Report on
DST-Workshop

29-30 AUGUST 2001

A SLIP and DIFRES initiative: the possibilities and perspectives of collecting individual based data on the behaviour of gadoids

Fishnet.dk
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DST-WORKSHOP - A SLIP AND DIFRES INITIATIVE: THE POSSIBILITIES AND PERSPECTIVES OF COLLECTING INDIVIDUAL BASED DATA ON THE BEHAVIOUR OF GADOIDS

Resume

Electronic 'data storage tags' (DSTs) for continuous recording of depth, temperature and light have over the last 10 years been developed by CEFAS (Lowestoft, UK). The latest tag (Mark IV) is less than 2 cm long and 1 cm wide, will record data over several years, and can be used for fish of a size down to 25 cm. The original Mark I (depth and temperature) has been used on hundreds of plaice in a large EU-funded project in the Netherlands. DST and other telemetric measurements provide fisheries biologists with data on the behaviour and migration of the single individual. Such data are crucial for an improved understanding of fish behaviour, heterogeneous population dynamics and the effect of closed areas in fisheries management.

To improve the knowledge about data storage tags, the SLIP network and the Ecosystem project of the department for marine fisheries (DMF) have invited the CEFAS team (G. Arnold, J. Metcalf, D. Righton and E. Hunter) to present the state-of-the-art in DST technology and applications, and to participate in discussions on how DST-data can be used for geolocalising the individuals.

DMF, the department of marine ecology and CEFAS plan to participate in an application to EU for funds to establish a cod project to study the horizontal and vertical migrations of cod in the Baltic. The discussions during the meeting resulted in an improved proposal and in other ideas to strengthen the cooperation between the SLIP network and the fish behaviour group in Lowestoft.

COURSE PROGRAM

Wednesday, 29 August

10.00 – 10.05	Opening - Jan E. Beyer (DIFRES)
10.10 – 10.40	**Conventional tagging – a historical and Danish perspective** - Ole Bagge (DIFRES)
10.45 – 11.20	**Fish migration: what data storage tags can tell us** - Geoff Arnold (CEFAS)
11.20 – 11.50	Discussion on pros and cons for DST and potential in combining DST with traditional tagging
11.50 – 12.50	Lunch
12.50 – 13.10	**Migration information for cod fisheries management** - Hans Lassen (ICES)
13.20 – 13.50	**From simple measurements to complex behaviours** - Julian Metcalf (CEFAS)
13.50 – 14.10	**Scaling from individual behaviour to populations using otolith accretion characteristics** - Henrik Mosegaard (DIFRES)
14.10 – 14.40	Discussion on scaling from a limited number of individual DST data to the whole population – what do we know, and what do we think we know?
14.40 – 14.55	Coffee
14.55 – 15.25	**New perspectives on migration using electronic tags** - Ewan Hunter (CEFAS)
15.25 – 15.45	**Possibilities for geo-localisation of Baltic cod using DST data** - Hans H. Hinrichsen (IFM) & Stefan Neuenfeldt (DIFRES)
15.45 – 16.00	**Diffusion of fish from a central release point using conventional tags** - Anders Nielsen (SLIP Ph.D.)
16.00 – 16.30	Discussion of uncertainties in geo-localisation and potential of using stochastic modelling for DST data analysis
16.30 – 16.45	Coffee
16.45 – 17.10	**Vertical reality: how cod behaviour may affect survey methodology** - David Righton (CEFAS)
17.10 – 17.30	**Temperature preference under hypoxia as a function of haemoglobin genotypes** -Maria Petersen (SLIP Ph.D.)
17.30 – 17.55	Round-up discussion of the integration of behavioural information with fisheries management
17.55 – 18.00	Closing - Jan E. Beyer

Thursday, 30 August

09.30 – 09.35	Welcome - Jan E. Beyer (DIFRES)
09.40 – 09.50	**Feeding biology and bioenergetics: sensor needs** - Niels G. Andersen (DIFRES)
09.55 – 10.25	**Physiological sensors** - John F. Steffensen (MBL)
10.30 – 11.00	**A feeding sensor** - Bo Lundgren (DIFRES)
11.00 – 12.00	Discussion of the applicability of sensors to answer questions about small scale activities
12.00 – 13.00	Lunch

PARTICIPANTS

Name		Affiliation
Andersen*	Niels Gerner	DIFRES, Marine Ecology and Aquaculture
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Boll	Ulrik Harring	DIFRES, Marine Fisheries
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Faber*	Peter	DIFRES, Information Technologies
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Teilmann	Jonas	National Environmental Research Institute of Denmark
Thygesen*	Uffe Høgsbro	DIFRES, Ecosystem Modelling

* also participated in second day

SELECTED ABSTRACTS

Fish migration: what data storage tags can tell us
Geoff Arnold, FB CEFAS Lowestoft

Outlines the development of electronic tags and briefly surveys their use in marine fisheries research over the last 30 years. Surveys the range of data storage tags that are currently available on the market, from the smallest, simplest recording devices to the largest, sophisticated tags that detach from the fish after a pre-programmed time interval and transmit data to the laboratory via satellite. Reviews the application of data storage tags to date and considers future uses and further technical developments, including new sensors.

