caught off Greenland (Bossi *et al.* 2005) as well as in beluga and narwhals in the eastern Arctic (Tomy *et al.* 2004; SOCER 2005 and literature therein).

Only in recent decades have **short-chained chlorinated paraffins** (SCCPs) been found in cetaceans, e.g. in belugas, narwhals and minke whales from Greenland: Highest levels are known from belugas, with 0.28 µg/g wet weight in blubber (INAC 2003b).

2.4. *Brucella*

The bacterium *Brucella* sp. causes the infectious disease brucellosis, which is a comparatively new phenomenon in both marine mammals and humans. However, the high occurrence in whale and dolphin populations all over the world – an endemic infection of up to 78% (CFSPH 2007) – calls for considering this item in the context of human health assessment of whaling.

At least two North Pacific species of baleen whales are infected: In the JARPN program, up to 38% of the minke whales tested positive for *Brucella* antibodies, in Bryde whales 9% tested positive (Ohishi *et al.* 2003). In the North Atlantic, *Brucella* pathogens have been found in several cetaceans, with 14% of investigated sei whales, 11% of fin whales and 8% of minke whales being infected (Tryland *et al.* 1999). Antibodies were also detected in pygmy sperm whales (CFSPH 2007), but hitherto not in Antarctic minke whales and in sperm whales (Ohishi *et al.* 2007; 2003).

Brucella is also known to affect small cetaceans. For example, 53% of Pacific bottlenose dolphins off the Solomon Islands are antibody positive (Tachibana *et al.* 2006). The pathogen has also been detected in striped and common dolphins, Maui's dolphins; beluga, narwhal, pilot and killer whales, harbour porpoise, short- and long -beaked dolphins, white beaked dolphins, white-sided, white-headed, dusky, Burmeister's and Hector's dolphins (Hernández-Mora *et al.* 2008; CFSPH 2007; New Zealand Department of Conservation 2007; Groussaud *et al*. 2007; González *et al*. 2002).

Brucella may induce chronic meningoencephalitis, abortions, inflammation of testes, infections, peritonitis, and hepatetic abscesses in cetaceans (SOCER 2004 and literature therein). **Marine mammal *Brucella* can also infect humans. According to CFSPH (2007), people may be increasingly exposed, particularly when dressing carcasses or consuming raw meat**. In humans, headache, fatigue, severe sinusinitis, chronic vomiting, and epileptic seizures have been diagnosed due to marine mammal -associated *Brucella* strains. So far, only four cases of *Brucella*-transfer from cetaceans to humans are scientifically described (Sohn *et al.* 2003; McDonald *et al.* 2006); however, further cases may be under-diagnosed (CFSPH 2007). Transmission pathways remain unclear.

3. Health Risks for humans

In the 1960s/1970s the "Minamata disease" in Japan (section 3.1.1) showed the disastrous aftermath of mercury toxication, when tons of industrial mercury had been dumped into local waters. In the following years, thousands of people fell ill or died; many newborns showed severe deformities or neurological disorders due to the prenatal mercury exposure (Harada 1995).

Bio-magnification of toxic substances in marine food webs may be extraordinary for species from high trophic levels such as many cetaceans. Toxic substances, ingested through whale meat, are known to negatively impact human health (NRC 2000; Stern *et al.* 2004; for details see table 4, in Annex). Results, with a focus on mercury, PCB and DDT, are available from many regions:

- In the Faroe Islands (section 3.2), a correlation between a variety of diseases or abnormal developments in humans and consumption of pilot whale meat has been indicated (details see section 3.2.1.).

- The daily intake of mercury for Arctic Inuit has been estimated at 170 µg/day of marine mammal meat and 2.4 µg/day of blubber. More than 93% of their daily mercury intake is from marine mammals (Mahaffey & Rice 1997).
- In Inuit children, who have been exposed to PCB in the womb and during weaning, both birth weight and immune system function are reduced (AMAP 1997).
- Interaction from co-exposure to low doses of both mercury and PCB enhances neurotoxicological effects (Fischer *et al.* 2008).
- Whereas a reduction of whale meat intake due to dietary advice resulted in lower mercury levels in consumers, PCBs levels remained high, as they are more persistent (Weihe 2007; Weihe *et al.* 2003).
- Only recently, new compounds such as organic fluorines and PBDEs were found in humans whose diet includes whale meat (Weihe *et al.* 2008; Fängström *et al.* 2005; Bossi *et al.* 2005).

Although the toxicity of mercury, PCB & Co. are widely accepted, in some countries so far no national safety limits for these substance are set, and in those with safety limits, these may vary significantly (table 3, Annex).

3.1. Japan

In recent years Japan has been step by step expanding its "scientific whaling", using a loophole of the ICRW. Presently, Japan has set an annual quota for 850 minke, 50 humpback and 50 fin whales to be caught in the Antarctic region (JARPA II) and 340 minke, 50 Bryde's, 100 sei and 10 sperm whales in the western North Pacific (JARPN II; IWC 2009d). Additionally, smaller species such as Dall's porpoise, striped and bottlenose dolphin, Risso's dolphin, short-finned pilot whale, and Baird's beaked whale are hunted in drive fisheries, hand harpoon hunts and small-type coastal whaling, with a total number of 16-20,000 annually (NRIFSF 2005, 2004, 2002).

In the year 2000 alone, "scientific whaling" yielded 2,400 tons of whale products, the hunting of small cetaceans 1,720 tons of products (Endo *et al.* 2003). Since then, the hunting of large whale species has been further intensified. Fresh and frozen red meat, the most popular whale products in Japan, as well as boiled internal organs, including liver, lung, kidney and small intestine, are on sale in Japanese retail outlets and supermarkets. Contrary to the Government's version, consumption of whale meat in Japan does not have a long tradition, apart from a few communities in which small cetaceans have been caught for about 400 years. Instead, whale products became only popular after the Second World War due to acute foot shortage (Head 2005; Nanami 2001).

Presently, products from both baleen and toothed whales are on sale. The range includes northern and southern minke whale, Bryde, sei, fin, and sperm whale from JARPA and JARPN. The hunting of small cetaceans has exploded from less than 5,000 animals annually before the IWC moratorium to 15,-20,000 since then. These numbers reveal that small cetaceans have been used to replace large whales on the markets (EIA 2005).

3.1.1. Health implications from whale products in Japan

In 1980, Japanese scientists raised alarm about the high mercury levels in whale meat sold in Japanese markets (Taguchi *et al.* 1980). Their paper, presented at the IWC Scientific Committee, highlighted that mercury levels in all meat samples from toothed whales in Japan were substantially higher than national safety limits. Since

Mercury testing in cetacean products, Japan © EIA then, Japanese scientists regularly detected high levels of mercury and PCB in whale meat from Japanese markets, which exceeded national health advisory levels for marine foods (0.4 µg/g for mercury and 0.5 µg/g for PCB) several fold. This was the case for small cetaceans (see table 1, Annex) and the large minke and Bryde whales in the North Pacific (see table 2, Annex), but not for minke whales from the Antarctic (Haraguchi *et al*. 2000). A chronology of scientific findings:

- **2000**: Mercury and PCB levels in both small cetaceans and northern Pacific minke whales exceeded Japanese safety levels (Haraguchi *et al*. 2000).
- **2002**: Mercury levels of up to 1,980 µg/g were identified, which exceed Japanese health advisory levels by up to 5,000 fold (Endo *et al*. 2002). The authors state that "***only 0.15 g of liver exceeds the permitted weekly intake*** [set by WHO at 5 µg/kg /week*]… suggesting the possibility of an acute intoxication by total mercury even after a single consumption of the product*." On average, mercury levels in cetacean livers were 370µg/g – 900 times the government's limit.
- **2003**: A new survey found **all 137 whale and dolphin meat samples exceeding the safety limits**, some of them 200 fold (Endo *et al*. 2003).
- **2004**: Red meat from small cetaceans the total mercury level exceeded the safety limits by 22 times (Endo *et al*. 2004).
- **2005**: Boiled liver of different dolphin species, offered for sale, has such high mercury levels that it **induces renal toxicity** (Endo *et al*. 2005b).
- **2008**: In striped dolphins, contamination levels for PCB and DDT had not changed significantly during 1978-2003, whereas levels of **PBDE and other brominated substances** significantly increased within that period (Isobe *et al*. 2008).
- **2009**: In sperm whales from the North Pacific, mercury levels of up to 130 µg/g were detected (Yasunaga & Fujise 2009c), which is 325 fold the allowed limit.
- **2009**: Even in baleen whales, liver and kidney of **minke whales from the North Pacific** exceeded the Government's safety limit, peaking at 0.8 µg/g and 1.3 µg/g, respectively. This was also the case for **Bryde's whales**, having maximal levels of 0.49 µg/g in liver and 0.6 µg/g in kidney (Yasunaga & Fujise 2009c).

Can with whalemeat, Japan © EIA

- In 2011, **Baird's beaked whales**, captured off Wada, Chiba, hat levels of 1.42 µg/g, exceeding maximal allowance level by 3.5 times (Hemmi 2012).

Since 2001, the Japanese law demands a correct labelling of seafood. In 2003, however, the Japanese Health Ministry found 10% of "whale" products on sale in Japanese markets to be mislabelled. NGOs even estimate the mislabelling rate to more than one third (EIA 2004; Oceancare 1999). Much of this "whale meat" originates from higher contaminated small cetaceans.

3.1.2. Governmental response to human health risks

Japanese authorities should be especially aware of the risk for mercury poisoning due to the Minamata disaster of the 1950s, when more than 10,000 people were sickened and an estimated 3,000 people killed in the city of Minamata as a consequence of mercury dumped into the sea as industrial waste. But today's reality is different: Although the Government's Health Ministry took some measure to meet the problem, these measures are insufficient and are undermined by the actions of other government departments:

a) Insufficient controls

Whereas national safety limits for contaminants in seafood do exist, a large portion of whale products on sale still significantly exceeds the limits. Scientists criticize that the Japanese Government failed to react to their findings (Endo *et al.* 2002). The scientific findings had been published in scientific journals, but rarely in Japanese media, and hence remained ignored by the broad public for several years.

b) Health advices – late and incomplete

As a consequence of Endo's findings, the Japanese Health Ministry conducted its own investigations on cetacean products from five species and, as a result, in 2003 issued safety guidelines for pregnant women on the consumption of four species as follows: to limit "*Meat of bottlenose dolphin, in 60 to 80 g per serving size, to once per two months or less, and meat of Baird beaked whale, short-finned pilot whale, and sperm whale (muscle meat only), in 60 to 80 g per serving size, to once a week or less*" (JMHLW 2003).

However, other cetacean species on sale in Japan – among them the most intensively hunted Dall's porpoise – were not considered in this advice. Furthermore, the advice was based on a provisional tolerable weekly intake (PTWI) of 3.3 µg/kg and week. Shortly afterwards in 2003, FAO and WHO revised the PTWI from 3.3 to 1.6 µg/kg per week (Endo *et al.* 2005). It took two years before the Japanese officials revised their advice for pregnant women (JMHLW 2005) as follows: "*Meat of bottlenose dolphin: up to 80g per 2 months (10 g/week); Short-finned pilot whale: a max of 80g per 2 weeks (40 g/week); Baird's beaked/sperm whale: up to 80 g/week; Dall's porpoise: up to 160 g/week.*"

Although Dall's porpoises were added in this second advice, **other cetacean species still remained unconsidered**, such as Risso's dolphin and false killer whales, although they also exceed the safety limits for mercury.

c) Dumping prices to push consumption

In Japan, whale products remain luxury goods, with prices of typically 450 yen per 100 g and up to 2,500 yen per 100 g bacon block (Anon. 2006). In 2005, the domestic whale meat stock piles had mounted up to 3,900 tonnes, according to Japan's second biggest newspaper Asahi Shimbun (Anon 2006). Just at that time the Government decided to expand JARPA and JARPN, and stockpiles hence threatened to further expand to 5,500 tonnes. **As a first step the Japanese Government decreased the prices for whale products** (Kher 2006), but national demand did not increase as hoped. In January 2009, retail outlets reduced prices for whale meat to levels of the early 1980s, according to the newspaper Asahi Shimbun (Anon. 2009).

d) Toxic whale meat for schools and hospitals

- To further stimulate domestic consumption, a program was started in early 2005 to introduce whale products as "health food" to schools and hospitals (Head 2005; Anon. 2006; Kher 2006). In 2006, about 3,500 schools all over Japan offered whale dishes (Anon. 2006). In January 2008, the Institute of Cetacean Research supplied 10 tonnes of whale meat to 254 Yokohama schools – a total of 200,000 lunches of whale meat – within a two-day public relation campaign (Anon. 2008). During all these decisions the Government was fully aware of the high contamination burden of whale meat from JARPN II: **During 2002-2007, the Institute for Cetacean Research in every single year detected PCB levels in minke whale blubber exceeding the Japanese safety limit of 0.5 µg/g** (Yasunaga & Fujise 2009b) – with peaks reaching 2.7 µg/g. **Nevertheless, the Government did not flinch from distributing this meat to schools**: Of the yield resulting from JARPA and JARPN in recent years, portions of up to 26% have been allocated for "public purposes", including school lunches. In 2004, the volume for public purposes was more than 1,000 tons, which decreased to 900 tons in 2006 (Anon 2007). In 2011, products from **Baird's beaked whales** were served to school children on the day of the hunt – later analysis showed the mercury level exceeded safety limits by 3.5 times (Hemmi 2012).

e) "Wall of silence" to local resistance

In 2007, local politicians in the town Taiji initiated laboratory analysis of whale products locally on sale. The samples contained mercury levels up to 16 times above advisory levels (ENS 2007). As a consequence, some schools, which before offered whale products two to three times a month (AFP 2007), took pilot whale from the menu and local supermarkets removed it from their fridge shelves. **However, the mayor trivialised the risks, and local media refused to report about the health warnings of Japanese scientists.** This might be explained by the local economic role of dolphin meat, which accounts for about US$ 1 million of the town's annual fishing revenue (Fackler 2008). The two politicians who had initiated and financed the analysis privately, also paid for folders to inform the local citizens about the contamination of cetacean products. Residents bemoaned the "wall of silence" by the authorities (Fackler 2008; ENS 2007). This was the first time local politicians tried to override their government's belittlement on health risks from whale meat. Instead of taking precautionary measures, the mayor of Taiji is planning to build a new US$ 2.85 million dolphin slaughterhouse and to intensify the school lunch program (AFP 2007).

f) Import of contaminated whale products

In deference to concerns of national consumer health organisations, the Japanese Government for several years refused to import contaminated whale meat from the North Atlantic. In November 2008, however, import permits for shipments of whale products from Norway and Iceland were given for the first time (Black 2008) after a delay of five months after the shipment. This change in policy may reflect the increasing political pressure that the whaling nations want to put on the anti-whaling nations within the IWC.

f) Whaling policy to save the "holy cow"

The obstinate pro-whaling campaign of the Japanese Government has a broader background and seems to be a **bulwark for deep-sea fisheries in general** (Nanami 2001): Indeed, a representative of the Japanese Fisheries Agency is cited in the media as saying that "*if the current ban on hunting whales is allowed to become permanent, activists may direct their efforts to restricting other types of fishing*", e.g. the significant tuna fisheries (Head 2005; Nanami 2001).

