Electronic Monitoring of Norwegian Minke Whaling

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Management surveillance of hunting

Successfully managed harvesting of resources must ensure that harvesting practices fit within long term resource sustainability goals. Most commercial fisheries and hunting activities therefore utilize monitoring programs to ensure compliance with the regulations in addition to collection of information supporting fishery and wildlife management, stock assessment and scientific research. The methods for management surveillance of activities at sea have traditionally been at-sea inspector and observer programs, logbooks and data collection by scientists and trained observers. Most monitoring programs at sea are therefore costly because of the high labour component associated with at-sea observers.

The traditional methods for at sea monitoring of the harvest of minke whales in Norway have included logbooks and at-sea inspector programs. In addition, every boat is controlled and must be approved for hunting by governmental inspectors from the Norwegian Directorate of Fisheries and the Norwegian Food Safety Authority before they are allowed to start the hunt. The control includes relevant documents and licences, weapons and hunting equipment, and that the standards of hygiene comply with Norwegian regulations. In addition, at-sea inspectors have also been trained to collect data for scientific institutions in addition to the scientists that are at sea on several boats during the hunt.

The inspector program has given 100% coverage of the boats and hunting activities, which is highly unusual both compared with most fisheries management regimes, wild game hunting as well as several other activities where animals are harvested or killed. For example, at hunting of terrestrial animals in Norway specially trained officers are present in the area and monitor the hunting activities by random or periodical checks in addition to hunter's licence check and weapons control. The terrestrial hunters themselves are also commonly ordered to sample specimen for science and management surveillance.

The Norwegian minke whale hunt

In Norway only one whale species is targeted, namely the minke whale, and it is hunted from small fishing vessels that are rigged for whaling in the season. The IWC definition of this catching operation is "small type whaling", see Schedule, para 1 C. The whales are killed using a penthrite grenade mounted on a harpoon. The dead whales are hauled on board across the deck and butchered. The products are stored in ice in the hold before it is brought to processing plants on land.

The boats operate in areas through which whales migrate or feed. A stealthy approach is normally used to get close to the whale. There is no chasing in high speed or support of electronic devices like sonar. The hunters simply idle the boat slowly towards the position

where they believe that the whale will surface to take its next breath and the whales are often shot when they are passing by or approach the boat. The hunt is therefore depending on calm sea and little wind. In periods with windy weather, which sometimes might last for days and weeks, the boats usually must stay at port. From 1993 to 2004, one inspector was present on every vessel through its whole season that normally could last up to 7-8 weeks.

Electronic monitoring and surveillance of minke whaling

Traditional methods for monitoring the hunt in the Norwegian harvest of minke whales have included logbook inspection, at-sea inspectors from Norway, Sweden, Denmark and Germany, and North Atlantic Marine Mammal Commission (NAMMCO) nation observers. The monitoring program using inspectors on every vessel has gradually become extremely costly. The costs have annually been about NOK 6 million (€ 750 000/US $ 950 000). The system has been useful in monitoring hunting regulations, but it has unintentionally imposed important side effects on the execution of the hunt and the hunting practice. The annual cost for the inspection scheme has been far too high for the vessels to be paid from the income from the harvest and has been paid by the government. To keep the costs down, inspection time has been limited (less than 2 months per boat). This time restriction has prevented the hunters from their earlier and traditional opportunistic "fair weather" hunt, which had quite many similarities with the aboriginal hunting of whales and forced them to start the season when the inspectors are available. In periods with much "bad" or windy weather the vessel's "inspection time" will run without any hunting, which sometimes result in a tendency to hunt the largest animals instead of the young ones to secure their income before the time is over. Another serious effect is that, for the smallest vessels, one of the crew must stay at port and consequently loose income, to make room for the inspector during the season.

An electronic tamper-proof automated computing system to independently monitor the whaling activities would ease some of these unnecessary and unintended restrictions and be superior to the traditional monitoring system in many ways. It would provide a lower cost alternative, it would bring the hunt back to its traditional opportunistic "good weather" hunt and still secure that the harvest fit within long-term resource conservation targets and sustainable goals. It takes little space, it does not sleep, eat, and does not socialize with anyone.

Program for development of Automated Electronic Monitoring Technology for Minke Whaling 2001-2005

A project to develop an electronic monitoring system, a trip recorder, named Blue Box (BB) system, started with governmental funding in 2001 at Norwegian School of Veterinary Science after request of Norwegian Fishermen Association.

The Blue Box system consists of a control and data logger box (Blue Box) designed to independently monitor and log hunting activity data provided by an independent GPS and different sensors (deliverers) placed in certain areas and structures of the boat, data that prove that a whale is shot and taken on board. The control box and the sensors are configured and calibrated individually for each vessel. The system is automated with programs designed for the continuous operation and logging of data for at least 4 months and equipped with backup batteries and automatically restarting functions following system interruption.

The Blue Box system includes in summary the following components:

- Control Box (Blue Box)

- Independent GPS - antenna
- Shock transducers
- Strain transducers
- Heel sensor

Control Box (Blue Box)
The heart of the electronic monitoring system is a metal, tamper-proof box that houses the computer system, system and data disks, backup batteries and heel sensor. The locked and sealed box is normally mounted in a cabin that can be locked from outsiders and operates on an independent circuit of 24 volts DC. Data are stored on high capacity disks. The system operates within a temperature range of ±30°C (+85°F/÷20°F). Potentially failures in the power supply or data supply from the sensors will be logged and the system restarts itself and restores the sensor function. Each system is signed individually. Data is encrypted and can be sampled either at random or periodical checks or at the end of the season by educated personnel. To get access to the data and for analysis a specific encoded key (WIBU key) is needed.

