IOSR Journal of Engineering (IOSR JEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
PP 90-96

Study On Aquatic Animal Tracking

[1]Pooja Balbudhe, [2]Mrs. Rashmi Dukhi
[1] *Student of Department of Computer Science, MCA Sem-5, G.H.Raisoni Institute of Information Technology, Nagpur*
[2] *Asst. Professor,Department of Computer Science, G.H.Raisoni Institute of Information Technology, Nagpur*

Abstract: *Aquatic animal tracking is significantly improving our understanding of aquatic animal behaviour and are emerging as key sources of information for conservation and management practices. Over the past three decades, passive acoustic telemetry has significantly helped marine scientist to study and understand the spatial ecology, migratory behaviours, and mortality rates of aquatic animals. A popular telemetry system consists of two components: an acoustic transmitter tag attached to an aquatic animal and powered by a small battery, and a stationary station that receives the acoustic signals from the tagged animal and determines its location. The added weight and increased size of the tag introduced by the battery limit the implementation of this system to relatively large animals. In this paper, used two broad classes of electronic tags (transmitters & dataloggers) in our studies. Transmitters send data from their host animal remotely via sound or radio waves to a receiver. Dataloggers store all of their data in onboard memory and must be recovered from the animal for downloading. The major trade-off between these two approaches is dataloggers generally provide much larger quantities of data than transmitters, but datalogger recovery is not guaranteed, hence the desirability of remote transmission. Some electronic tags combine both datalogger and transmitter in a single device.*

Keywords: *Acoustics, Animals, Magnetoacoustics effect, Environmental monitoring.*

I. Introduction

The study of aquatic animalspresentsuniquechallengestoscientistsbecauseofthephysicalcharacter-is ticsofwaterandtheremotenatureofmanyoftheworld's aquatichabitats.Aquaticsystemsarehighlyinterconnected,enablinganimalstotraverselongdistances,todivethrough-outthewatercolumn,and,forsomespecies,tomovebetweenfreshandsaltwaterenvironments.Thescientificstudyofthese movements requires the ability tomonitoranimalsremotely,andeffortshaveincreasinglyturnedtotheuseofelectronic tags, which have transformedourunderstandingofaquaticsystemsandtheirinhabitants.In their most basic form, electronic tagsinclude*radio*or *acoustic* beacons that transmit signals,oftenspecificcodes, to identify animals and allow them tobe trackedusingreceiversthatdetectthetransmittedsignals.Mostelectronictagsarepoweredbybatteries,but*passiveintegratedtr ansponders*(PITs)dependonanexternalpowersupply to transmit the tag's signal.Becausethestrengthofradiosignalsatallbutthelongestwavelengthsrapidlyattenuateinsaltwater, acoustic transmissions or satellite connectivity is necessary foranimaltrackinginmarineenvironments.Radiofrequency identification (*RFID*) tags at low frequencyhaverestrictedutilityacrossshort distancesandaresuitedtohabitatssuchasnoisy,spatially complexreefs.Moreadvanced tagsincorporatesensorsthatmeasureandrecordasuite of environmental and biological parameters. Basic*archivaltags*mustbephysicallyrecoveredtoobtainthe data,butinmoreadvancedmodels,thedatacanbeuplinkeded tosatelliteortoground-basedreceivers.Thesetransmissionsaremadeduringintervalswhentheanimalisatthe surfaceorafterthetaghasreleasedfromtheanimalandis floatingatthesurface. Thesetelemetrytoolshavealreadyenabledimportantdiscoveriesaboutaquaticanimalsandtheecosystemsinwhich theseanimalslive.

Aquatic Animal Tracking with Acoustic Telemetry:

Acoustic telemetry has become increasingly popular as a method of choice for monitoring the movements and behavior of aquatic animals globally. Increasingly smaller tags along with improvements in battery technology have allowed for tagging a wide variety of species and life stages, enabling monitoring of individuals as small as salmon smolts and as large as whale sharks for periods from 30 days to 10 years. Receiver technology also continues to evolve and increasingly allows for data to be collected at finer spatial and temporal scales than ever before. In addition, with more and more acoustic diagnostics information available telemetry datasets are becoming richer, allowing more detailed analyses of system performance over time and more robust interpretation of animal detection data.