So far, the Japanese Government has also been ignoring the risks from *Brucella*: Those consumers who eat raw whale products do risk an infection with *Brucella* (CFSPH 2007). Despite the epidemic infection rate in minke whales caught under JARPN (38%; for details see section 2.4), it is astonishing that this whale meat has been processed and packaged for human consumption (Parsons *et al.* 2006). Symptoms of Brucellosis in humans include fever, headaches, chills, depression, weakness, joint and muscle pain, epididymitis and, in the long-term, hepatic disease, colitis, endocarditis, and meningitis.

3.2. Faroe Islands

The citizens of the Faroe Islands have been hunting small cetaceans for more than a thousand years. Pilot whales are the most commonly targeted species (currently about 1,000 per year), but occasionally also Atlantic white-sided dolphins and northern bottlenose whale are hunted. Whale products are distributed among the 45,000 citizens following a traditional system. Whale and fish together constitute an average of 55% of all dinner meals (Barr *et al*. 2003), and on average 12 g whale meat and 7 g blubber are consumed per day and adult person (AMAP 2003). Within the last decade, however, alarming scientific findings have raised the question whether this old habit can still be justified. In autumn 2008, the Faroese health authorities recommended to stop consumption of whale products due to the enormous health risks (Weihe & Joensen 2008).

3.2.1. Health implications from whale products at the Faroe Islands

In the 1980s, Prof. Grandjean and Dr. Weihe started a study at the Faroe Islands, collecting blood samples of a birth cohort of more than 1,000 human mother-child pairs. The scientists found very high mercury and PCB levels in maternal hair, with many of them exceeding the critical limit of 10µg/g, where a risk of neurobehavioral dysfunction in the child may occur (Weihe *et al.* 1996). At the age of seven years the children were tested psychologically and neuropsychologically. The study revealed an **impact on reaction time, attention, verbal memory, language and visuospatial function** (Grandjean *et al.* 2003b; Weihe *et al*. 1996). These results were published in 1997 and led to recommendations by the Faroese public health authorities to pregnant and lactating women, not to consume whale meat and blubber.

A follow-up examination was conducted when the children reached the age of 14 years. It was found that **some neurotoxic effects from intrauterine mercury expo-**

Pilot whale hunt at the Faroe Islands © EIA

sure had not disappeared but are irreversible, and that a subsequent consumption of pilot whale meat exacerbates the symptoms (Weihe 2007; Debes *et al.* 2006; Murata *et al.* 2004). The impact is not limited to neuropsychologic development but includes **differences in heart function** in relation to mercury exposure (Grandjean *et al.* 2004). Maternal exposure to mercury and PCBs during pregnancy and breast feeding **delays the postnatal growth in weight and height** (Grandjean *et al.* 2003a).

A third cohort study (1998-2000) found that Faroese have a significantly **higher risk for Parkinson's disease**, compared to other parts in Denmark and Norway (Wermuth *et al.* 2008, 2000), which is apparently related to the consumption of pilot whale meat and blubber during adult life (Petersen *et al.* 2008a, b).

A fourth cohort study (2000-2001) in adult Faroese found that the risk of **hypertension and arteriosclerosis** is higher in adults, who have an increased mercury exposure. Furthermore, PCB in whale meat is increasing risks for **hypoinsulinemia and type 2 diabetes** (Weihe & Grandjean 2012 and literature herein).

Mercury levels were primarily related to the frequency of whale meat dinners during pregnancy, while the frequency of fish dinners was of much less importance (Petersen *et al.* 2008a; Weihe *et al.* 1996). On average, the daily intake of PCB through whale products and fish has been estimated to be 200 µg (compared to 15-20 µg in Scandinavia), of mercury 36 µg (Weihe *et al.* 1996). Pilot whales contain predominantly the higher chlorinated PCB forms, which are only slowly metabolised and are therefore especially hazardous (Fängström *et al.* 2002).

Recent findings indicate that the consumption of only one pilot whale meal every two weeks is enough to increase the concentrations of poly-fluorinated compounds in Faroese 14-year old teenagers by up to 50% (Weihe *et al.* 2008). Although the impact of PFCs on human health is not yet known, it clearly has an **endocrine disrupting effect and the potential to affect male reproduction** (Jensen & Brunn Poulsen 2008). For further details see also the website "Children's' health and the Environment in the Faroese" (www.chef-project.dk).

3.2.2. Governmental response to human health risks

In August 2008, the alarming findings on health risks for consumers of pilot whale meat reached a dramatic peak: The Faroese Chief Medical Officer and Chief Physician in an open letter recommended to their Government "**that pilot whale is no longer used for human consumption**" (see box) (Weihe & Joensen 2008).

Whereas the Government as a consequence has started its internal consultations whether or not to ban pilot whaling, the website of the Prime Minister's Office in January 2009 still stated "*Contaminant loads in pilot whales are an obvious source of concern, but are no reason to stop whaling*" (FØroya Landsstyri 2009).

Already in 1989 the Faroese public health authorities recommended a maximum of 150-200 g of pilot whale meat and 100-200 g blubber per week, and pregnant women should consume "much less". As a result of the alarming study by Weihe *et al.* (1996), the recommendation for pregnant and lactating women and those plan-

Extract from the open letter of the Faroese Chief Medical Officer and Chief Physician to the Government, dated August 7th 2008:

"…the results have so far shown that mercury from pilot whale meat adversely affects the foetal development of the nervous system:

a) The mercury effect is still detectable during adolescence

b) The mercury from the maternal diet affects the blood pressure of the children

c) The contaminants of the blubber adversely affect the immune system so that children react poorly to immunisations."

and according to newest studies

d) "contaminants in pilot whales appear to increase the risk of developing Parkinson's disease in those who often eat pilot whale

e) The risk of hypertension and arteriosclerosis of the carotid arteries is increased in adults, who have an increased exposure to mercury." …

"...It can therefore be concluded that pilot whales today contain contaminants to a degree that neither meat nor blubber would comply with current limits for acceptable concentrations of toxic contaminants"…

ning to become pregnant was changed to zero for the consumption of whale products. The warning received broad attention and, as a result, consumption of whale products by pregnant women has dropped from 5 g of whale meat and 7 g of blubber in the 1980s to 1 g of whale meat and 0.5 g blubber in 2001 (Weihe 2007). Accordingly, blood samples in 2001 contained only 5% of the mercury level in the 1980s. However, other population groups continued to consume whale products at former levels. With the warning of the health authorities and new alarming findings, this will hopefully change.

3.3. Greenland

In Greenland, both large and small cetaceans are hunted on a large-scale basis: The IWC's approved quota for aboriginal subsistence hunting is presently 19 fin, 200 minke, and two bowhead whales per year in West Greenland and 12 minke whales in East Greenland (IWC 2009a). Additionally, small cetaceans are hunted. Quotas for beluga and narwhals are set by the Greenland authorities and have recently been reduced: Between the mid 1990s and 2000s, the annual harvest of narwhal in Greenland was 683 and for belugas 507 on average (WWF 2005). The present annual harvest in West Greenland is about 165 belugas and 300 narwhals (NAMMCO 2008a). Both quotas are still significantly higher than recommended as sustainable, which is 100 and 135, respectively (NAMMCO 2008b).

The hunt on small cetaceans has a strong commercial aspect: Narwhal tusks are in high demand in Greenland tourist shops and pieces of raw ivory easily reach 170 Euro per kg; trade in narwhal ivory is increasing (WWF 2005). Tusks and carvings are commercially exported, e.g. to Switzerland, Norway, and the USA (WCMC 2009). Furthermore, beluga meat and "*mattak*" are both in high demand, with the latter being considered as a delicacy. The products are sold at local markets or to regional buyers like the "*Greenland Trade*". A single beluga can bring up to 4,300 Canadian Dollars. In some years the estimated value of mattak (from beluga and, to a lesser extent, from narwhal) alone equalled the commercial value of all trade fish products and seal skins (Sejersen 2001).

3.3.1. Health implications from whale products in Greenland

Within the Arctic, Greenlanders have the highest burden

Narwhal meat, supermarket, Ilulissat, Greenland © WSPA

of mercury and of most organochlorines (table 4, Annex). This contamination burden is related mainly to the intake of traditional food such as marine mammals (Johansen *et al.* 2004; AMAP 2003; INAC 2003a). The daily intake of traditional food, including whale products such as narwhal skin and meat, has decreased during the last 30 years, and along with it the contamination burden (Deutch *et al.* 2006). However, recent scientific findings give reason for concern that even these lower levels might still be hazardous to human health:

As in the Faroe Islands, also in a traditional Inuit community in Qaanaaq, Greenland, **neuropsychological deficits, such as delayed reaction time, were related to maternal mercury exposure.** The findings correlated with the frequency of traditional dinners (Weihe *et al.* 2002). In some regions in Greenland blood mercury concentrations in more than 90% of women of child-bearing age still exceeds guideline levels (AMAP 2011). Other studies found an **immune system suppression and an increased risk of infections related to contaminated whale meat** (INAC 2003a). Recently, scientists found indications for a connection between **Parkinson's disease** and exposure to organochlorines in Inuit from Greenland (Koldkjaer *et al.* 2003).

Johansen *et al.* (2004) identified four classes of contaminant levels in traditional food in Greenland: Group 1 (very low concentrations), Group 2 (low to medium), Group 3 (high) and Group 4 (very high concentrations). No whale product was in the lowest contamination group for PCB, CHL, or mercury, but many whale products were in Groups 3 and 4:

- **Mercury**: Group 4 (> 1 µg/g) for liver and kidney of beluga and narwhal; Group 3 (0.1-1.0 µg/g) for muscle and skin of both species, together with minke whale liver and kidney. Group 2 (0.01-0.09 µg/g) for blubber of all three whale species and minke whale skin. For comparison: Products from terrestrial species, such as caribou or hare, and most marine fish were classified in Groups 1 and 2.

- **PCB**: Blubber of beluga, narwhal and minke whale in Group 4 (> 500 ng/g), minke whale skin in Group 3 (50-500 ng/g), muscle, liver and kidney of all three whales and skin of the two small cetaceans in Group 2 (5-49 ng/g). For comparison: No other animals, not even seals, reached Group 4 for PCB, and all products of terrestrial species were in Group 1.
- **CHL**: Blubber of all three whales was assigned to Group 4 (> 100 ng/g); liver, skin and muscle from the small cetaceans and minke whale liver to Group 3 (10 -100 ng/g), and minke whale muscle and kidney to Group 2 (1-9 ng/g). For comparison: Almost all terrestrial species were in Group 1, marine fish (except for halibut liver with very high chlordane concentrations) in 2 and 3.

The results of Johansen *et al*. (2004) clearly demonstrate that traditional food from terrestrial species and almost all marine fish products are much more suitable for human consumption than whales. Accordingly, they recommend avoiding or minimizing the intake of these extraordinarily contaminated dishes. This recommendation has not been implemented.

3.3.2. Governmental response to human health risks

Despite the contamination level of whale products the Greenlandic authorities argue that the positive health and social aspects of traditional food would "*far outweigh any negative health effects of pollutants*" (AMAP

Whale meat in supermarket, Ilulissat, Greenland © WSPA

1997). Still the health authorities undifferentiated encourage the consumption of traditional foods for nutritional and cultural reasons (AMAP 2003). Currently, the position of the authorities is gradually changing: In 2004, the National Environmental Research Institute (NERI) of the Danish Ministry of Environment published a report on "contaminants in traditional Greenland diet" (Johansen *et al*. 2004), in which is stated: "***A way to minimize contaminant intake would be to avoid or limit the consumption of diet items with high contaminant levels***." The report identifies – apart from seals – beluga and narwhal (liver, kidney and blubber) and minke whale (blubber and mattak) as the most important contaminant sources (see section 3.4.). However, until today the authorities have failed to draw adequate consequences by reducing or banning the whale hunts. They have also failed to explicitly brief consumers in Greenland to avoid eating whale products and to choose other traditional food.

