Platforms and Methods for Acoustic Detection and Monitoring of Key Ecosystem Properties

Nils Olav Handegard
• Introduction
• Platforms carrying acoustics
• Methods
• Applications – What we have done
• Applications – What we would like to do
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Norwegian fisheries

Capture (2005)

Value (2005)

First hand value 1980-2005

Fisheries in 2005
US: ~3,800 million USD
Norwegian: ~3,000 million USD
Observation methodology

- Acoustics
- Lidar (airborne)
- Stationary platforms
- Buoys
- "Vessels of opportunity"
- AUV
- Bottom mounted platforms
Population structure of "Observation Methodology"

- **Staff scientists (7)**
  - Olav Rune Godø (head of group, biology)
  - Egil Ona (biology, fisheries acoustics)
  - John Dalen (acoustics)
  - Rolf Korneliussen (acoustics)
  - Nils Olav Handegard (applied math)
  - Alf Harbitz (statistics)
  - Ruben Patel (programming, electrical engineering)

- **Engineers (3)**
  - Atle Totland (electrical engineering, programming)
  - Ingvald Svellingen (electrical engineerin)
  - Terje Torkelsen (mechanical engineering)

- **Post docs (3)**
  - Georg Skaret (marine biology)
  - Geir Pedersen (acoustics)
  - Eirik Tenningen (electrical engineering)

- **PhD students (1)**
  - Lise Doksaeter (biology)

- **Master students**

- **Adjunct professors (3)**
  - Kenneth Foote (acoustics)
  - Vidar Hjellvik (statistics)
  - Dag Tjøstheim (statistics)

- **Prof. Emeritus (1)**
  - Johannes Hamre
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The Mini Lander

- Short term deployments
- Single freq echosounder
- Downward (gimbal) or upward (fixed) looking
- Midwater deployment easy
- Pressure, compass, tilt/roll sensors
The Searching Lander

- Long term deployment (high payload)
- Mission plan (1 year deployment possible)
- Normally deployed close to bottom
- Steerable sounder:
  - Tracking single targets (fish and whales)
  - Increased sampling volume
  - Next: Profiler, camera, mission control?
Drop sonde
Next generation lander (Hermes project)
Lander & Mooring
• Introduction
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• Methods
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Acoustic registrations of Cod
Oscar Sund (1935), Nature
Acoustic registrations of individual Cod 1957
Echo integration (Sætersdal)
The graph illustrates the relationship between the radar cross-section ratio ($\sigma/\sigma_{\text{ref}}$) and frequency for different types of objects. The $x$-axis represents frequency, while the $y$-axis represents the ratio of radar cross-section ($\sigma$) to the reference radar cross-section ($\sigma_{\text{ref}}$). The graph shows resonant objects, such as fish larvae, and non-resonant objects like swimbladdered fish and fluid-like zooplankton. Different categories of objects are indicated by their radar cross-section ratios at specific frequencies (18kHz and 200kHz). The graph is courtesy of Rolf Korneliussen.
Tracking of individuals

Handegard et al. (2005)
Tracking individual fish from a moving platform using a split-beam transducer

Handegard (2007)
Observing individual fish behavior in fish aggregations: Tracking in dense fish aggregations using a split-beam echosounder
Within school behaviour

Lowering the transducer* into the school

*Simrad EK60 echo sounder with a ES38DD Split beam transducer (pressure stabilized)
Estimating tailbeat frequency

Handegard et al. (in press)
Estimating Tail-beat Frequency using split-beam echosounders
ICES Journal of Marine Science, in press
• Introduction
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• Methods
• Applications – What we have done
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Silent vessels are not quiet

R/V G.O.Sars
R/V Johan Hjort

EK60 / ADCP / Hydrophone
Silent vessels are not quiet

Ona et al. (2007)

Silent research vessels are not quiet
JASA Express Letters
What to expect
Diel effects – support modelling

- 25m

**Day**

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**Night**

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25m
The arrival of herring in 2006

• Demonstrates increasing biomass and changing behaviour.

27/10/06
25/11/06

10/11/06
New acoustic technology for assessing ecosystem processes – improving predictions from a drift model for 0-group gadoids in the Barents Sea

Geir Odd Johansen, Olav Rune Godø, Morten Skogen & Terje Torkelsen
• Introduction
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EURO-ARGO

- Acoustic systems to measure zooplankton from new generation ARGO floats
- Challenge: Power
Designing an Ocean Mid-trophic Automatic Acoustic Sampler (MAAS)

January 15-19, 2007, Sète, France

- Needs two complementary approaches:
  - A more sophisticated system
  - A simple pelagic drifter to be deployed widely
- Cliotop MAAS endorsed by CLIOTOP SC
- Two phases
  - Prototype development (phase 1, project plan developed)
  - Large scale deployment (phase 2)

Satellite data transmission

Database/web

Analysis

Data assimilation

0-700m vertical profile of mesozoo/micronekton biomass

Stratis Georgakarakos (IMB, Greece), Olivier Maury (IRD, France), Lars Nonboe Endersen (SIMRAD, Norway), David Demer (NOAA, USA), Rudy Kloser (CSIRO, Australia), Erwan Josse (IRD, France), Laurent Dagorn (IRD, France), Christophe Corbières (Simrad, France) Nils Olav Handegard (IMR, Norway), Patrick Lehodey (CLS, France), François Gerлотto (IRD, France), Hiroki Yasuma (HOKKAIDO UNIVERSITY, Japan), Meng Zhou (UMB, USA), M-H. Radenac (IRD), P. Gaspar (CLS).
What we would like to do

• Couple models and observations
• Test of concept:
  – Couple observations and models based on existing series
  – Deployment of existing systems to feed models
• Develop observation models