Acoustic telemetry is most frequently used to track aquatic animals, and originated in the cloak and dagger days of submarine World War I warfare. ... Acoustic tracking systems consist of two primary components (transmitter and receiver), which work together to provide information about moving animals.

Transmitter: The transmitters are electronic tags that emit a series of sound pulses into the surroundings. They can be surgically implanted or attached externally to an organism. The range of signal reception can vary from a few meters to more than a thousand meters. The signal typically transmits once every minute or two, in order to conserve battery life.
Receivers: Receivers are small, data-logging computers that "listen" for tagged individuals. When a signal is identified, the tag's unique ID code is saved with the date and time. The data from any single receiver provides a record of each signal to that location by a tagged individual. Researchers might deploy many receivers over large regions to understand the movement patterns of tagged individuals.

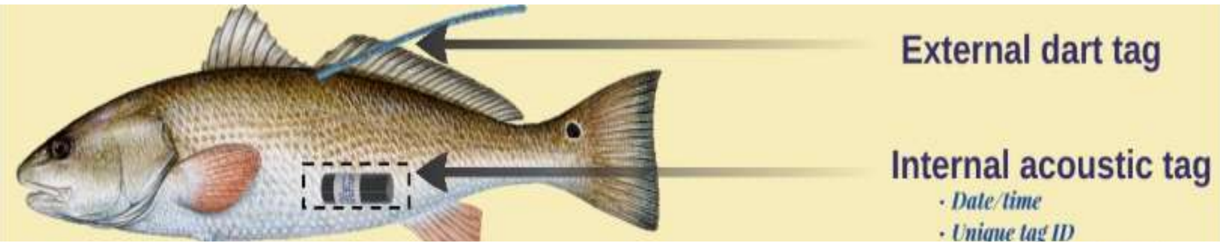

Figure 1: ***Redfish with an acoustic transmitter.***

How do Acoustic Tags work?

Acoustic Tags transmit an underwater sound signal or acoustic "ping" that sends identification information about the tagged fish to hydrophones (hydrophone). By determining the sound's time of arrival at multiple hydrophones, the 3D position of the fish can be calculated, in a manner similar to how GPS is used to calculate positions. The hydrophone receiver receives the sound signal and converts it to digital data that researchers use to plot the resulting tag positions in 3D, in real-time. Post-processing software, Mark Tags takes that data and delivers the end result, the 3D track.

Advantages of acoustic tags over radio tags:
Acoustic tags have several advantages over radio tags for tracking fish and other animals in water. Unlike radio tags, which are typically only detected within the first 10 m (32 ft) of the surface, acoustic fish tags detect fish movement anywhere in the region of interest within the detection range of the tag [up to 1 km (3280 ft)] in freshwater.
• Acoustic Tag software permits display of three-dimensional tag tracks on a PC.
• No antenna required for the tag, reducing drag and the potential for atypical behaviour with radio tags.
• Better tag detectability with acoustic tags (typically > 95%).
• Positive indication that hydrophones are functioning properly.
• Manual mobile tracking of fish tagged with acoustic tags is possible using the 12 VDC Model 291 Portable Acoustic Tag Receiver.
• Acoustic tags function in seawater, unlike radio tags.

Different types of Electronic Tags Used for Aquatic Animal Tracking:

II. Overviews

We use two broad classes of electronic tags (transmitters & dataloggers) in our studies. Transmitters send data from their host animal remotely via sound or radio waves to a receiver. Dataloggers store all of their data in onboard memory and must be recovered from the animal for downloading. The major trade-off between these two approaches is dataloggers generally provide much larger quantities of data than transmitters, but datalogger recovery is not guaranteed, hence the desirability of remote transmission. Some electronic tags combine both datalogger and transmitter in a single device. For example, Pop-Up Archival Satellite Tags (PATs) store large volumes of data in onboard memory and summarize data for lower-volume transmission to satellites. If PATs are physically recovered then the full record can be downloaded from memory.

Many electronic tags obtain environmental information via a suite of sensors. The most commonly used sensors measure depth (pressure), temperature, salinity (conductivity) and light levels. Sensor information helps biologists to better understand the environment in which animals live. For example, depth and temperature sensors can tell us whether a shark lives primarily in the warm surface waters of the ocean, or is a frequent visitor to deeper, colder zones. One of the frontiers in electronic tag science is development of new types of sensors (e.g. pH sensors) to provide new insights into important aspects of shark & fish behaviour such as how often they feed.