3.4. Norway and Iceland

Norway holds a reservation against the moratorium. In 1993, the commercial hunt was resumed, with increasing self-set quotas. By late 2008, more than 8,600 minke whales were killed for commercial purposes (IWC 2009c). No other species are taken. For current quotas see 3.4.2.1.

Iceland's whaling activities since the moratorium can be divided in two phases: From 1986 to 1989, a total of 292 fin and 70 sei whales was killed under "scientific whaling". After a 14-year break, Iceland resumed whaling in 2003. From 2003 to 2007, 200 minke whales were again killed using the loophole of "scientific whaling", while in 2006/2007 both seven fin and minke whales were caught under reservation (IWC 2009b,c). In January 2009, the Fisheries Minister, as his last activity before his retirement, authorised an annual quota for 2009-2013 of 150 fin and 100 minke whales. Although the new government might cancel the quota for 2010-2013, the quota for 2009 is valid.

3.4.1. Health implications from whale products in Norway and Iceland

3.4.1.1. Norway

In Norway, whale meat is not a daily food, but only consumed occasionally. For whale blubber, in which much higher levels of toxic substances are accumulated, there is no domestic market, and therefore it is stored for possible exports to Japan. Despite a high fish consumption rate in Norway, the levels of PCBs, DDT, and CHL in breast milk are generally very low (AMAP 1997). In May 2003, **Norwegian scientists advised pregnant and nursing women not to consume whale meat** (Reuters 2003) due to new findings regarding mercury and PCB:

- In minke whale meat from the whaling season 2002, **mercury levels of up to 0.80µg/g were found in muscle** (Grønvik 2003). Contamination was lowest in whales hunted in the Barents Sea (mean 0.14 µg/g), followed by Spitsbergen (mean 0.25 µg/g) and North Sea (mean 0.28 µg/g), and the highest levels in Jan Mayen (mean 0.34 µg/g). Grønvik also reports that animals caught later in the season showed higher toxic levels.
- According to Hobbs *et al.* (2003) **minke whale blubber from the Barents Sea (up to 11.8 µg/g lw) and the North Sea (up to 14.8 µg/g) had significantly higher concentrations of ΣPCBs** than those of the Vestfjorden/Lofoten (up to 8.07 µg/g), and West Svalbard (up to 5.25 µg/g).
- **ΣDDT concentrations in blubber from minke whales** hunted in Norway (up to 7.77 µg/g lw) were significantly higher compared to animals from West Greenland (up to 3.34 µg/g) and East Greenland (up to 0.68 µg/g).

Whale meat stall, Bergen, Norway © Pro Wildlife

3.4.1.2. Iceland

The Icelanders' diet heavily relies on marine fish; however, the consumption of whale products is much lower than in Greenland and the Faroe Islands. The only traditional dish with whale meat is "*sour whale*", which is occasionally offered at social events (Altherr 2003). In recent years, some upscale restaurants have tried to establish whale dishes on their menu, e.g. as whale sashimi or whale burger with lobster mayonnaise. Furthermore, it was tried to establish whale meat as school lunch (Michaels 2008).

Circumpolar studies have shown that levels of heavy metals and POPs in Icelandic people is marginally higher than in Swedish or Norwegian people and significantly less than in Greenlandic people, where consumption of whale products is much higher (AMAP 2003, 1997). Presently, in Iceland, the consumption of whale products has been (and is still) very low, and therefore so far no health impacts for the population are anticipated – if dietary habits do not change.

3.4.2. Governmental response to human health risks

3.4.2.1. Norway

Norway resumed commercial whaling in 1993 and since then expanded these activities. Although scientists reported alarming concentrations of POPs in blubber of minke whales hunted in Norway (Grønvik 2003; Hobbs *et al.* 2003; Kleivane & Skaare 1998), the Government continued to expand catch quotas and to subsidise whaling, processing and storage of whale products. Furthermore, it promotes the consumption of whale meat. It also aims to export whale blubber to Japan, although even **Norwegian officials from the Food Control Authority cautioned particularly against the high PCB levels in the blubber** (Hobbs *et al.* 2003; Farden 2001).

Several attempts have been made to increase the domestic consumption of whale meat: The government stated that whale meat "*tastes delicious and is very healthy. Recent research indicates that the oil in whale meat and blubber contains substances which have a pre-*

Whale meat recipe, leaflet from supermarket, Iceland

ventive effect on cardiovascular diseases, among others" (Ministry of Fisheries *et al.* 2000). Recipes for whale dishes are promoted by e.g. the High North Alliance, a pro-whaling organisation closely cooperating with the Norwegian Government. Whale meat is sold in supermarkets, at markets and sometimes offered at whale watching tours.

In 2006, the Norwegian Government established its new calculations for "sustainable quotas" (which are not approved by the IWC) and increased its annual quota to 1,052. Since then, however, the number of landed whales has remained significantly behind the new quota and remained at a similar level to the former annual harvest of 600-700 animals. Officially, Norway explains this discrepancy with bad weather conditions, but the low domestic demand for whale products and the so far very limited export options to Japan probably also play a role. Whatever the real reasons are, in 2009 the quota was reduced to 885 specimens.

3.4.2.2. Iceland

The Icelandic Government, while preparing its resumption of whaling in the early 2000s, tried to increase the domestic consumption of whale products by launching a media campaign: Cooking recipes were published, Icelandic politicians ate whale meat in front of the media, and in the press it was claimed that whale meat would be especially "healthy" (Altherr 2003 and references herein). Such promotion was done although the Icelandic Government should have been fully aware of the alarming findings of Norwegian scientists on PCB and DDT contamination in North Atlantic minke whales (see table 4, annex).

The Icelandic government, under pressure from whaling lobbyists, is still trying to revive a taste for whale among young people and hence supports whale meat as school lunches (Michals 2008). On the other hand, in October 2003, the Environment Agency of Iceland recommended for pregnant and nursing women to consume minke whale meat "*not more than twice a week*". A health risk for consumers is considered to be low as the "*principle food source [of Icelandic minke whales] is believed to be krill*". As a conclusion it is said that "*concentrations of contaminants should thus not be high in the minke whale as it is quite low in the food chain*". This position reveals an inconsistency of the Icelandic whaling policy: On one hand it is argued that whaling is needed to conserve commercial fish stocks that would be depleted by whales, on the other hand it is stated that whale meat is healthy because their low trophic status means contaminant levels are low.

3.5. Other regions: Canada, Alaska & Russia

Canada: Only occasionally, Canadian Inuit hunt bowhead whales, with a total of eight animals killed within the period 1985-2008 (Blatchford 2008; IWC 2009a). However, small cetaceans are hunted in large numbers: In 1999, a former quota system for narwhals was replaced by a community-based management. On average, 372 specimens are annually landed in Nunavut (COSEWIC 2004). In December 2008, the hunters from the community of Pond Inlet, Nunavut, killed the exceptionally high number of about 560 narwhals (SIKU News 2008). Narwhals are hunted for their skin, which is regionally sold as maqtaq or muktuk, and for the males' ivory tusks (COSEWIC 2004). The hunt has a strong economic aspect, with the tusks being sold as a whole or as carvings. Depending on quality and length, tusks can achieve prices of up to 7,500 US Dollars (Chichester undated). Tusks are regularly exported to Japan, Switzerland, and before the 1990s many went also to Great Britain (WCMC 2009). The quota for the beluga hunt in Nunavik has been reduced during recent years from 360 (2002), to 135 (in 2006) and 121 (in 2007). However, these quotas were ignored in 2006 and 2007 (SIKU News 2007a,b). In Nunavut, there is currently no management of these whales (Tyrrell 2007), and the annual hunt is presently still more than 300 belugas (FOC 2007).

Alaska: From 1985 to 2007, a total of 1,070 bowhead, nine gray and two minke whales were killed under Aboriginal Subsistence Whaling (IWC 2009a).

Russia: Since the moratorium up until 2007, a total of 2,646 gray whales, 13 bowhead and three minke whales were killed under Aboriginal Subsistence Whaling (IWC 2009a). In Russia, similar to the situation in Greenland, both large and small cetaceans are hunted by native people in Chukotka. In accordance with an IWC-approved quota for aboriginal subsistence whaling, 110-130 gray whales and up to three bowhead whales are annually hunted by Russia (IWC 2009).

3.5.1. Health implications from whale products in Alaska, Canada & Russia

3.5.1.1. Canada

People from northern Canada are among the groups most heavily exposed to PCB, DDT, chlordane and mercury compared to other northern regions. The burden varies in the different territories and is highest among Inuit from the eastern Northwest Territories and Nunavik, and Baffin Island (AMAP 2003). Contamination levels correlate with the dietary preferences in these regions on marine mammals and fatty sea fish (AMAP 2003, 1997). In the Baffin region, for example, marine mammals represent up to 28% of the total energy intake (AMAP 2003). "Muktuk", the skin of belugas and narwhals, is considered to be a delicacy among native Canadian people and belongs to the top five traditional foods most often consumed, e.g. in Baffin (INAC 2003a). 36.1% of men and 32 % of women consumed marine mammal kidney and liver at least once a year (Fontaine *et al.* 2008). The consumption of whale products poses risks to human health:

- Virtually all samples of beluga whales hunted 1981-2002 in the Canadian Arctic contained **mercury levels in liver higher than the Canadian consumption guideline for fish**, i.e. 0.5 µg/g wet weight (see table 1, Annex). Even more alarming is that mercury levels have clearly increased over the sampling period (Lockhardt *et al.* 2005). The consumption guidelines were also exceeded for muktuk from narwhal (Wagemann & Kozlowska 2005).
- In Nunavut, mercury levels in some communities (e.g. Igloolik and Repulse Bay) partially exceed the Health Canada level of minimal concern. A significant correlation between mercury exposure and traditional food intake was verified in the two communities (INAC 2007).
- **Mercury and PCB levels in humans were similar to those found in the Faroe Islands** (Muckle *et al.* 2001b). Mercury concentration was higher in blood of Inuit from the Hudson Bay, where significantly more marine mammals are consumed, compared to Ungava Bay (Fontaine *et al.* 2008).
- **Levels of Chlordane-metabolites in Inuit maternal/cord blood are 6-12 times higher than in mothers of other ethnic background** (Butler Walker *et al.* 2006; INAC 2003a). Inuit mothers from Baffin region showed the highest HCL levels (0.58 µg/l on average, with maxima of 2.4 µg/l), followed by Kivalliq (0.36 µg/l), Nunavik (0.30 µg/l) and Kitikmeot (0.29 µg/l). Similar patterns have also been found for other contaminants.
- **73% of the Inuit mothers from Baffin region, 59% from both Kivalliq and Nunavik, and 41% from Kitikmeot (Nunavut) showed PCB blood levels that exceed the Health Canada level of concern of 5 µg/l** (INAC 2003a).
- Results from a Nunavik cohort study indicate subtle health impact in infants at 11 months of age. Prenatal exposure to **PCB had effects on birth weight, duration of pregnancy and visual memory**. Prenatal exposure to mercury reduced the infants' memory ability (INAC 2003a).
- According to studies in the Northwest Territories, Nunavut and Nunavik the **maternal blood of Inuit women (especially from Baffin and Nunavik) contains significantly higher mercury concentrations than other northern women**. Levels were highest in Nunavik (10.4 µg/l), followed by Baffin (6.7 µg/l), Kivalliq (3.7 µg/l), Kitikmeot (3.4 µg/l) and Inuvik (2.1 µg/l) – whereas in Caucasian women, mercury content was only 0.9 µg/l (INAC 2003a).
- In Nunavut, 59% of pre-school children have mercury-intakes that exceed acceptable safety limits for children (AMAP 2011).
- Studies of infant development in Nunavik have linked **deficits in immune function, an increase in childhood respiratory infections and an impact on birth weight** with prenatal exposure to organic chlorines (Van Oostdam *et al*. 2005).

Male narwhal with hunter, Canada © K. Finley CMEPS

A broad-scale health survey in 2004 showed a 32% decrease of mercury concentration compared to another study in 1992. This decrease was attributed by dietary changes: The mean intake of marine mammals had been reduced from 28.7 to 17.5 g/day – a decrease of 40% (Fontaine *et al.* 2008).

Despite widespread knowledge about the burden of mercury and PCBs in traditional food, many Inuit women in Nunavik increase their consumption of marine mammals during pregnancy – partially because of the belief that this food would be beneficial during pregnancy (Muckle *et al*. 2001a). The most frequently consumed marine mammal food is beluga blubber and muktuk, followed by seal meat, fat, and liver and beluga meat. **The consumption of these food items is still recommended in local media by Inuit midwives.** However, a change is on the horizon as younger Inuit pregnant women consume less beluga products (Muckle *et al.* 2001a).

In belugas and narwhals from Nunavut, Nunavik and Hudson Bay, ***Brucella*** infections have been detected, with an epidemic infection of up to 35.7% (Nielsen *et al.* 2001). As in Inuit diet whale products are often consumed raw, and the pathogen is still infective. However, data on related health risks for humans are not available.

