VESSEL MONITORING SYSTEMS

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RADIO REPORTING SYSTEMS

The use of Reporting Systems to monitor the activities of fishing vessels is not a new development. Radio Reporting Systems were in existence in the 1960s when they were introduced as a safety measure. Vessels would report every 24 hours and if they failed to report an alert was raised and Search and Rescue operations commenced. There were three weaknesses in the system. The first was the arbitrary nature of the reliability of radio communications. A radio transmission could be received on the other side of the world, yet still not be received by a local station due to the effect of atmospheric conditions. The second weakness was the intense work cycle of fishermen when on fish or when their attention is required elsewhere. On many occasions, fishermen merely forgot to make the report. The third was the nature of fishing where a skipper, who is fishing well, is unwilling to disclose his position over the radio, where a competitor can note the position where he is fishing. In fact, he was sometimes likely to transmit a false position, thereby informing the authorities that all is well, but defeating the purpose of the system should the vessel subsequently experience difficulties and fail to report. For all these reasons, there were many false alerts and the system fell into disuse.

SATELLITE COMMUNICATIONS

GLOBAL MARITIME DISTRESS SAFETY SYSTEM

Against this background, the maritime authorities and at an international level, the International Maritime Organisation (IMO) recognised that the emergence of satellite communications could contribute greatly to Safety of Life at Sea (SOLAS). Such was the benefits that this was expected to bestow on the maritime community that a special international organisation, the International Maritime Satellite Organisation was set up with close links to IMO in 1979. Such was the support for INMARSAT that four geostationary radio communication satellites were put into orbit, each covering a major part of the oceans.

Initially mainly emergency signals such as those emitted by EPIRBs (Emergency Position Indicating Radio Beacons) were used, but gradually IMO created a Global Maritime Distress Safety System (GMDSS) largely based on the transmission capabilities of INMARSAT C, which transmits data (i.e., not voice). It has to be said that GMDSS also uses VHF radio when close to the coast so it is not solely satellite based. The reliability of the satellite communications systems and the positions that are given are so good that they literally take the “Search” out of “Search and Rescue”. With GMDSS, if a distress message is sent, the message has a 99.9% probability of being received and the rescue units know the exact position of the casualty.

At the same time other satellites were being launched that also had communications capabilities, which were open to general use. Some of these were the NOAA satellites, which are used by ARGOS, a French company, based in Toulouse, which tend to be used for scientific oceanographic and environmental monitoring, such as sea surface temperatures, etc. ARGOS did not have the same communications capabilities as INMARSAT for two-way communications, but was capable of receiving one-way messages from a vessel to the ARGOS central system in Toulouse, from whence the information could be forwarded on to the customer[7]. ARGOS also has the disadvantage that it is based on an orbiting satellite, so in some cases the messages have to be stored before being relayed to an earth station. On the other hand INMARSAT has a limitation in that it does not cover the higher latitudes. Nevertheless, in the future, with vast proliferation of communications satellites, most areas of the world will have access to a satellite communications system (e.g., Iridium, Globalstar and ICO).

GLOBAL POSITIONING SYSTEM

In the 1990s the great advances made in communications technology increased the amount of traffic that the existing satellites could carry and the use of satellite communications became more used for simple telephone conversations, gradually replacing the old systems of radio communications. Another development was the introduction of the Global Positioning System (GPS), which although under the control of the US military is also available for all users. The incorporation of GPS into satellite communications systems along with the computerisation of the equipment meant that together they could automatically transmit a signal with the position of the vessel and identification of the vessel encoded. Although initially envisaged as a GMDSS facility, this system has not only been applied to maritime vessels but is also in use by railway wagons, motor transport and even private cars to provide a deterrent against thieves.

VESSEL MONITORING SYSTEMS

In fishing vessels, a very similar use was envisaged in Vessel Monitoring Systems (VMS). It is important to understand that with INMARSAT equipment both GMDSS and VMS can use the same equipment. Although seen initially as a great advantage, there has been a problem created in the very high level of false alerts generated by GMDSS[8], some of which have been attributed to transmissions initiated by untrained personnel. There has also been a problem with some suppliers simplifying the system by removing the receiving communication interface on the vessel. In this case, the vessel cannot receive communications, including messages asking if a distress message that has been sent is genuine.