GPS
The Global Position System (GPS) receiver is an important tool that provides the Blue Box with continuous and independent information on time, position, speed and course of the vessel. The data from the GPS can be used to plot the activities of the vessel in connection with the hunt. The search for, killing and hauling in of the dead whale can be read from the plot by personnel that are well trained and with good knowledge about the hunting practice.

Shock transducers
Two independent shock transducers mounted on each harpoon gun identify the shock waves from the firing of the harpoon gun. The transducers are configured and calibrated individually and for each gun in a testing program set up for this purpose.

Strain transducers
Strain transducers provide data by measuring static and dynamic strains to structures like beams and ribs, strains that occur in the structures when a whale is hauled on board across the deck and processed. The strain transducers that are attached to the measurement object where the surface conditions are good are connected to the power supply, an amplifier and the Blue Box in protected wires. If any risk of mechanical damage, moisture etc. to the transducers and electrical wires, they are additionally covered with enclosures.

Heel sensor
Due to the swelling, some heel movements will always occur on a boat at sea. The Norwegian minke whale hunt is normally conducted in fair weather with moderate swelling and heeling, but when the whale is hauled in and across the deck, it produces a very distinct and characteristic heel movement of the vessel. This movement, which is most distinct on the smaller boats, can be registered on all vessels. The registration from the heel sensor cannot be used alone to verify a catch but helps to verify the data from the other sensors.

Field trials in 2004
In 2004, after 2½ years of development, testing of different computer and sensor systems, and field trials, 13 units were installed on 13 whaling vessels. Before installation, the electricians and other personnel working with installation and calibration of BB were trained in a three days workshop that also included installation of one vessel under supervision of experts. The

vessels chosen for the trials were of different size and construction (steel and wooden boats) and were operating in 3 different areas. Experienced and trained inspectors were chosen and taught to supervise the function of the BB system. They were instructed to record their observations in separate logs that were made for this specific purpose and report directly to the manager of the development project, Dr. Egil Ole Øen at Norwegian School of Veterinary Science. Simultaneously the skippers wrote their official logbook used for control by the Directorate of Fisheries. These logbooks (from inspector and skipper) were later used to control and qualify the data sampled in the BB. Three to 12 weeks after the conclusion of season the BBs were actively switched off and system and data disks were removed for analysis.

Results

The analyses of data from the BB in 2004 showed that all trip recorders had functioned and logged data through the whole season. When the system was turned off, it had been actively logging data in average for 116 days (range 68 - 159 days). 235 whales were registered caught during the registration period. The number of harpoon gun firings, number of whales caught, time and positions were in accordance with the data from the logbooks from the inspectors (and the hunters). For some of the boats, GPS and all sensors had functioned to a 100%, for some others, one or two of the sensors had not functioned quite successfully for every whale taken, and for three of the wooden boats, some of the strain transducers had not functioned satisfactorily for several of the whales. However, data from the GPS in combination with logged data from other sensors were sufficient to verify the exact number of whales taken and when and where they had been caught.

Field trials in 2005

System upgrading and instruction of personnel

After the 2004 season all BB hardware were upgraded and slightly modified. By thorough studies of the raw data from the 2004 season it was discovered that the flaws in the sensor data were mainly caused by inaccuracies in placement and calibration of the actual sensors. It was therefore decided to hold a new workshop prior to the 2005 season, where the main topics were sensor installation and configuration. A new installation and configuration manual was compiled, and the personnel were trained in installation and calibration on one vessel under surveillance of experts before recalibration and modification of the system on the 13 vessels that had been equipped with BB in 2004 and installation on 16 new vessels started. In 2005 the program manager has been present at installation and recalibration on most of the vessels.

The skippers on every boat attended a compulsory workshop in 2005. They were given an introduction in the function and the planned routines for the control of the BB in 2005. In addition, they were given instructions in recording of a new logbook that had been prepared for the season.

There is a strong focus on assuring the integrity of the logged data in all parts of the system. In addition to the upgrading of Blue Box and sensors and training of personnel for installation, 22 inspectors were trained in a 2 days workshop to supervise and control the hunting in 2005 and to record a separate log that will be used for the quality control of the system and logged data in 2005. The plan is that 7 of the inspectors will be present and stay on board the same vessel the whole season (mainly the largest vessels), while the other 15 will stay on board alternate boats for shorter periods of time and do random checking of hunting boats on sea and at port.

When the hunting season is closed, the encrypted data will be collected from the BBs, decrypted and analysed. The development program is expected concluded in 2005.

Analysis tool for data from BB

In 2004 the Ministry of Fisheries started an independent project to develop an automatic configuration and analysing tool to analyse data from the BB. An early version of this tool was used for the analysis of data from the 2004 season. The analysing tool is still under development but is expected concluded in fall 2005.

Fig. 1. The Blue Box (Control Box) of the Automated Electronic Monitoring System developed for monitoring the minke whale hunting in Norway.