3.5.1.2. Alaska

Considering the contamination level of blubber and liver of bowhead whales (table 2, Annex) and the recommended safe limits for daily intake, O'Hara *et al*. (1999) concluded a **restrictive daily intake of maximally 47 g of blubber to be safe for the Inuit diet**. This low amount is due to the comparatively high levels of chlordane, while for other toxic substances the daily intake could be higher. In contrast, mercury levels in bowhead whales from Alaska are considered to be low and of no concern (O'Hara *et al*. 2004).

According to the US EPA's monthly fish consumption limits for methylmercury, products with more than 1.9 µg/g methylmercury should not be consumed at all (UNEP 2002). Accordingly, some gray whale products from Alaskan hunts should not be consumed, having mercury levels in kidney and liver of 2.3 and 4.4 µg/g, respectively (Varanasi *et al*. 1993; see table 2, Annex).

3.5.1.3. Russia

Gray whales in the Russian subsistence hunt in the Bering Sea have **such high chlordane levels in blubber that a restrictive consumption rate of maximally 23 g/day was recommended**. PCB concentrations in blubber reach up to 0.68 and DDT up to 0.54 µg/g ww (Rowles & Ilyashenko 2007; Krahn *et al*. 2000). Unfortunately, from the Chuckchi region no recent contamination data for mercury, PCB, DDT and chlordane in human blood are available.

Up to 10% of the gray whales killed in aboriginal whaling in Chukotka are so-called "**stinky whales**", a phenomenon involving inedible whales with still unclear cause. Environmental pollution is being discussed as one potential explanation. Aboriginals have reported about the problem since 1998, but older hunters apparently recognized the problem 30 years earlier. Consumption of the meat can cause temporary problems like oral numbness, skin rashes, and/or stomach pain (Rowles & Ilyashenko 2007). There is some concern that a yet unidentified biotoxin might be involved and therefore toxicologists warn to not consume the meat of stinky whales (Ilyashenko 2007).

3.5.2. Governmental response to human health risks

3.5.2.1. Canada

Already in 1985, as a reaction to several alarming scientific publications, the Canadian authorities established a working group on contaminants in native diets. High levels of toxins, such as chlordane, DDT, PCB and mercury, were found in marine mammals, including narwhal and beluga (INAC 1989). Nevertheless, so far no regulatory guideline for contaminants in marine mammals were defined, but only in fish, i.e. 0.5 µg/g wet weight (Lockhardt *et al.* 2005).

In 1991, the Canadian government launched the Northern Contaminants Program (NCP), which continues to date (INAC 2007, 2003; AMAP 1997). Between 1991 and 1996, the NCP focused on assessing contaminants and at which levels and where they were found. From 1998 to 2003, the focus shifted to health risk aspects (INAC 2007). Several detailed reports were published by the Canadian government since then (e.g. INAC 2003a, 2003b).

The Canadian government is well aware of the "*large and complex public, moral and political dilemma what to recommend*" (INAC 2003a). Almost all beluga samples in Canadian Arctic hunts contained contaminants above the government's guidelines (Lockhardt *et al.* 2005). Since the mid-1990s, women of reproductive age were told to consume less beluga whale and other contaminated traditional food (AMAP 1997). For other consumer groups, the government's recommendation is still to continue eating traditional food. And this position is hold until today: In 2011, new results of a cohort study involving 300 children from all 14 Nunavik communities were published. The study **associated mercury exposure from beluga meat consumption with "*poor intellectual function and attention in school*".** However, the resulting advise was still just to "*decrease their intake of beluga meat*" (Nunavik Regional Board of Health and Social Services (2011).

The Indian and Northern Affairs Canada (INAC, undated) stresses that "*meat, kidney and liver have less PCBs and pesticides than blubber*", but ignores the fact that beluga liver, followed by kidney and muscle, contains the highest mercury levels (Lockhardt *et al.* 2005), clearly above its own guidelines. The Government instead argues that **"eating *[of beluga] helps keep people connected with the land and their cultures*" and that "*hunting for belugas helps keep people fit and healthy*"** (INAC undated). This position shows that socio-political aspects are ranked higher than health concerns – a policy that increasingly becomes negligent considering the available scientific data.

The most recent example: In December 2008, 516 narwhals which had been trapped in ice in the Pond Inlet area, were shot with backing by the authorities, and meat and skin were distributed throughout Nunavut. Despite the known high levels of PCB, DDT and CHL in narwhal products from Nunavut (see table 1, Annex), the senior administrative officer of Pond Inlet then stated to the media: "*A lot of kids who are (usually) eating chips and drinking pop are eating healthy. It's a lot better than craving Chiclets and gummi bears*" (SIKU News 2008) – as if those items would be the only alternative. This actual example shows the extent to which the health risks of contaminated whale products are still ignored even by officials.

Despite the known risks for Inuit consuming cetacean products, the government's website states: "*Health Canada has determined that Canadians are not exposed to PCBs in foods at levels that pose a health risk and that there is no need for specific advice regarding fish consumption and PCB exposure*" (Health Canada 2002).

The pathogen ***Brucella*** (for details see 2.4) has been found in several Arctic cetacean species, including beluga and narwhal (Nielsen *et al*. 2001). Also other viral and bacterial pathogens were detected, including herpes and influenza A. **In Inuit diet, whale meat is mostly consumed raw, yet it undergoes no formal governmental inspection or certification** (Nielsen *et al*. 2004). Accordingly, there is an increasing concern about *Brucella* infection risks for consumers.

3.5.2.2. Alaska

Since 1999, the hunting quota for beluga in Alaska has been set to a maximum of two individuals per year for conservation reasons (US NMFS 2008).

3.5.2.3. Russia

At the IWC, Russia is encouraging discussions to find a solution for the "stinky whale" problem. However, no information is available on government advice regarding the consumption of whale products.

4. Health concerns on the IWC Agenda

The IWC's involvement in the issue of contamination in cetaceans started in 1981, when a resolution was passed noting the potential threats to whales (particularly sperm whales) caused by heavy metals, PCBs and other organochlorines (Res. 1981-App.7). This resolution called upon governments to start research on this matter and the subject remained on the agenda. In 1985, a working group was established to consider, inter alia, chemical pollution. However, these efforts showed little concrete results and did not consider human health aspects. Only in the late 1990s and early 2000s, scientific publications (such as Simmonds *et al*. 2000; Haraguchi *et al*. 2000; Kleivane & Skaare 1998) and several reports from NGOs (Hassauer *et al*. 2002; Hanly 1997) brought the issue into the focus of the IWC parties. A legal analysis by Prof. Wold (2000) underlined the competence of the IWC for the human health aspect, as some IWC parties had previously stated that this would be beyond the IWC's competence. All these findings, combined with a range of other environmental concerns, led to the establishment of regular "*State of the Cetacean Environment Reports*" (SOCER) starting in 2000. This situation also led to several resolutions recognising the health risks from consumption of contaminated whale products:

- **IWC-Res. 1998-11** ("IWC concern about human health effects from the consumption of cetaceans") invites governments to provide relevant information.
- **IWC-Res. 1999-4** on health effects from the consumption of cetaceans calls on the producing countries to take measures to reduce the pollution and to governments and other organisations to further provide data concerning contaminations in cetaceans to the Scientific Committee.

Dolphin drive fishery, Japan © EIA

- **IWC-Res. 2000-6** on POPs and heavy metals urges IWC parties to sign and ratify two protocols on international actions on POPs and heavy metals under the *Convention on Long Range Transboundary Air Pollution* (LRTAP).

Whale meat stall, market, Bergen, Norway © Pro Wildlife

- **IWC-Res. 2001-5** on commercial whaling expresses the IWC's concern on the reportedly high levels of contaminants in blubber from minke whales hunted in Norway. The resolution also requests that the Norwegian government refrain from issuing export permits for whale products.
- **IWC-Res. 2001-13** on small cetaceans recalls the recommendations of the Scientific Committee that range states continue studies to, inter alia, conduct contamination analysis and health assessments and provide relevant scientific data to the SC.

Since then, the IWC's attention was occupied by the controversial debates on the *Revised Management Scheme* (RMS) and the development of potential compromises between whaling and non-whaling nations. **The increasingly crucial discussion on human health aspects fell behind, but should urgently be resumed.**

5 . Recommendations

5.1. Recommendations to the IWC

In the 1990s and early 2000s, the IWC has been increasingly engaged in the issue of health risks for both cetaceans and human consumers due to toxic substances. Since the mid-2000s, however, this important agenda item was neglected while the further development of the RMS and the increasing abuse of ICRW loopholes by some whaling nations came into the focus of the debates. Nonetheless, the recent scientific findings and alarming developments regarding health risks from consumption of whale meat call for a resumption of this vital discussion. In the recent past, some whaling nations have been preparing the expansion of their activities despite the health risks for the consumers in their own countries.

For example, in Japan, a large-scale distribution of cetacean products to lunchrooms of schools and hospitals has been launched to reduce rising stock piles of whale products (see 3.1.2.). These stockpiles resulted from the politically-motivated expansion of the *Japanese Whale Research Program under Special Permit in the Antarctic* (JARPA) and *Japanese Whale Research Program under Special Permit in the western North Pacific* (JARPN).

Despite international criticism of the unsustainable hunting of small cetaceans, **Greenland** is sticking to the present quotas and is apparently trying to use small cetaceans as a subject for negotiations to achieve increased quotas for humpback whales. This tactic was evident at IWC 59 and 60. ⇨ Accordingly, **the IWC Parties should carefully analyse proposals by Greenland for an expansion of quota and should insist on detailed information on the real demand of aboriginal people.**

Iceland and Norway are attempting to artificially stimulate the low national consumption of whale products by advertisements, distribution of cooking recipes or image campaigns that whale products would be a healthy and stylish food. ⇨ **The IWC Parties should call on these countries to halt their whaling activities.**

All these politically motivated measures ignore the potential health impact on people. Whale products, especially in contaminated waters and from high trophic species, are definitely a health risk for consumers. There are healthier alternatives – not only in remote Arctic areas, but even more in industrial nations.

⇨ **The IWC Parties should pass Resolution IWC/64/13, which highlights the scientific warnings and calls on whaling nations to responsibly inform consumers about associated health risks.**

The IWC as the leading body to manage whales and to regulate whaling can no longer sit on the fence and ignore the alarm calls of scientists worldwide. The IWC should therefore intensify its considerations regarding the exposure of cetaceans to toxic substances and the potential health risks for consumers. ⇨ **The IWC is urged to cooperate in this issue with the WHO.** Furthermore, whaling nations should be encouraged to develop dietary alternatives and to critically reflect on whether their whaling interests are still legitimate.

5.2. Recommendations to consumer protection organisations

For centuries Arctic people had heavily relied on whale products and other marine food. Since the alarming facts about contaminant levels have become widely known, the difficult balance between benefits and risk has become the "*Arctic dilemma*". **However, even in remote areas it is possible to compose a diet in which the benefits outweigh the risks, i.e. by reducing the most contaminated food items,** such as whale products, and preferring less risky food, such as from terrestrial animals and plants (Deutch *et al.* 2006; Johansen *et al.* 2004).

In May 2007, the International Conference on Foetal Programming and Developmental Toxicity was held in Torshavn, Faroe Island – a place that has become symbolic for this issue due to the long-term studies by the Faroese health authorities and their alarming findings (see section 3.3). In a joint statement the conference participants emphasized that prevention of harm is the central challenge, especially when taking into account the "*susceptibility of early development and the long-term implications of adverse programming in a variety of organ systems*", including brain and nervous, immune and cardiac systems. A variety of substances that are hardly toxic in adult organisms are nevertheless hazardous to the growing foetus (Grandjean *et al*. 2007). As a consequence of the ongoing alarming findings in the Faroe Islands, the health authorities there called on their government in August 2008 that pilot whale meat should no longer be consumed at all – even though without success. In other geographic regions, however, whale products are similarly contaminated and consumption should also be stopped, especially in regions where nutritional alternatives are sufficiently available.

Almost without exception, organochlorine levels are lower in the terrestrial environment than the marine environment due to higher trophic levels and the higher fat content in marine mammals and large fish (AMAP 2003).

Accordingly, for native people in Arctic regions that heavily rely on traditional foods, a reduction of marine mammals in their diet is urgently recommended, while an increased consumption of terrestrial traditional food would reduce the risk of contamination.

For citizens in other regions, e.g. the western North Pacific, for whom sufficient dietary alternatives are available, the consumption of whale products should be generally put into question.

Japan: Consumer protection organisations in Japan should call on their government **to immediately halt the distribution of cetacean products to schools and hospitals**. Due to the high contamination levels that have been found in whale products on Japanese markets, **it is highly irresponsible to feed the weakest and most fragile members of their society with such items**. As a second step, the public in Japan should receive advice to not consume whale products as the toxic burden might seriously impact their health.

Denmark: Consumer protection organisations should launch awareness campaigns in Greenland while cooperating with representatives of the native people there. The results of Johansen *et al*. (2004) clearly underline the high contamination burden of marine mammals eaten in **Greenland**, compared to terrestrial traditional food and most fish species. Traditional food as a whole need not be questioned, but an effort should be made to clearly discriminate the different risk potentials of the different traditional foods and **to encourage native people to rely on food components that are less contaminated**. In the **Faroe Islands**, the responsible authorities should be urged to draw their consequences from the warnings of their own health authorities and **to stop the hunting of pilot whales and other small cetaceans**.

Canada: The results of Johansen *et al*. (2004) from Greenland are transferable to the situation of Canadian Inuit. Their findings clearly underline the high contamination burden of marine mammals compared to terrestrial traditional food and most fish species. As a consequence, native people should be encouraged by Canadian consumer protection organisations **to critically scrutinize their current dietary habits** and to reduce the consumption of marine mammals in favour of less contaminated fish and terrestrial food sources.