National and Regional Systems

In discussing the current status of introduction of VMS by countries, it is important to understand that the development is expanding exponentially. It is believed that the number of vessels fitted with VMS has trebled since February 2000. Therefore it is exceedingly difficult to keep updating the information. The following information is only intended as indicative of the current status in each country and it is certainly not comprehensive (see Table 1).

[7] The problem of lack of two way communications is now said to be overcome.
[8] About 95% of GMDSS alerts are false alerts.

Table 1 Number of Vessels fitted with VMS early 2000, by Country/State/Region

Country/State/Region	**Number of Vessels**	**EU member states**	**Estimates of vessels at beginning of the year 2000**
Argentina	400	Belgium	82
Australia		Denmark	191
AFMA	230	Finland	25
Queensland	670	France	196
Tasmania	80	Greece	79
South Australia	42	Germany	111
West Australia	45	Ireland	76
Canada	31	Italy	172
Chile	300	Netherlands	347
Forum Fisheries Agency	133	Portugal	183
Greenland	21	Spain	933
New Zealand	3000	Sweden	33
Norway	80	United Kingdom	369
Panama	100?	***Total EU***	***2797***
Peru	787		
South Africa	75		
USA	411		
Total except EC	***6405***	**Global Total**	**Approx. 9200**

The first use of satellite communications systems for fisheries management was in Hawaii in the mid 1980s, when several foreign fishing vessels were convicted of infringing the USA's jurisdiction and the authorities were faced with the problem of how to prevent the offence being repeated. Given the vast expanse of the Pacific and the USA's EEZ, there was a high risk of such offences being undetected by conventional means. It was decided that, as part of the penalty for the offence, the vessels should be fitted with satellite communications with an inbuilt GPS that would report back to the US authorities and thereby ensure that the vessels did not enter the EEZ of Hawaii. At this time the phrase Vessel Monitoring System (VMS) was coined. The individual units to be installed on the vessels were called Automatic Location Devices (ALD). This latter term is somewhat redundant as most marine satellite communications systems can be programmed with the inbuilt computer to perform the functions of an ALD. The term transponder has sometimes been used, but in a strict sense VMS equipment does not "transpond" unless programmed to do so.

The first national systems were introduced in Australia and New Zealand around 1993. The New Zealand system was introduced to monitor the activities of its large trawlers fishing in its vast EEZ (the fourth largest in the world) and also to monitor foreign fishing activity within the zone. The system introduced by New Zealand is in the form of an "open system", in which the responsibility for supplying the equipment and paying for the reporting costs are borne by the operator. The administration merely advises the operator on the equipment that can report adequately to meet the reporting requirements. This means that the operator can use INMARSAT, Argos or even VHF (if within range). This means that VMS is not necessarily confined to satellite communications systems[9]. There are advantages in the specifications of such “open systems” in that they can be readily updated when new communications equipment becomes available and that they also become the responsibility of the fishing operator to maintain. If the equipment fails then the operator is given a period of time to rectify the situation.

The first Australian VMS system was introduced to monitor Japanese fisheries (squid jigging and long-lining for tuna) within the Australian EEZ, but it rapidly spread to include the domestic South East trawl fishery. This fishery was thought to be particularly at risk because of deep-sea species such as orange roughy, one of the main species, that has a long life span. There were also claims that some Australian vessels were landing fish from remote seamounts when fisheries on the Australian continental shelf were closed or limited.

The success of the VMS system in this fishery has led to VMS being rapidly being adopted for other State-managed fisheries in Australia not only for MCS purposes but also for environmental reasons (Great Barrier Reef). It has also been used for implementing more realistic real time fisheries management policies (Pilbara fishery on the North West shelf). In the case of Queensland’s fisheries, most of the fishing areas lie within the Great Barrier Marine Park, which covers most of the area between the Reef and the Australian coastline. To regulate fisheries within this area, most of the larger vessels (large Queensland’s context is over 15 m) and those that are considered to have an impact on the environment, 670 in total, are fitted with VMS.

It is worthwhile noting that some State fisheries administrations in Australia (e.g. NSW) have considered implementing VMS but felt that the existing monitoring systems are sufficient enough to manage the fisheries adequately. This is because the landing points are limited and can be covered satisfactorily by in-port inspection. Also information on the exact area in which the fish is caught is not regarded as important for fisheries management. At the other end of the spectrum is the Gulf of Carpentaria shrimp fishery, where the operators asked for VMS to be installed. The time of starting the fishery on banana prawns is critical with regard to the size of prawn and sampling is carried out to ascertain the exact time the fishery should start. The proposal was that the sampling should include all vessels and each vessel should report back to the Fishery Monitoring Centre this data. The FMC can then make a decision on far more samples than could be collected under normal circumstances by the limited number of research vessels and subsequently allow the fishery to continue operation or suspend the opening as appropriate. Of course the positions of the vessels are continually monitored.