Different types of Electronic tags used for Aquatic animal tracking are as follow as:
1. Acoustic Pinger
2. Passive Acoustic Monitoring
3. Satellite Transmitters - SPOT Tags
4. Satellite Transmitters - PAT Tags
5. Business Card Tag
6. Accelerometer Dataloggers
7. pH Datalogger/Transmitter
8. Hydrophone Tags

1.Acoustic Pinger:

The simplest version of the acoustic transmitter is the 'Pinger'. The 'Pinger' produces ultrasonic pings that can be heard using a hydrophone (underwater microphone) and receiver. This was the original type of fish tracking tag. Pinger's are attached to sharks and fishes which are then followed in a vessel equipped with a hydrophone and receiver. This process is known as 'active tracking' because the researcher actually follows the fish to find out where it goes. More sophisticated versions of these tags include onboard sensors (typically pressure and temperature) to provide depth and water temperature information from the fishes' track. The depth and temperature information are encoded in the acoustic pings transmitted from the tag.

Figure 2: ***Blue spine unicorn fish with externally attached acoustic Pinger.***

2. Passive Acoustic Monitoring:

Passive acoustic monitoring uses the same basic transmitter-receiver technology as active tracking but is for longer-term (months or years) studies. This system consists of uniquely identifiable ultrasonic transmitters that are surgically implanted into sharks and fishes to ensure longer retention. These transmitters are then detected by underwater receivers stationed at various locations on the sea floor. The receivers are deployed on subsurface moorings and continuously listen for transmitters, 24 h a day 365 days of the year. When a tagged shark comes within detection range of a receiver (detection radius is up to 1 km depending on transmitter type), its unique ID code is recorded, together with the date and time. The records from receivers at different locations are combined to create an overview of shark movement patterns.

Figure 3: ***Surgical implantation of a coded acoustic transmitter***

3. Satellite Transmitters - SPOT Tags:

Satellite tags are detectable over broad geographic areas and remotely relay information to satellite arrays. These tags utilize radio transmissions, requiring the tag to have contact with air to send data (hence satellite tags must be externally attached). External attachment makes satellite tags prone to damage and premature shedding. For studies of shark movements, Smart Position or Temperature Transmitting Tag (SPOT tags) are commonly attached to the dorsal fin. SPOT tags transmit a signal to the Argos satellite array whenever the dorsal fin breaks the surface of the water. These transmissions resulted in geo-location estimates with location accuracies that range from a few hundred meters to 'somewhere on planet Earth'.

Figure 4: ***SPOT tag attached to the dorsal fin of a tiger shark***

4. Satellite Transmitters - PAT Tags:

Popup Archival Transmitting tags (PATs) collect and store temperature, depth and light intensity data as the host animal swims through the ocean. At a pre-programmed date and time, the PAT detaches from its host, floats to the surface and uploads stored data to the Argos satellite array. PATs store large volumes of data in onboard memory and summarize these data for lower-volume transmission to satellites. If PATs are physically recovered then the full record can be downloaded from memory. Because day length changes with latitude, and sunrise and sunset times change with longitude, light level data can be analysed to determine where the host animal travelled between PAT deployment and release. Light-level geolocation works best with animals which move over long distances.

Figure 5: ***PAT tag deployed on a tiger shark***

5. Business Card Tag:

The Business Card Tag (BCT) is a prototype datalogging tag manufactured by Vemco Ltd. The BCT combines both acoustic receiver and transmitter in a single device, allowing BCTs to swap identification codes with one another. This provides an important new tool for quantifying inter-animal interactions, shedding light on how frequently, and at what times marinal animals encounter one another. In addition to 'talking' to one another, BCTs can also detect other Vemco transmitters, and are themselves detectable by other Vemco receivers.

Figure 6: ***The Verco Business Card Tag***

6. Accelerometer Dataloggers:

Tri-axial accelerometer dataloggers measure accelerations due to gravity along three axes, providing a high resolution, three-dimensional record of animal movements. These devices are providing important new insights into animal behaviour. We have been collaborating with colleagues from the Ocean Research Institute in Tokyo, and using these devices to shed new light on shark swimming behaviour. The package in the picture includes both accelerometer and a digital camera which provides a 'sharks eye' view of the environment. This enables us to compare the swimming behaviour with what the shark is seeing as it swims through the ocean.