USA: Consumer protection organisations should cooperate with representatives of the native people and launch awareness campaigns in Alaska. The results of Johansen *et al.* (2004) from Greenland are transferable to the situation of Alaska's Inuit. Accordingly, whalers should be encouraged to critically scrutinize their current dietary habits and **to reduce the consumption of marine mammals in favour of fish and terrestrial food sources**.

5.3. Recommendations to the WHO

The World Health Organisation is the central body for health risk assessments and corresponding advice for consumers. In response to the recent scientific findings on toxic burden of cetacean products the WHO should:

- establish a commission, which should conduct **in depth reviews and give precautionary and updated WHO advice for consumers**. This pertains especially to the recent findings for mercury, PCB, DDT and Chlordane, but also to the so far hardly considered components such as PBDEs, short-chained chlorinated paraffins and fluorinated compounds;
- **call on whaling nations to inform their citizens on the risks of cetacean products**;
- **closely cooperate with the IWC on this issue**;
- make relevant scientific publications on health risks from cetacean products available on its website.

6 .References

AFP (2007): Japanese lawmaker calls for dolphin meat ban. News dated 3rd September.

Altherr, S. (2003): *Iceland's whaling comeback – Preparations for the resumption of whaling*. Pro Wildlife, WDCS & HSUS (eds.). www.prowildlife.de/en/Iceland-report-english.pdf.

AMAP (2011): AMAP Assessment 2011: Mercury in the Arctic. Arctic Monitoring and Assessment Programme Oslo, Norway.

AMAP (2011): Arctic Pollution 2011. Oslo, Norway.

AMAP (2003): AMAP Assessment 2002: Human Health in the Arctic. Oslo.

AMAP (1997): Arctic Pollution Issues: A state of the Arctic Environment Report. Oslo.

Anon. (2009): Whale meat on sale at half price. Article in *Asahi Shimbun* of 28th January.

Anon. (2008): School kids urged to eat whale meat. Article in *Herald Sun*, Australia, dated 28th February.

Anon. (2007): Whale consumption still driven by private demand. Blog news 12th June http://david-in-tokyo.blogspot.com

Anon. (2006): Whale meat abundance – Fisheries Agency in all outmarket efforts, but prices high. *Asahi Shimbun,* 10 Sep.

Aono, S. *et al.* (1997): Persistent organochlorines in minke whales (*Balaenoptera acutorostrata*) and their prey species from the Antarctic and the North Pacific. *Environmental Pollution* 98: 81-89.

Barr, D. *et al.* (2003): PCBs and organochlorine pesticide concentrations in a Faroe Island 14-year old cohort: Measurement using new methodology and evaluation of correlations and patterns. *Organohalogen Comp* 63: 385-8.

Beineke, A. (2003): Untersuchung des möglichen Einflusses von Umweltchemikalien auf die lymphatischen Organe von Schweinswalen aus der Nord- und Ostsee sowie dem Atlantik unter besonderer Berücksichtigung der Zytokin-Expression. Dissertation. http://geb.uni-giessen.de/geb/frontdoor.php?source_opus=1341.

Black, R. (2008): Japan sells Icelandic whale meat. *BBC news* dated 5th December.

Blatchford, A. (2008): Nunavik hunters land bowhead whale in Hudson Strait. Canoe News of August 15th. http://cnews.canoe.ca/CNEWS/Canada/2008/08/15/pf-6465531.html.

Borrell, A. (1993): PCB and DDT in blubber of cetaceans from the northeastern North Atlantic. *Mar Pollut Bull* 26: 146-151.

Bossi, R. *et al.* (2005): Preliminary screening of perfluorooctane sulfonate (PFOS) and other fluorochemicals in fish, birds and marine mammals from Greenland and the Faroe Islands. *Environ Pollut* 136(2): 323-9.

Bowles, D. (1999): An overview of the concentrations and effects of metals in cetacean species. *J. Cetacean Res. Manage* (Special Issue 1: Chemical Pollutants & Cetaceans): 125-148.

Butler Walker, B. *et al.* (2006): Maternal and umbilical cord blood levels of mercury, lead, cadmium, and essential trace elements in Arctic Canada. *Environ Res* 100(3): 295-318.

CFSPH (2007): Brucellosis in marine mammals. Center for Food Security & Public Health. www.cfsph.iastate.edu/Factsheets/pdfs/brucellosis_marine.pdf.

Chichester (undated): online price list for narwhal tusks. www.chichestercanada.com/NarwhalTusks.htm. Viewed at Feb 3rd 2009.

Das, K. *et al.* (2003): Heavy metals in marine mammals. In: Toxicology *of marine mammals*. Vos, J. *et al.* (eds.). Taylor & Francis, London, New York

Debes, F. *et al.* (2006): Impact of prenatal methylmercury exposure on neurobehavioral function at age 14 years. *Neurotox Teratol* 28(3): 363–375.

De Guise, S. *et al.* (1995): Possible mechanisms of action of environmental contaminants on St. Lawrence beluga whales (*Delphinapterus leucas*). *Environ Health Perspect Suppl* Volume 103 (S4): 73-77.

Deutch, B. *et al.* (2006): Dietary composition and contaminants in North Greenland, in the 1970s and 2004. *Sci Total Environ* 370(2-3): 372-381.

EIA (2008): Poisonous policies – Japan's failure to stop the sale of polluted whale, dolphin and porpoise products. Environmental Investigation Agency (ed.), London, Washington.

EIA (2005): Japan's Dall's porpoise hunt: A quarter of a century as the largest cetacean kills in the world. Briefing. www.eia-international.org/files/news276-1.pdf

EIA (2004): Global chemical pollution and the hunting of whales, dolphins and porpoises. Briefing, London.

Endo, T. *et al.* (2005a): Total mercury, methyl mercury, and selenium levels in the red meat of small cetaceans sold for human consumption in Japan. *Environ Sci Technol* 39(15): 5703-5708.

Endo, T. *et al.* (2005b): Distribution and toxicity of mercury in rats after oral administration of mercury-contaminated whale red meat marketed for human consumption. *Chemosphere* 61: 1069-1073.

Endo, T. *et al.* (2004): Contamination by mercury and cadmium in the cetacean products from Japanese market. *Chemosphere* 54: 1653-1662.

Endo, T. *et al.* (2003a): Mercury contamination in the red meat of whales and dolphins marketed for human consumption in Japan. *Environ Sci Technol* 37 (12): 2681–2685.

Endo, T. *et al.* (2002): Mercury and selenium concentrations in the internal organs of toothed whales and dolphins marketed for human consumption in Japan. *Sci Total Environ* 300: 15-22.

Environment Agency of Iceland (2003): Report on consumption by pregnant women and nursing mothers of the meat of the minke whale and other seafood. http://ust.is/media/fraedsluefni/hrefnukjot_ofl_f_barnshafandi-a_ensku.doc.

Fackler, M. (2008): Mercury taint divides a Japanese whaling town. Article in *New York Times* of 21st February.

Fängström, B. *et al.* (2005): A retrospective study of PBDEs and PCBs in human milk from the Faroe Islands. *Environ Health: A Global Access Science Source* 4: 12-20.

Fängström, B. *et al.* (2002): Hydroxylated PCB Metabolites and PCBs in Serum from Pregnant Faroese Women. *Environ Health Persp* 110: 895-899.

Farden, K. (2001): cited in the *BBC article* of 24th January "Japan warned on contaminated blubber".

Fischer, C. *et al.* (2008): Neonatal co-exposure to low doses of an ortho-PCB (PCB 153) and methyl mercury exacerbate defective developmental neurobehaviour in mice. *Toxicology* 244:

157-165.

FOC (2007a): Potential impacts of an increased harvest of beluga whale in the Nottingham and Salisbury Islands areas. Fisheries and Oceans Canada. Canadian Science Advisory Secretariat, *Science Response* 2007/017.

Jensen, A. & Brunn Poulsen, P. (2008): Survey and environmental health assessment of fluorinated substances in impregnated consumer products and impregnating agents. Survey of chemical substances in consumer products, No. 99; Danish Ministry of Environment (ed.). www2.mst.dk/udgiv/publications /2008/978-87-7052-845-0/pdf/978-87-7052-846-7.pdf.

Føroya Landsstyri (2009): Whales and whaling in the Faroe Islands - Whales and the marine environment. Available at www.whaling.fo/whalesthemarine.htm, viewed 9th January.

Fontaine, J. *et al.* (2008): Re-evaluation of blood mercury, lead and cadmium concentrations in the Inuit population of Nunavik (Québec): a cross-sectional study. *Environ Health* 7: 25.

Goerke, H. *et al.* (2004): Increasing levels and biomagnification of persistent organic pollutants (POPs) in Antarctic biota. *Mar Poll Bull* 48(3-4): 295-302.

Grandjean, P. *et al.* (2007): The Faroes Statement: Human Health Effects of Developmental Exposure to Chemicals in Our Environment. *Basic & Clinical Pharmacol Toxicol* 102: 73–75.

Grandjean, P. *et al.* (2004): Cardiac autonomic activity in methylmercury neurotoxicity: 14-year follow-up of a Faroese birth control. *J Pediatr* 144(2): 169-176.

Grandjean, P. *et al.* (2003a): Attenuated growth of breast-fed children exposed to increased concentrations of methylmercury and PCBs. *FASEB Journal* 17(6): 699-701.

Grandjean, P. *et al.* (2003b): Neurotoxic risk caused by stable and variable exposure to methylmercury from seafood. *Ambul Pediatr* 3: 18-23.

Grønvik, S. (2003): Norway. Progress report on cetacean research, January 2002 to December 2002, with statistical data for the calendar year 2002. SC/55/ProgRepNorway, presented at IWC 53.

Hanly, K. (1997): *Polar exposure: Environmental threats to Arctic marine life and communities*. Swiss Coalition for the Protection of Whales & Global Survival Network (eds.), Wädenswil, Switzerland.

Harada, M. (1995). Minamata disease: methylmercury poisoning in Japan caused by environmental pollution. *Crit Rev Toxicol* 25(1):1-24.

Haraguchi, K. *et al*. (2000): Contamination Survey of Heavy Metals and Organochlorine Compounds in Cetacean Products Purchased in Japan. *J Food Hyg Soc Jap* 41(4): 287-296.

Hassauer, M. *et al.* (2002): Wale: vergiftet und verkauft - Evaluierung von Umweltgiften in Fleisch- und Fettgewebe von Minkewalen. Greenpeace Germany (ed.).www.greenpeace.de/fileadmin/gpd/user_upload/themen/meere/greenpeace_wale_vergiftet.pdf.

Head, J. (2005): Japan pushes whale meat retrieval. *BBC News*, Tokyo, June 19th.

Health Canada (2002): Fish and seafood survey 2002. Background. Available at www.hc-sc.gc.ca/fn-an/surveill/other-autre/fish-poisson/index-eng.php.

Hernández-Mora, G. *et al.* (2008): Neurobrucellosis in Stranded Dolphins, Costa Rica. *Emerging Infectious Diseases* 14(9): 1430-1433.

Hobbs, K. *et al.* (2003): Levels and patterns of persistent organochlorines in minke whale (*Balaenoptera acutorostrata*) stocks from the North Atlantic and European Arctic. *Environ Pollut* 121(2): 239-252.

Hoekstra, P. *et al.* (2003): Trophic transfer of persistent organochlorine contaminants (OCs) within an Arctic marine food web from the southern Beaufort-Chukchi Seas. *Environ Poll* 124: 509-522.

Hoydal, K. & Dam, M. (2005): AMAP Faroe Islands heavy metals and POP core programme 2004. Food, Veterinary and Environmental Agency, Faroe Islands. www.hfs.fo/pls/portal/docs/PAGE/HFS/WWW_HFS_FO/UMSITING/KUNNANDITILFAR/ KUNNANDITILFARRITG/AMAP%202004-2005%20150%20DPI.PDF.

INAC (2007): *Northern Contaminants Program: Summary of 2004 -2005 results and 2005-2006 projects*. Ottawa.

INAC (2003a): *Human Health. Canadian Arctic Contaminants Assessment Report II.* Northern Contaminants Program. Ottawa.

INAC (2003b): *Contaminant levels, trends and effects in the biological environment.* Canadian Arctic Contaminants Assessment Report II. Northern Contaminants Program. Ottawa.

INAC (2003c): *Sources, occurrences, trends, and pathways in the physical environment.* Canadian Arctic Contaminants Assessment Report II. Northern Contaminants Program. Ottawa.

INAC (2003d): *Knowledge in action*. Canadian Arctic Contaminants Assessment Report II. Northern Contaminants Program. Ottawa.

INAC (2003e): *Highlights*. Canadian Arctic Contaminants Assessment Report II. Northern Contaminants Program. Ottawa.

INAC (1989): *Contaminants in northern ecosystems and native diets*. Summary of an evaluation meeting, Ottawa, Feb 28 to March 2.

INAC (undated): Northwest Territories contaminants fact sheet Beluga Whale. Available at nwt-tno.inac-ainc.gc.ca/card/pdf/eng/Northern%20Contaminants%20program/english/Beluga_e.pdf.

Ilyashenko, V. *et al.* (2007): Considerations of Management Implications of "Stinky" Gray Whales for the Eastern North Pacific Stock. IWC/59/ASW 7.