Staying in the southern hemisphere, the countries of the South Pacific Forum have set up the Forum Fisheries Agency (FFA), which regulates foreign fisheries within the EEZs of the member countries. Australia and New Zealand are the two developed country members of the FFA and therefore it is not surprising that VMS is prominent in the fisheries management policies of the FFA. A centralized system has been set up with a Central Monitoring Centre in Honiara, Solomon Islands. It is intended that all foreign vessels licensed to fish in the EEZs of the FFA send VMS messages to the CMC. The Vessel Reports are then distributed from Honiara to the countries in which the vessel is fishing. This system is therefore known as a “Hub” system. The amount of time the fishing vessel spends in each country’s EEZ is used to attribute the licence fees to the various countries of the FFA. It is worthwhile, in passing, to observe that the on board equipment requirement for the FFA VMS is a dedicated

[9] Note this is also true of GMDSS

INMARSAT C terminal. This has caused difficulties with vessels claiming that they have much higher standard INMARSAT A (Voice) equipment that could perform the task adequately and that they are being asked to duplicate equipment.

Peru and Chile have implemented ARGOS-based VMS for their fleets of larger vessels. These vessels mainly fish for small pelagic species for reduction to fishmeal and there is not such a requirement for compliance monitoring as much of that can be done at the point of landing (i.e. fishmeal factories). The unusual factor in these countries is the combination of VMS data along with sea-surface temperature charts, which show the location of the vessel relative to the sharply defined oceanographic fronts. This allows the management to have almost real time knowledge of the dynamic changes in the fishery and to make management decisions quickly. A smaller number of their vessels fishing for demersal species such as hake are also fitted with VMS. It is estimated that 787 vessels are fitted with VMS in Peru and 300 in Chile.

South Africa implemented VMS for monitoring the activities of vessels mainly fishing in the CCAMLR area, including fishing with long lines for Patagonian toothfish. They have reported that 75 vessels are fitted with VMS

By far the largest implementation of VMS was supposed to take place at the beginning of 2000 in the member countries of the European Union (EU). Experiments had taken place as far back as 1995 in Portugal, which implements the “blue box” system. This was seen as the experimental phase of the programme conducted by the EU in VMS. In 1997, all the EU fishing countries undertook pilot schemes to determine the systems that they felt should be implemented. The VMS programme was gradually implemented, first of all covering those vessels that were considered to be fishing for certain sensitive stocks and then for vessels fishing on the high seas or in NAFO waters. Eventually in 2001, all vessels over 24 m were to be fitted with VMS with a few exceptions for vessels fishing close to a port.

Vessels are required to report every two hours. The equipment that is implemented within the member states differs, with some states adopting open systems and insisting that the vessel owner pays for the system and other states supplying standard equipment to the fishermen free or at subsidised prices. It is expected that around 4,000 - 6,000 vessels will be covered by this scheme. However, given that there has been a delay in implementing the system and it is not known how many vessels will apply for exemption from the scheme, the exact figures are not known. The administration of the EU system is very complex in that despite the member countries having a Common Fisheries Policy (CFP) and most waters are accessible to the fishing vessels of all countries (within the limitations of their licence), the responsibility for monitoring, control and surveillance is divided up for the different countries. This means that if a vessel is fishing in the zone controlled by its Flag State it merely reports to the Flag State. If the vessel is fishing within the waters controlled by another EU State then it reports by VMS to its Flag State and the message is automatically communicated by the Flag State to the country that is responsible for that area. If the vessel is fishing outside the EEZs of the EU countries and other European countries, but within the NEAFC area, the vessel reports to the Flag State, which then automatically passes on the report to NEAFC. It can be seen that the primary reporting responsibility is regarded as to the Flag State. This is also true on the high seas.