Figure 7: ***Accelerometer datalogger and digital camera deployed on a tiger shark***

7. pH Datalogger/Transmitter:

PH tags are a valuable new tool for quantifying shark feeding. These devices are placed in the sharks' stomach where they measure changes in acidity over time. The shark stomach is generally very acid, but the pH changes dramatically when the shark ingests food. This provides a convenient pH signal indicating a shark has fed. In recent decades we have learned a lot about where sharks travel but, in most cases, we don't know when and where they are feeding. pH tags can help us to fill in the blanks.

Figure 8: A stomach pH transmitter

8. Hydrophone Tags:
Hydrophone tags such as the Bioacoustics Probe are devices which record underwater sounds. In effect they are like an underwater tape-recorder. The ocean is a very noisy place, and sounds can provide a lot of information about an animal's environment and behaviour. Hydrophone tags can tell us what animals are hearing and what sounds they themselves are making. We can use these tags to learn about important behaviours such as feeding and mating**.**

Figure 9: ***The Bioacoustics Probe hydrophone tag***

III. Conclusion

The Animal Tracking Facility is one of eleven facilities of the Integrated Marine Observing System (IMOS). It represents the higher biological monitoring of the marine environment for the IMOS program.Currently the Animal Tracking Facility uses acoustic technology, CTD satellite trackers and bio-loggers to monitor coastal and oceanic movements of marine animals from the Australian mainland to the sub-Antarctic islands and as far south as the Antarctic continent.The Animal Tracking Facility is set up to collect data over a long period of time. This sustained approach will enable researchers to assess the effects of climate change, ocean acidification and other physical changes that affect animals within the marine environment.Currently, a large range of fish, sharks and mammals are collecting a wide range of data. This includes behavioral and physical data such as depth, temperature, salinity and movement effort of individual marine animals.Aquatic telemetry has emerged through technological advances in miniaturization, battery engineering, and software and hardware development, allowing the monitoring of organisms whose habitats range from the poles to the tropics and the photic zone to the abyssal depths.Electronic tags can now be equipped with sensors that measure ambient physical parameters (depth, temperature, conductivity, fluorescence), providing simultaneous monitoring of animals' environments.

References

[1]. http://imos.org.au/facilities/animaltracking/
[2]. https://atstrack.com/animal-class/marine-mammals.aspx
[3]. https://academic.oup.com/bioscience/article/67/10/884/4103291
[4]. https://www.sciencedirect.com/topics/earth-and-planetary-sciences/aquatic-organism
[5]. Auger-Méthé M, Albertsen CM, Jonsen ID, Derocher AE, Lidgard DC, Studholme KR, Bowen WD, Crossin GT, Flemming JM. 2017. Spatiotemporal modelling of marine movement data using Template Model Builder (TMB). Marine Ecology Progress Series 565: 237–249.
[6]. Baras E, Bénech V, Marmulla G. 2002. Outcomes of a pilot fish telemetry workshop for developing countries. Hydrobiologia 483: 9–11.
[7]. Deng ZD, Carlson TJ, Li H, Xiao J, Myjak MJ, Lu J, Martinez JJ, Woodley CM, Weiland MA, Eppard MB. 2015. An injectable acoustic transmitter for juvenile salmon. Scientific Reports 5 (art. 8111).
[8]. Goulette GS, Hawkes JP, Kocik JF, Manning JP, Music PA, Wallanga JP, Zydlewski GB. 2014. Opportunistic acoustic telemetry plat- forms: Benefits of collaboration in the Gulf of Maine. Fisheries 39: 441–450.

[9]. Li H, Tian C, Lu J, Myjak MJ, Martinez JJ, Brown RS, Deng ZD. 2016. An energy harvesting underwater acoustic transmitter for aquatic animals. Scientific Reports 6 (art. 33804).
[10]. Deng ZD, Carlson TJ, Li H, Xiao J, Myjak MJ, Lu J, Martinez JJ, Woodley CM, Weiland MA, Eppard MB. 2015. An injectable acoustic transmitter for juvenile salmon. Scientific Reports 5 (art. 8111).