Isobe, T. *et al*. (2008): Organohalogene contaminants in striped dolphins (*Stenella coeruleoalba*) from Japan: Present contamination status, body distribution and temporal trends (1978–2003). *Mar Poll Bull*, in press.

IWC (2009a): Catch limits for aboriginal subsistence whaling. www.iwcoffice.org/conservation/catches.htm#aborig.

IWC (2009b): Special permit catches since 1985. Available at: www.iwcoffice.org/conservation/catches.htm#aborig.

IWC (2009c): Catches under objection since 1985. Available at: www.iwcoffice.org/conservation/catches.htm#aborig.

IWC (2009d): Information on scientific permits, review procedure guidelines and current permits in effect. www.iwcoffice.org/conservation/permits.htm.

IWC (2009e): Information on scientific permits, review procedure guidelines and current permits in effect. www.iwcoffice.org/conservation/permits.htm; viewed 28th April.

JMHLW (2005): Advice for pregnant women on fish consumption and mercury. Dated 2nd November. Available at www.mhlw.go.jp/topics/bukyoku/iyaku/syoku-anzen/suigin/dl/051102-1en.pdf.

JMHLW (2003): Advice for pregnant women on fish consumption concerning mercury contamination. 3rd June. www.mhlw.go.jp/english/wp/other/councils/mercury/index.html.

Johansen, P. *et al.* (2004): Contaminants in the traditional Greenland diet. National Environmental Research Institute Denmark (ed.). 74 pp –NERI Technical Report No. 492. http://technical-reports.dmu.dk

Kher, U. (2006): Whale on the plate. *Time*, April 17th.

Kleivane, L. & Skaare, J. (1998): Organochlorine contaminants in northeast Atlantic minke whales. *Environ Pollut* 101: 231-239.

Koldkjaer, O. *et al.* (2003): Parkinson's disease among Inuit in Greenland: organochlorines as risk factors. *Int J Circumpolar Health* 63, Suppl. 2: 366-368.

Krahn, M. *et al.* (2001): Organochlorine contaminant concentrations and lipid profiles in eastern North Pacific gray whales (*Eschrichtius robustus*). *J. Cetacean Res Manage* 3(1): 19-29.

Krahn, M. *et al.* (2000): Environmental assessment of eastern North Pacific gray whales (*Eschrichtius robustus*): Lipid and organochlorine contaminant profiles. IWC SC/52/E1.

Krahn, M. *et al.* (1999): White whales (*Delphinapterus leucas*) from three Alaskan stocks: Concentrations and patterns from persistent organochlorine contaminants in blubber. *J. Cetacean Res Manage* 1(3): 239-249.

Lindström, G. *et al.* (1999): Identification of 19 polybrominated diphenyl ethers (PBDEs) in long-finned pilot whale from the Atlantic. *Arch Environ Contam Toxicol* 36: 355-363.

Lockhart, W. *et al.* (2005): Concentrations of mercury in tissues of beluga whales (Delphinapterus leucas) from several communities in the Canadian Arctic from 1981 to 2002. *Sci Total Environ* 351-352: 391-412.

Mahaffey, K. & Rice, G. (1997): Mercury Study Report to the Congress. Vol. IV: An assessment of exposure to mercury in the United States. US Environmental Protection Agency. December

McDonald, W. *et al*. (2006): Characterization of a Brucella sp. strain as a marine-mammal type despite isolation from a patient with spinal osteomyelitis in New Zealand. *J Clin Microbiol* 44(12): 4363-4370.

Ministry of Fisheries, Ministry of Foreign Affairs and the North Atlantic Marine Mammal Commission (2000): Facts about whales in Norwegian waters. www.regjeringen.no/nb/dep/fkd/dok/veiledninger_og_brosjyrer/2000/Facts-about-whales-in-Norwegian-waters.html?id=419222, viewed Feb 23th.

Muckle, G. *et al.* (2001a): Determinants of Polychlorinated Biphenyls and Methylmercury Exposure in Inuit Women of Childbearing Age. *Environ Health Perspect* 109 (9): 957-963.

Muckle, G. *et al.* (2001b): Prenatal exposure of the northern Quebec Inuit infants to environmental contaminants. *Environ Health Perspect* 109(12): 1291-9.

Murata, K. *et al.* (2004): Delayed brainstem auditory evoked potential latencies in 14-year-old children exposed to methylmercury. *J Pediatr* 144(2): 177-83.

NAMMCO (2008a): Scientific Committee, Report of the 15th meeting, Qeqertarsuaq, Greenland, 11-14 April 2008. www.nammco.no/webcronize/images/Nammco/922.pdf.

NAMMCO (2008b): Statement to the 15th ASCOBANS Advisory Committee Meeting, Doc. AC15/Doc.33.

Nanami, K. *et al.* (2001): Japanese people speak out against whaling. The *Japan Observer* July 3rd.

New Zealand Department of Conservation (2007): Evidence of *Brucella* found in Maui's dolphins. News release of 23rd April.

Nielsen, O. *et al.* (2004): Results of a community based disease monitoring program of marine mammals in arctic Canada. Presentation to the Techno Oceans 04 Conference, Kobe, Japan. November 9-11, 2004.

Nielsen, O. *et al.* (2001): Serological survey of *Brucella* spp. antibodies in some marine mammals of North America. *J Wildl Dis* 37(1): 89–100.

Nunavik Regional Board of Health and Social Services (2011): http://www.youtube.com/watch?v=1Q4tImMuR4Y

NRC (2000): Toxicological effects of methylmercury. National Research Council, National Academy Press (ed.), Washington.

NRIFSF (2005, 2004 and 2002): Japanese progress reports on small cetacean research. National Research Institute of Far Sea Fisheries (ed.), Shizuoka, Japan.

Oceancare (1999): *Die Internationale Walfangkommission (IWC) und menschliche Gesundheit*. Wädenswil, Schweiz.

O'Hara, T. *et al.* (2004): Bowhead whale contaminants: A review of current state of knowledge and possible future research directions. IWC SC/56/E1.

O'Hara, T. *et al.* (1999): Organochlorine contaminant levels in Eskimo harvested bowhead whales of Arctic Alaska. *J Wildlife Disease*, 35(4): 741–752.

O'Hara, T. *et al.* (1998): Heavy Metal, Radionuclide and Organochlorine Contaminant Levels in Eskimo Harvested Bowhead Whales of Arctic Alaska with a Review of Contaminant Levels and Effects in Arctic Ecosystems. IWC SC/50/E5.

Ohishi, K. *et al.* (2007): Brucella infection in whales in the western North Pacific and Antarctic: A review. SC/59/DW1.

Ohishi, K. *et al.* (2003): Pathological and serological evidence of *Brucella*-infection in baleen whales (Mysticeti) in the western North Pacific. *Comp Immunol Microbiol Infect Dis* 26: 125-136.

Parsons, E. *et al.* (2006): It's not just poor science – Japan's "scientific" whaling may be a human risk, too. *Mar Pollut Bull* 52: 1118-1120.

Petersen, M. *et al.* (2008a): Impact of dietary exposure to food contaminants on the risk of Parkinson's disease. *Neurotox* 29(4): 584-90.

Petersen, M. *et al.* (2008b): Increased prenatal exposure to methylmercury does not affect the risk of Parkinson's disease. *Neurotox* 29(4): 591-5.

Rowles, T. & Ilyashenko, V. (2007): Summary of finding on the investigation of the stinky whale condition in eastern North Pacific gray whales. IWC/59/CC 15.

Sejersen, F. (2001): Hunting and Management of Beluga Whales (*Delphinapterus leucas*) in Greenland: Changing Strategies to Cope with New National and Local Interests. *Arctic* 54 (4): 431-443.

SIKU News (2008): Narwhal hunt provokes animal rights groups. www.sikunews.com/art.html?catid=5&artid=5845.

SIKU News (2007a): Beluga strife in Nunavik - Hunters are in revolt over restrictive beluga quotas. April 13th, www.sikunews.com/art.html?artid=2942&catid=4.

SIKU News (2007b): Beluga hunt ends in northern Quebec's Hudson Strait - Canada's department of fisheries and oceans is frustrated that hunters didn't respect the quotas. Article of Nov 16th , www.sikunews.com/art.html?artid=4093&catid=4 .

Simmonds, M. *et al*. (2002): Human health significance of organochlorine and mercury contaminants in Japanese whale meat. *J Toxicol Environ Health*, part A, 65:1211-1235.

Simmonds, M. *et al.* (2000): Cetacean contaminant burdens: regional examples. Paper SC51/E13 for the IWC Scien. Com.

SOCER (2008): State of the Cetacean Environment Report 2008 – Atlantic Ocean. Stachowitsch, M. *et al.* (eds.). Available at: www.iwcoffice.org/sci_com/socer.htm#files.

SOCER (2005): State of the Cetacean Environment Report 2005 – Arctic and southern Ocean. Stachowitsch, M. *et al.* (eds.). Available at: www.iwcoffice.org/sci_com/socer.htm#files.

SOCER (2004): State of the Cetacean Environment Report 2004 – North and South Pacific. Stachowitsch, M. *et al.* (eds.). Available at: www.iwcoffice.org/sci_com/socer.htm#files.

Sohn, M. *et al.* (2003): Human neurobrucellosis with intracerebral granuloma caused by a marine mammal *Brucella* spp. *Emerging Infectious Diseases* 9(4): 485-488.

Stern, G. *et al.* (2005): Spatial trends and factors affecting variation of organochlorine contaminant levels in Canadian Arctic beluga. *Sci Total Environ* 351-352: 344-368.

Subramanian, A. *et al.* (1987): Reduction of testosterone levels by PCBs and DDE in Dall's porpoises of north-western North Pacific. *Mar Pollut Bull* 18:643-646.

Tachibana, M. *et al.* (2006): Antibodies to Brucella spp. in Pacific bottlenose dolphins from the Solomon Islands. *J. Wildlife Diseases* 42(2): 412-414.

Taguchi, M. *et al.* (1980): Mercury levels in whale meat sold in Japan. IWC SC/32/O11.

Trasande L. *et al.* (2005): Public health and economic consequences of environmental methylmercury toxicity to the developing brain. *Environ Health Perspect* 113: 590–596.

Tryland, M. *et al.* (1999): Evidence of *Brucella* infection in marine mammals in the North Atlantic Ocean. *Vet Rec* 144(21): 588-592.

Tomy, G. *et al.* (2004): Fluorinated organic compounds in an eastern Arctic marine food web. *Environ Sci Technol* 38(24): 6475-6481.

Tyrrell, M. (2007): Sentient Beings and Wildlife Resources: Inuit, Beluga Whales and Management Regimes in the Canadian Arctic. *Human Ecol* 35(5): 641-642.

UNEP (2002): Current mercury exposures and risk evaluation for humans. In: Global Mercury Assessment. Report, Geneva Switzerland: 50-72. Available at: www.chem.unep.ch/mercury/Report/Final%20report/final-assessment-report-25nov02.pdf

US NMFS (2008): Conservation plan for the Cook Inlet beluga whale (*Delphinapterus leucas*). National Marine Fisheries Service, Juneau, Alaska. Available at: www.alaskafisheries.noaa.gov/protectedresources/whales/beluga/mmpa/final/cp2008.pdf

Van Oostdam, J. (2005): Human health implications of environmental contaminants in Arctic Canada: A review. *Sci Total Environ* 351-352:165-246.

Varanasi, U. *et al.* (1993): Chemical contaminants in Gray Whales (Eschrichtius robustus) stranded in Alaska, Washington, and California, USA. NOAA Technical Memorandum NMFS-NWFSC-11. www.nwfsc.noaa.gov/publications/techmemos/tm11/tm11.htm.

Wagemann, R. & Kozlowska, H. (2005): Mercury distribution in the skin of beluga (*Delphinapterus leucas*) and narwhal (*Monodon monoceros*) from the Canadian Arctic and mercury burdens and excretion by moulting. *Sci Total Environ* 351-352: 333-343.

WCMC (2009): Export data for narwhal products from Greenland and Canada 1976-2008. UNEP World Conservation Monitoring Centre. Available at www.unep-wcmc.org/citestrade/.

Weihe, P. & Grandjean, P. (2012): Cohort studies of Faroese children concerning

potential adverse health effects after the mothers' exposure to marine contaminants during pregnancy. *Acta Veterinaria Scandinavica* 54(Suppl 1):S7

Weihe, P. (2007): in interview with J. Bennion, aired on Jun 26th. www.pbs.org/frontlineworld/stories/faroe605/interview_weihe.html.

Weihe, P. & Joensen, H. (2008): Recommendation to the Government of the Faroe Islands concerning the pilot whale. Open letter to the Prime Minster, the Minister of Health and the Minister of Trade and Industry, Landslaegen, dated August 7th.

Weihe, P. *et al.* (2008): Serum concentrations of polyfluoroalkyl compounds in Faroese whale meat consumers. *Environ Sci Technol* 42(16): 6291-5.

Weihe, P. *et al.* (2003): Sustained high concentrations of PCBs in Faroese pregnant women despite dietary intervention. *Organohalogen Compounds* 63: 389-392.

Weihe P. *et al.* (2002): Neurobehavioral performance of Inuit children with increased prenatal exposure to methylmercury. *Int J Circumpolar Health* 61(1): 41-49.

Weihe, P. *et al.* (1996): Health implications for Faroe Islanders of heavy metals and PCBs from pilot whales. *Sci Total Environ* 186: 141-148.

Wermuth, L. *et al.* (2008): Prevalence and incidence of Parkinson's disease in the Faroe Islands. *Acta Neurol Scand* 118(2): 126 -131.