In the USA, several VMS systems are in the course of implementation, but lacking the overall jurisdiction that there is in the EU (in the USA, fisheries becomes the mandate of State governments) it has been applied on a fishery-by-fishery basis, rather than the blanket approach used in the EU. There are nearly fifty major fisheries in the USA. However, there is some regionalization in the five regions of the National Marine Fisheries Service (NMFS). In Alaska, there is VMS monitoring of the Alaska pollock fishery which includes reporting of production of the factory trawlers. In the North East scallop fisheries about 70 vessels are covered. In the South East, there is the proposal to cover longline fisheries in co-operation with ICCAT presently covering 10 vessels, which has run into legal problems. Hawaii, of course, maintains a VMS control over its long-line fleet. However, there has been a suggestion that VMS in all five NMFS regions will be centred in one location (i.e., similar to the FFA Hub system). There appear to have been many legal challenges to the implementation of VMS systems in the USA, which has somewhat delayed the early promises of adoption from the first Hawaii experiences.

Canada has a limited number of vessels monitored by VMS, but some of the scallop fisheries employ a very sophisticated system of reporting to the administration. The skippers use electronic mapping to display where, when and what catches are made and these are reported to the administration in almost real-time. The administration can control the fishery by noting the size of scallop caught and opening and closing various areas to maximise the catch. This is used in close co-operation with the companies and skippers.

Panama is an interesting case of implementation of VMS. Generally regarded as a “flag of convenience country”, Panama had a substantial number of fishing vessels entitled to fly the Panamanian flag. Under pressure from other countries imposing an embargo on tuna and particular pressure from ICCAT, that made it a condition of entry that they adopted VMS, Panama made it a condition of fishing vessel registration that the vessels should be fitted with VMS (based on Argos). As would be expected, many vessels, about 50%, then re-flagged to other “flags of convenience”. However, it is estimated that 100 Panama-flagged vessels are now fitted with VMS.

Morocco has announced a contract that will lead to about 300 vessels being monitored via an INMARSAT C VMS. Argentina has awarded a contract to the Spanish company Sainsel to implement a VMS to monitor 400 vessels. Sainsel uses a modified INMARSAT C transceiver on board and is primarily a position tracking system. Japan has conducted a number of trials with various types of VMS equipment and has used an INMARSAT A system for about four years to receive catch and effort reports and historical position data from a significant number of vessels. The position report is historical because of the importance that is placed on the commercially sensitive issue of reporting on fishing grounds.

DISCUSSION

In addition to the rapid expansion of VMS, there has been a remarkable decrease in the cost of the ship-borne equipment. An INMARSAT C station can be purchased for around $4,000 and the cost of the equipment for a Fisheries Monitoring Centre is about $50,000. Compared to the costs of conventional means of MCS, this is very little, yet the synergies that it creates can increase the effectiveness of patrols quite substantially.

There could appear to be an explanation of why the countries in the southern hemisphere have adopted VMS far more quickly than northern hemisphere countries in that the southern hemisphere has a far greater extent of sea to be monitored (individually and collectively). The fishing grounds are remote from centres of population (e.g. Antarctica) and with far less capability to monitor that area with conventional means such as patrol aircraft and vessels. It has also been expressed that in such areas, monitoring of position is more relevant than monitoring catches, fish sizes and mesh sizes, which is much more relevant for the continental shelf fisheries of the northern hemisphere.

The use of VMS is one of the concrete measures that a Flag State can use to demonstrate that it is able to monitor the activities of the vessels that are entitled to fly the flag of that state, as required in the Compliance Agreement and in the UN Implementing Agreement (UN/FAO, 1998). The latter Agreement specifically mentions VMS. This mention of VMS reflects the fact that the UN Implementing Agreement was agreed in 1995, whereas the Compliance Agreement, which was negotiated in 1993, is silent on VMS. This is one of the issues that might have to be addressed when the Compliance Agreement comes into force.

FAO has developed “Recommendations for the Implementation of Vessel Monitoring Systems in Developing Countries”. These recommendations are due to be circulated to the Regional Fisheries Bodies for discussion and possible implementation, where appropriate. If thought appropriate, regional or sub-regional proposals will be submitted to donors. In a preliminary phase, it is intended that awareness of the potential capabilities should be promoted. For example, a West African country can benefit from VMS even though it does not have an operational system. It can make it a condition of access agreements that VMS information should be supplied to its MCS authorities. EU vessels fishing under such an access agreement have to report back by VMS to their Flag State. It is then a simple exercise for the Flag State to forward that information to the coastal state. Part of the Strategy is for FAO to develop a Web-site for MCS in general and on VMS in particular. This Web-site will give information on national VMS schemes that are available and where possible will provide hyper-links direct to national sites. The FAO Guidelines on Vessel Monitoring Systems, which have been published under the Code of Conduct series (No. 1, Suppl.1), will be reviewed and reprinted (FAO Fishing Technology Service, 1998).