From simple measurements to complex behaviours
Julian Metcalfe, FB CEFAS Lowestoft

Various forms of data-loggers have been used in animal telemetry since the 1960s. The earliest were simple mechanical devices, and some of the successful early applications in wildlife telemetry involved using time-depth recorders (TDRs) to the study of diving behaviour in marine birds and mammals in the early 1980s. However, it was not until the early 1990s that such devices became sufficiently small that they could be deployed widely on marine fish. During the last decade, thousands of devices (known variously as either "archival" or "data storage" tags) have been deployed on a wide range of species including plaice, salmon, thornback rays, tuna and cod. The rapid advances in microelectronic technology over the past decade have resulted in the development of increasingly sophisticated, "archival" or "data storage" tags. However, while some carry out limited on-board data processing, most are essentially "dumb" recorders. That is, they spend most of their time "asleep" (important for a long recording life) and occasionally "wake up" to record one or more continuously available environmental or physiological variables like temperature, pressure and ambient daylight. This talk will explore the sort of complex biological and environmental information (including geoposition) that can be deduced from such apparently simple time-series.

Vertical reality: how cod behaviour may affect survey methodology
David Righton, FB CEFAS Lowestoft

Fish behaviour has a profound effect on how the data from sampling gears are interpreted. In particular, the vertical movements of fishes determine their accessibility to trawl and acoustic gears. In addition, vertical movements have a significant effect upon the target strength of roundfish that have closed swimbladders. We attached electronic data storage tags on cod in the North Sea and Irish Sea to investigate the natural behaviour of free-ranging fish and show that the vertical movement patterns of cod change through the year, and differ between regions. In addition, we use DST data to calculate depth adaptation rates and demonstrate that the rates of ascent and descent of cod can only be explained by the maintenance of negative buoyancy at mean residence depth. The synthesis of our results indicates how an improved understanding of fish behaviour can be used to estimate the proportion of time that fish are accessible to different sampling gears, and how variations in vertical movement patterns affect estimates of target strength.

New perspectives on migration using electronic tags
Ewan Hunter, FB CEFAS Lowestoft

Increased miniaturisation and recording capacity of electronic data storage (archival) tags (DST), and advances in methods applied to the interpretation of DST data now allow accurate and fisheries-independent description of the seasonal changes in spatial distribution of commercially exploited demersal fish species. Here the results from experiments conducted between December 1993 and September 1999, during which period 752 mature female plaice were tagged with DST and released throughout the North Sea. Tidal data recorded by returned DST have so far been used to reconstruct the movements of 145 free-ranging plaice for periods of up to 512 days, with a total behavioural record amounting to 20 403 days of data.
Of the population sampled, our results have revealed seasonal subdivision into three geographically distinct sub-units. Between May and October, these sub-units were centred on Amrum Ground to the west, Great Fisher Bank and Ekofisk Field to the north, and between the north coast of East Anglia and Dogger Bank to the east.

During the spawning period (December-April), individuals from both the eastern and northern sub-units were found simultaneously on German Bight spawning grounds, while individuals from all three sub-units visited spawning grounds in Southern Bight. The only fish in the current study to leave the North Sea were a sub-set of the western sub-unit that visited spawning grounds in the eastern English Channel. Only one fish entered Scottish waters (Aberdeen Bank), but no fish ever entered coastal Scottish waters.
The role of the tidal-streams, thermal stratification, and other possible factors involved in the maintenance of the observed distribution are considered, and the observed distribution patterns compared with those predicted from conventional plaice tagging experiments.

Possibilities for geo-localisation of Baltic cod using DST data
Hans H. Hinrichsen (IFM) and Stefan Neuenfeldt (DIFRES)

Localisation of tagged fish obtained from records of temporally resolved physical parameters depend on geographic area specific properties. Here, physical parameters have to be selected in order to account first for the hydrographic characteristics of the area as well as for the main predominant processes involved. Three-dimensional distributions of these parameters require gradients large enough to resolve locations related to DST measurements on small scale as well as to account for the accuracy and resolution of the sensor specification. Because of its humid climate, hydrographic conditions in the Baltic Sea can mainly be described by the three dimensional salinity distribution determined by river runoff, net precipitation (precipitation minus evaporation), and the in- and outflow through the Baltic Sea entrance area. In general, salinity of the potential habitat of Baltic cod decreases from west to east. Horizontal gradients of salinity are generated by the local distribution of freshwater. Vertically, an important stratification is clearly seen with an incline in salinity within a depth range of 20 m. This permanent halocline is situated between 20 and 80 m and is deepening from west to east. The possibility of utilising existing hydrographic data bases to construct three-dimensional distributions of temperature and salinity fields for comparison and localisation of DST measurements are discussed. For the same purpose the advantage of simulated highly spatially and temporally resolved fields obtained from hydrodynamic modelling has been emphasized. Besides hydrographic standard variables and simulated velocity fields, the hydrodynamic model also provides three-dimensional oxygen distributions. Thresholds in oxygen have been suggested to be a prerequisite for Baltic cod habitats. Thus, this parameter could give additional evidence for localisation of Baltic cod.

Diffusion of fish from a central release point using conventional tags
Anders Nielsen (SLIP Ph.D.)

I will briefly present my Ph.D. project and then illustrate some of the model types I intend to investigate with a simple example. An investigation of a small-scale diffusion in a natural environment is conducted. In mid May more than 3000 7-8 cm long turbots were released into a homogeneous area. The following nine days they were recaptured with the aim of being able to estimate the resulting population density. Further, as a result of the experimental design, the natural mortality and catchability can be estimated. Two approaches towards parameter estimation are proposed.