Wermuth, L. *et al.* (2000): A two-fold difference in the age-adjusted prevalences of Parkinson's disease between the island of Als and the Faroe Islands. *Eur J Neurol* 7(6): 655-660.

WHO & UNEP (2008): Guidance for identifying populations at risk from mercury exposure. UNEP DTIE Chemicals Branch and WHO Department of Food Safety, Zoonoses and Foodborne Diseases (eds). Geneva, Switzerland.

Wold, C. (2000): Legal opinion on the competence of IWC to include humane treatment and human and cetacean health concerns in the RMS. Presented at IWC 52, Adelaide, Australia.

Wolkers, H. *et al.* (2007): Accumulation and transfer of contaminants in killer whales (*Orcinus orca*) from Norway: Indications for contaminant metabolism. *Environ Toxicol Chem* 26(8) 1582-1590.

WWF (2005): The big four – a WWF update on Greenland's efforts with regard to species conservation and nature protection. Available at http://assets.panda.org/downloads/thebigfour.pdf.

Yasunaga, G. & Fujise, Y. (2009a): Temporal trends and factors affecting mercury levels in common minke, Bryde's and sei whales and their prey species in the western North Pacific. Paper SC-J09-JR23.pdf for IWC JARPN II Review Workshop, 26-30 January 2009 in Tokyo, Japan.

Yasunaga, G. & Fujise, Y. (2009b): Temporal trends and factors affecting PCB levels in baleen whales and environmental samples from the western North Pacific. Paper SC-J09-JR24.pdf for IWC JARPN II Review Workshop, 26-30 Jan 2009, Tokyo, Japan.

Yasunaga, G. & Fujise, Y. (2009c): Accumulation features of total and methyl mercury and selenium in tissues of common minke, Bryde's and sperm whales from the western North Pacific. Paper SC-J09-JR25.pdf for IWC JARPN II Review Workshop, 26-30 January 2009 in Tokyo, Japan.

Yasunaga, G. *et al.* (2005): Spatial and temporal variation in organochlorine contaminants in the Antarctic minke whales, *Balaenoptera bonaerensis*. Institute of Cetacean Research. Paper JA/J05/JR14 for JARPA Review Meeting 2005. Available at www.icrwhale.org/eng/JA-J05-JR14.pdf.

7 . Annex

Table 1: Contamination levels in toothed whales

*lw = lipid weight; ww = wet weight; dw = dry weight; * mixed samples of three different dolphin species. Values in bold exceed particular national health advice (see table 4). For the Faroe Islands and Greenland, belonging to Denmark, the EU safety limits are taken as a basis.*

Whale species	Region	Pollutant	Tissue	Concentration	Reference
Sperm whale (*Physeter catodon*)	Iceland	PCB DDT	Blubber	10.51 µg/g lw 7.8 µg/g lw	Borrell 1993
	Japan, western North Pacific	Mercury	Liver Kidney Muscle	**≤ 130 µg/g ww** **≤ 4.2 µg/g ww** **≤ 2.1 µg/g ww**	Yasunaga & Fujise 2009c
	Caribbean	PCB DDT	Blubber Blubber	0.7-4.0 µg/g ww ≤ 15.5 µg/g ww	Simmonds & Johnston 1994
Beluga (*Delphinapterus leucas*)	Canada Western Arctic	Mercury	Muktuk Blubber Muscle Liver	**0.84 µg/g ww** **0.12 µg/g ww** **1.4 µg/g ww** **≤ 464 µg/g dw**	Wagemann & Kozlowska 2005 " " Das *et al*. 2003
	St. Lawrence	Mercury	Liver	**≤ 45 µg/g ww**	AMAP 2011
	Mackenzie Delta, NW Territories	Mercury	Liver Kidney Muscle Muktuk	**≤ 44.3 µg/g ww** **≤ 9.43 µg/g ww** **≤ 1.95 µg/g ww** **≤ 1.15 µg/g ww**	Lockhart *et al*. 2005 " " "
	Hendrikson Island, NW Territories	PCB DDT CHL	Blubber	≤ 5.73µg/g ww ≤ 5.77µg/g ww ≤ 3.03 µg/g ww	Stern *et al*. 2005 " "
	Nunavut	Mercury PCB DDT CHL	Liver Blubber	≤ 13.8 µg/g dw < 9.17 µg/g ww ≤ 7.3 µg/g ww ≤ 5.97 µg/g ww	INAC 2003b Stern *et al*. 2005 " "
	Baffin Island	Mercury PCB DDT CHL	Liver Kidney Muscle Blubber	**≤ 11.4 µg/g ww** **4.64 µg/g ww** **< 0.98 µg/g ww** ≤ 4.95 µg/g ww ≤ 7.54 µg/g ww ≤ 2.4 µg/g ww	Lockhart *et al*. 2005 " " Stern *et al*. 2005 " "
	Eastern Hudson Bay	PCB DDT CHL	Blubber	0.3µg/g ww 0.05 µg/g ww 0.3 µg/g ww	INAC 2003b " "
	Alaska Cook Inlet Point Hope/Lay	PCB DDT CHL Mercury	Blubber Liver	≤ 3.1 µg/g ww ≤ 2.9 µg/g ww **≤ 1,1 µg/g ww** **25 µg/g ww**	Krahn *et al*. 1999 " " AMAP 2011
	Eastern Chukchi	PCB DDT CHL	Blubber	≤ 6.9 µg/g ww ≤ 4.9 µg/g ww **≤ 3.3 µg/g ww**	Krahn *et al*. 1999 " "
	Beaufort-Chuckchi Sea	PCB DDT CHL	Blubber	≤ 2.6 µg/g ww ≤ 1.33 µg/g ww **≤ 1.53 µg/g ww**	Krahn *et al*. 1999 " "
	Greenland	Mercury	Liver Muscle Kidney	**4.04 µg/g ww** **0.58 µg/g ww** **1.78 µg/g ww**	Johansen *et al*. 2004 " "
		PCB	Liver Muscle Kidney Blubber Skin	**0.06 µg/g ww** **0.06 µg/g ww** **0.08 µg/g ww** **2.45 µg/g ww** **0.09 µg/g ww**	Johansen *et al*. 2004 " " " "
		DDT	Meat Liver Kidney Blubber Skin	0.03 µg/g ww 0.02 µg/g ww 0.04 µg/g ww 1.56 µg/g ww 0.06 µg/g ww	Johansen *et al*. 2004 " " " "
		CHL	Meat Liver Kidney Blubber Skin	0.02 µg/g ww 0.02 µg/g ww 0.02 µg/g ww 1.20 µg/g ww 0.05 µg/g ww	Johansen *et al*. 2004 " " " "

Narwhal (*Monodon monoceros*)	Canada, Eastern Arctic	Mercury	Skin (muktuk) Blubber Muscle Liver	**0.59 µg/g ww** 0.03 µg/g ww **0.81 µg/g ww** **≤ 137 µg/g ww**	Wagemann & Kozlowska 2005 Bowles 1999
	Broughton Island, E. Baffin Island, NWT	PCB DDT CHL	Blubber	≤ 4.8 µg/g ww ≤ 4.8 µg/g ww ≤ 1.75 µg/g ww	INAC 2003b
	Pond Inlet, NE Baffin Island, NWT,	PCB DDT CHL	Blubber	≤ 5.8 µg/g ww ≤ 7.2 µg/g ww ≤ 2.6µg/g ww	INAC 2003b
	Jones Sound, Nunavut	PCB DDT CHL	Blubber	≤ 3.5 µg/g ww ≤ 4.2 µg/g ww ≤ 1.5 µg/g ww	INAC 2003b
	West Greenland	Mercury	Liver	**≤ 16.3 µg/g lw** **≤ 73.3 µg/g ww**	SOCER 2005 Bowles 1999
		PCB	Blubber Muscle Liver Kidney Skin	**2.31 µg/g ww** **0.05 µg/g ww** **0.07 µg/g ww** **0.03 µg/g ww** **0.10 µg/g ww**	Johansen *et al*. 2004 " "
		DDT	Blubber Muscle Liver Kidney Skin	1.62 µg/g ww 0.04 µg/g ww 0.04 µg/g ww 0.02 µg/g ww 0.08 µg/g ww	Johansen *et al*. 2004 " " " "
		CHL	Muscle Liver Kidney Blubber Skin	0.03 µg/g ww 0.04 µg/g ww 0.02 µg/g ww 1.11 µg/g ww 0.06 µg/g ww	Johansen *et al*. 2004 " " " "
	East Greenland	PCB	Muscle Skin	**0.10 µg/g ww** **0.17 µg/g ww**	Johansen *et al*. 2004 "
		DDT	Muscle Skin	0.06 µg/g ww 0.39 µg/g ww	Johansen *et al*. 2004 "
		CHL	Muscle Skin	0.02 µg/g ww 0.33 µg/g ww	Johansen *et al*. 2004 "
Long-finned pilot whale (*Globicephala melas*)	Faroe Islands	Mercury	Muscle Liver Blubber	**≤ 3.3 µg/g ww** **≤ 179 µg/g ww** **30 µg/g ww**	Weihe *et al.* 1996; Hoydal 2005 Hoydal & Dam 2005 Weihe *et al.* 1996
		PCB	Muscle Blubber	**0.6 µg/g ww** **30 µg/g ww**	Weihe *et al.* 1996 Weihe *et al.* 1996
		DDT	Blubber Muscle	≤ 16.5 µg/g lw 0.3 µg/g ww	Hoydal & Dam 2005 Weihe *et al.* 1996
Short-finned pilot whale (*Globicephala macrorhynchus*)	Japan, coastal waters	Mercury PCB DDT	Muscle Liver Lung Blubber	**≤ 23.1 µg/g ww** **390-422 µg/g ww** **≤ 63.3 µg/g ww** **≤ 32 µg/g ww** ≤ 8.8 µg/g ww	Endo *et al.* 2003 Endo *et al.* 2004 " Simmonds & Johnston 1994 "
Atlantic white-sided dolphin	Faroe Islands	PCB DDT	Blubber	**42.68 µg/g lw** 22.46 µg/g lw	Borrell 1993
Striped dolphin (*Stenella coeruleoalba*)	Japan, coastal waters	Mercury	Liver Muscle Kidney Lung	**≤ 475 µg/g ww** **≤ 63.4 µg/g ww** **≤ 1,980.0 µg/g ww*** **≤ 153.0 µg/g ww***	Bowles 1999 Endo *et al.* 2003 Endo *et al.* 2004 "
		PCB	Blubber "Whale"	**≤ 5.0µg/g ww** **1.5 µg/g ww**	Simmonds & Johnston 1994 EIA 2005
		DDT	Blubber	≤ 17.1 µg/g ww	Simmonds & Johnston 1994
Risso's dolphin (*Grampus griseus*)	Japan, coastal waters	Mercury PCB	Muscle Liver Kidney Lung Blubber Blubber	**≤ 20.3 µg/g ww** **≤ 645.0 µg/g ww** **≤ 28.8 µg/g ww** **≤ 145 µg/g ww** **1.09 µg/g ww** **1.24 µg/g ww**	Endo *et al.* 2003 Endo *et al.* 2004 " " EIA 2008 EIA 2008
Bottlenose dolphin *(Tursiops truncatus)*	Japan, coastal waters	Mercury	Muscle	**≤ 98.9 µg/g ww**	Endo *et al.* 2005a
Baird's beaked whale *(Berardius bairdii)*	Japan, coastal waters	Mercury	Muscle	**≤ 6.46 µg/g ww**	Endo *et al.* 2005a, 2003
		PCB	Boiled meat Blubber	**≤ 2.63 µg/g ww** **1.9 µg/g ww**	EIA 2008 "

Dall's porpoise (*Phocoenoides dalli*)	Japan, NW Pacific	Mercury	Liver Muscle Blubber	6 µg/g dw **≤ 2.51 µg/g ww** **≤ 0.27 µg/g ww**	Das *et al.* 2003 Endo *et al.* 2003 EIA 2008
		PCB	Blubber Skin	**≤ 17.8 µg/g ww** **≤ 1.1 µg/g ww**	Subramaniam *et al.* 1987 EIA 2008
		DDE	Blubber	≤ 16.5 µg/g ww	Subramaniam *et al.* 1987
False killer whale (*Pseudorca crassidens*)	Japan, coastal waters, Okinawa Province	Mercury	Muscle	**≤ 81.0µg/g ww**	Endo *et al.* 2005a; 2003

Table 2: Contamination levels in baleen whales

lw = lipid weight; ww = wet weight; dw = dry weight. Values in bold exceed particular national health advice (see table 4). For the Faroe Islands and Greenland, belonging to Denmark, the EU safety limits are taken as a basis.