VMS will have to be considered in relation to national Fisheries Management Plans. In some cases VMS might be appropriate for MCS and in others catch reporting might be the objective. In some fisheries, VMS might even be thought to be inappropriate due to existing controls or because the fishery is not amenable to control. This means that the objectives of VMS must be clearly stated and understood before implementation is begun.

Nevertheless, VMS systems have the potential of revolutionising the Monitoring Control and Surveillance of fishing vessels. Present methods being used to report position represent merely a fraction of what is possible, for example, sensors can be attached to the fishing vessel’s engines, winches and instrumentation and the data from these sources transmitted back to shore. This will cost slightly more in terms of transmission charges than the present simple VMS system, probably slightly more than doubling the costs of transmission.

Given systems with a greater bandwidth, video imagery could be transmitted back to Fisheries Monitoring Centres, however this could cost many times more in terms of transmission costs. A realistic scenario would be a dual level system of monitoring, where the vessel could be monitored by a low-cost system and then when an alert is triggered, the higher cost monitoring system can be used to visually investigate what is actually happening on board. An alternative to this system could be to have photography equipment or video recording equipment on board that can be controlled from the shore. In that case there is a disadvantage in that the officials will have to wait until the vessel returns to the shore to recover the evidence.

There is a general feeling that if many VMS parameters are collected then fishing operations and perhaps the dynamics of the fish stocks will be better understood. More realistic data from a greater number of commercial vessels will be available to fisheries management rather than the limited amount of data from research vessels. However, there is a resistance from fishermen to the concept of total monitoring as evidenced by the common questions:

6. Why do you need to know?
7. Who is going to pay?
8. Who is going to collect the information?
9. Who is the information going to be available to?
10. Who eventually owns the information?
11. Is the collection of information going to interfere with the fishing operation?

There is also cynicism from experienced practitioners in data collection, who maintain, that the parameters that are monitored must be carefully selected and for the objectives of the monitoring are clearly transparent to all. “Rubbish in - Rubbish out” seems to be the battle cry of this group.

The wider use of VMS and the application of such data in fisheries management have been foreseen in the proceedings of the Symposium on Integrated Fisheries Monitoring which was held in Sydney, Australia, February 1999. Canada and Australia co-hosted the Symposium in co-operation with FAO. Much of the information within this paper is based on that Symposium and participants are recommended to consult the Proceedings for further information on Integrated Fisheries Monitoring (Nolan, 1999).

One paper presented during that Symposium is worthy of further attention because of an issue already raised on multi-species fisheries (Joll, Casey and Towers, 1999). The management of multi-species fisheries has been regarded as one of the most intractable problems in fisheries management. This is because of the difficulty in specifying a particular level of fishing effort that will satisfy the optimum harvesting levels for each of the fish species in the fishery. In such a fishery, there will always be some species that are over-harvested or under-harvested under conventional forms of management.

The Pilbara trawl fishery is carried out by a small number of trawlers for three main species. The area of the fishery is divided up into six sectors and the catch and positions of the vessels are reported in almost real time to fisheries management. The management analyses the proportional abundance and sizes of each of the species in the different sectors and because the exact distribution of the species are not the same they can vary the fishing effort in each of the sectors to achieve an different overall fishing effort on each of the species. The information on the amount of hours that a vessel can spend in a particular area is subsequently relayed back to the fishing vessel. Hence the satellite communications is involved in all stages: the reporting of catches, the monitoring of position and the monitoring of time within each zone. Incidentally the effort is measured by the time that the fishing vessel spends in each sector. (i.e. not fishing time).

SUMMARY

The cost-effectiveness of MCS has to be seen in the context of shrinking budgets. Patrol vessels and aircraft are very costly and governments are in an era of “the user pays”. In the case of countries that spend high amounts of money in relation to the revenue generated by the fishery, there will be an increasing requirement to justify their expenditure.

Satellite surveillance is two or three years away from being a useful complement for VMS, but when it does make its impact felt, it will be another opportunity for MCS to make their operations more cost effective.

The technology for the systems are available at present and the costs of equipment and transmission costs are rapidly decreasing, hence it is no longer a question of whether VMS is technically possible. The questions that are being raised are social and legal (Tsamenyi and Mfodwo, 1999).

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