Whale species	Region	Pollutant	Tissue	Concentration	Reference
Northern minke whale (*Balaenoptera acutorostrata*)	Norway, NE Atlantic	PCB	Blubber	**≤ 5.77 µg/g** **1.72 µg/g ww** **≤ 18.7 µg/g ww**	Kleivane & Skaare (1998) SOCER 2008 Hassauer *et al.* 2002
	Jan Mayen	Mercury PCB DDT CHL	Meat/Blubber Liver Blubber	0.34 µg/g ww 2 µg/g ww **≤ 8.63 µg/g lw** ≤ 4.69 µg/g lw 0.653 µg/g lw	Grønvik 2003 AMAP 2011 Hobbs *et al.* 2003 " "
	North Sea	Mercury PCB DDT CHL	Meat/Blubber Blubber	0.28 µg/g ww **≤ 14.8µg/g lw** ≤ 7.77 µg/g lw ≤ 1.49 µg/g lw	Grønvik 2003 Hobbs *et al.* 2003 " "
	Lofoten	PCB DDT CHL	Blubber	**≤ 8.07µg/g lw** ≤ 6.28 µg/g lw ≤ 1.26µg/g lw	Hobbs *et al.* 2003# " "
	West Svalbard	Mercury PCB DDT CHL	Meat/Blubber Blubber	0.25 µg/g ww **≤ 5.25µg/g lw** ≤ 1.96 µg/g lw ≤ 0.68 µg/g lw	Grønvik 2003 Hobbs *et al.* 2003 " "
	Barents Sea	Mercury PCB DDT CHL	Meat/Blubber Blubber	0.14 µg/g ww **≤ 11.9µg/g lw** ≤ 5.31 µg/g lw ≤ 2.11 µg/g lw	Grønvik 2003 Hobbs *et al.* 2003 " "
	West Greenland	Mercury	Liver Muscle Kidney Muktuk	≤ 11 µg/g dw 0.08 µg/g ww 0.18 µg/g ww 0.03 µg/g ww	Das *et al.* 2003 Johansen *et al.* 2004 " "
		PCB	Liver Muscle Kidney Blubber Skin	**0.01 µg/g ww** **0.04 µg/g ww** **0.02 µg/g ww** **3.14 µg/g ww** **0.7 µg/g ww**	Johansen *et al.* 2004 " " " Johansen *et al.* 2004
		DDT	Blubber Muscle Liver Kidney Skin	≤ 3.86 µg/g ≤ 14.8 µg/g ww 0.01 µg/g ww 0.02 µg/g ww 0.49 µg/g ww	Kleivane & Skaare (1998) Hassauer *et al.* 2002 Johansen *et al.* 2004 " "
		CHL	Blubber Muscle Liver Kidney Skin	0.3 µg/g ww 0. 006 µg/g ww 0.006 µg/g ww 0.005 µg/g ww 0.33 µg/g ww	SOCER 2008 Johansen *et al.* 2004 " " "
	East Greenland	PCB DDT CHL	Blubber	**≤ 1.88 µg/g lw** ≤ 0.68µg/g lw ≤ 1.42µg/g lw	Hobbs *et al.* 2003 " "
	Japan, western North Pacific	Mercury	Muscle Liver Kidney Lung	**≤ 0.54 µg/g ww** **≤ 0.80 µg/g ww** **≤ 13.7 µg/g ww** **≤ 63 µg/g ww**	Endo *et al.* 2003 Yasunaga & Fujise 2009c Endo *et al.* 2004 Endo *et al.* 2004
		PCB	??? Blubber	**2.8 µg/g ww** **< 4.00 µg/g ww**	Haraguchi *et al.* 2000 Yasunaga & Fujise 2009b
		DDT CHL	Blubber	< 3.5 µg/g ww < 0.64 µg/g ww	Aono *et al.* 1997 "

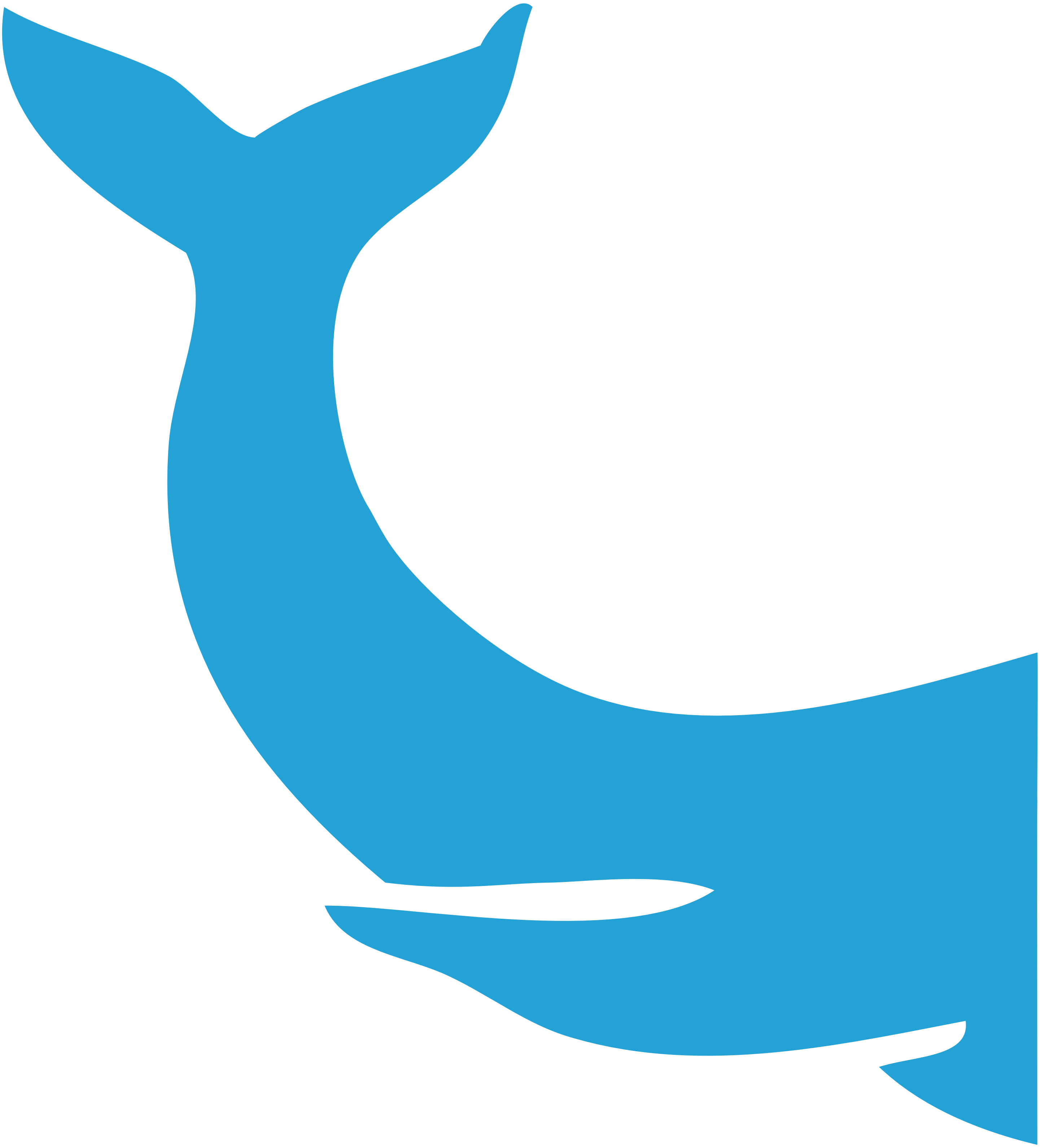
Southern minke whale (*Balaenoptera bonaerensis*)	Antarctic (JARPA)	Mercury	Muscle Liver ???	≤ 0.08µg/g ww ≤ 0.13 µg/g ww < 0.09 µg/g ww	Endo *et al*. 2003 Bowles 1999 Haraguchi *et al.* 2000
		PCB DDT CHL	Blubber	0.008 µg/g ww 0.34 µg/g ww ≤ 0.12 µg/g ww	Yasunaga *et al*. 2005
Bowhead whale (*Balaena mysticetus*)	Beaufort-Chukchi-Sea	PCB DDT CHL	Blubber	0.54 µg/g lw 0.44 µg/g lw **0.26 µg/g lw**	Hoekstra *et al*. 2003
	Alaska	Mercury	Liver Muscle Blubber	≤ 0.4 µg/g dw 0.02 µg/g ww 0.002 µg/g ww	Das *et al*. 2003 O'Hara *et al.* 1998 "
		PCB	Blubber Liver	0.54 µg/g lw 0.35 µg/g ww 0.98 µg/g lw	Hoekstra *et al*. 2003 Krahn *et al*. 2000 O'Hara *et al.* 1999
		DDT	Blubber Liver	0.13 µg/g ww 0.12 µg/g lw	Krahn *et al*. 2000 O'Hara *et al.* 1999
		CHL	Blubber	**0.26 µg/g lw**	Hoekstra *et al*. 2003
Fin whale (*Balaenoptera physalus*)	NW Atlantic	PCB DDT	Blubber	≤ 0.09 µg/g ww ≤ 2.58 µg/g ww	Simmonds & Johnston 1994
	North Atlantic	PCB	Blubber	**0.732 µg/g ww**	Krahn *et al*. 2000
	NE Atlantic	Mercury	Liver	**≤ 5.0 µg/g dw**	Das *et al*. 2003
	Iceland	PCB DDT	Blubber	1.26 µg/g lw 0.85 µg/g lw	Borrell 1993 "
	Antarctic	Mercury	Muscle	≤ 0.22µg/g ww	Endo *et al*. 2003
Gray whale **(***Eschrichtius robustus*)	Alaska	Mercury	Liver Kidney	**≤ 4.4 µg/g ww** **≤ 2.3 µg/g ww**	Varanasi *et al.* (1993) "
		PCB	Blubber Liver	≤ 1.2 µg/g ww ≤ 0.9 µg/g ww	Varanasi *et al.* (1993) "
		DDT	Blubber Liver	≤ 0.09 µg/g ww 0.01 µg/g ww	Varanasi *et al.* (1993) "
		CHL	Blubber Liver	0.01 µg/g ww ≤ 0.05 µg/g ww	Varanasi *et al.* (1993) "
	NW America	Mercury	Liver	≤ 0.1 µg/g dw	Das *et al*. 2003
	Russian Bering Sea	PCB DDT CHL	Blubber	≤ 0.9 µg/g ww ≤ 0.54 µg/g ww 0.15 µg/g ww	Rowles & Ilyashenko 2007 " Krahn *et al*. 2001
Humpback whale (*Megaptera novaeangliae*)	Caribbean	PCB	Blubber	≤ 1.5 µg/g ww	Simmonds & Johnston 1994
	NW Atlantic	PCB DDT	Blubber Blubber	≤ 6.0 µg/g ww ≤ 23.1 µg/g ww	Simmonds & Johnston 1994 "
Sei whale (*Balaenoptera borealis)*	Iceland	PCB DDT	Blubber	**0.46 µg/g lw** 0.40 µg/g lw	Borrell 1993
	Japan, Western North Pacific	Mercury PCB	Boiled meat Muscle Boiled meat Blubber	≤ 0.08 µg/g ww 0.05 µg/g ww ≤ 0.005 µg/g ww ≤ 0.47 µg/g ww	EIA 2008 Yasunaga & Fujise 2009a EIA 2008 Yasunaga & Fujise 2009b
Bryde whale (*Balaenoptera edeni)*	Japan, Western North Pacific	Mercury	Muscle Liver Kidney	≤ 0.22 µg/g ww **≤ 0.49 µg/g ww** **≤ 0.60 µg/g ww**	Endo *et al.* 2003 Yasunaga & Fujise 2009c "
		PCB	Blubber Muscle	≤ 0.21 µg/g ww 0.003 µg/g ww	Yasunaga & Fujise 2009b EIA 2008

Table 3:
Health risks of different chemicals and national health advice for marine food in different regions

Substance	Health effects for humans	National health advice
Mercury	Damage to brain and nervous system, weakening of immune system, MeHg easily passes placenta and may damage the foetus' development, arteriosclerosis, hypertension, increased risks for Parkinson's disease	**Japan**: 0.4 µg/g ww **Canada**: 0.5 µg/g ww **EU, Norway**: 0.5-1 µg/g ww **USA** (like WHO): 1 µg/g ww Me-Hg
PCB	Effects on liver, reproduction, immune system, neurobehavioural development, lower birth weight, cancer, dental caries	**Japan**: 0.5 µg/g ww **Canada**: no advice **EU**: 0.008 ng/g ww **Norway:** 0.2 µg/g ww (meat)
DDT	Suppressing immuno system, mimicking hormones, possibly cancerogenic	**USA (as WHO)**: 5.0 µg/g ww
CHL	headache, nausea, excitability, confusion, and muscle tremors	**USA**: 0.1 µg/g ww
PBDE	mimicking hormones, possibly cancerogenic, impact on neurodevelopment	No data

Table 4:
Contamination level in human blood (in µg/l) from different northern regions, maximal levels are highlighted (based on AMAP 2003)

Nordic Region	Mercury	PCB	DDT	CHL
Canada, Kivalliq	≤ 12.0	≤ 22.0	≤ 0.35	≤ 6.2
Canada, Baffin	≤ 34.0	≤ 9.4	≤ 0.47	≤ 2.4
Canada, Nunavik	≤ 44.0	≤ 16.0	≤ 1.1	≤ 3.9
Greenland, Nuuk	≤ 3.6	≤ 27.0	≤ 0.37	≤ 3.0
Greenland, Ittoqqortoormiit	≤ 10.5	≤ 127	≤ 1.3	≤ 15.0
Greenland, Disco Bay	*not available*	≤ 21.0	≤ 13.0	≤ 3.9
Alaska, Atka	*not available*	≤ 54.0	≤ 0.15	≤ 1.3
Alaska, St. Paul	*not available*	≤ 42.0	≤ 0.02	≤ 0.49
Iceland	*not available*	≤ 5.5	≤ 0.41	≤ 0.17
Norway, Lofoten	*not available*	≤ 6.2	*not available*	≤ 0.11
Faroe Islands	≤ 7.5	≤ 14.5	≤ 1.5	≤ 1.4



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