Joint Industry Programme (JIP) on Exploration & Production Sound and Marine Life

Programme Review Meeting

October 28-30, 2008

International Association of Oil & Gas Producers

PH01199

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Houston, Texas - Marriott Westchase

International Association of Oil & Gas Producers

Welcome!

October 28, 2008

Welcome to Houston and the first public review of the research undertaken by the Joint Industry Programme (JIP) on Sound and Marine Life.

Since its start 2.5 years ago, the JIP has funded more than 50 projects. Some of these are now completed. Others are still underway. During the next three days, you will hear about all of them from the researchers themselves.

To make the most of this opportunity for everyone concerned, I would like to encourage you to voice any questions you have about the work of the JIP. Equally valuable will be your own insights into the topics covered – as well as any suggestions you might have for future JIP research.

On the subject of logistics, if you have any questions about the agenda or any other PRM arrangements, please contact Mary Monaco of Shell on her cell (281-217-2637) or email (Mary.Monaco@Shell.com).

In closing, on behalf of the JIP, I'd like to thank you for joining us and hope that I can welcome you in person to the PRM reception here at the hotel's Rosegarden Room on Tuesday evening at 6.30 PM.

Yours sincerely,

John Young
Chair
JIP Executive Committee

Table of Contents

E&P Sound & Marine Life:
A joint industry programme (JIP) managed by OGP

In May 2006 many of the world's leading oil & gas companies and an industry association embarked on the second phase of a multi-year Joint Industry Program (JIP) to advance the understanding of the effects of sound on marine life. An approximately $24 million programme over three-year was commenced. Its aim: to advance the scientific understanding of the effects of sound generated by offshore oil and gas exploration and production operations on marine mammals, fish and reptiles through independent research projects – undertaken by some of the leading scientists and institutions in this field.
Committed to transparency from the outset, the programme has charted its progress on www.soundandmarinelife.org
Now, as research results from the commissioned studies come in, the JIP is hosting a three-day Programme Review in Houston, U.S.A. It will feature updates on all the research undertaken to date.
This work is testing scientific hypotheses and producing the data needed to address three main areas:

- What are the risks to marine life of procedures such as the oil & gas industry's seismic exploration, drilling or construction?
- Are additional mitigation measures necessary – and if they are, which are required?
- How might current methods of upstream operation be improved, as it relates to sound introduced to the marine environment?

To help answer these questions, the JIP's work is focusing on six areas:

- Sound source characterisation and propagation
- Physical, physiological and hearing effects
- Behavioural reactions and biologically-significant effects
- Mitigation and monitoring
- Additional research tools, and
- Communication of results.

Using the findings made by JIP research, the oil & gas industry will be able to determine what changes to exploration and production activities might be needed to safeguard marine life. These measures can then form the basis for more efficient and environmentally safe oil & gas operations to find the new sources of oil & gas that -- according to the International Energy Agency – the world will still need for decades to come.
By the end of its second year, the JIP had funded a total of 57 projects collectively worth a total of US$16.4 million.

About OGP:

The International Association of Oil & Gas Producers (OGP) encompasses most of the world's leading publicly-traded, private and state-owned oil & gas companies, oil & gas associations and major upstream service companies. OGP members produce more than half the world's oil and about one third of its gas.

The Association was formed in 1974 to develop effective communications between the upstream industry and an increasingly complex network of international regulators. From its headquarters in London, OGP's mission is to represent the interests of the upstream industry before international regulators and legislators and UN bodies such as the International Maritime Organization and the Commission for Sustainable Development. OGP also works with the World Bank and with the International Organization for Standardization (ISO). It is also accredited to a range of regional bodies that include OSPAR, the Helsinki Commission, the Barcelona Convention and the Arctic Council.

From an office in Brussels, OGP provides an essential conduit for advocacy and debate between the upstream industry and the European Union (EU). This involves regular contact with the European Commission and the European Parliament.

OGP also helps members achieve continuous improvements in safety, health and environmental performance, corporate social responsibility and in the engineering and operation of upstream ventures. OGP's extensive international membership brings with it a wealth of know-how, data and experience. OGP committees and task forces manage the exchange and dissemination of this knowledge through publications and events around the world.

For more information about OGP, visit www.ogp.org.uk

Area Restaurants

	AMERICAN/CONTINENTAL	
Republic *(Grill)*	2900 Briarpark	713-978-7400
Brownstone	2736 Westheimer	713-520-5666
Café Annie's	1728 Post Oak	713-840-1111
Magic Island	2215 Southwest Freeway	713-526-2442
Rainbow Lodge	2011 Ella	713-861-8666
Vargo's	2401 Fondren	713-782-3888
Tony's	3755 Richmond	713-622-6778
	ASIAN CUISINE	
Red Basil *(Thai)*	11322 Westheimer	281-293-0426
Benihana *(Sushi)*	9707 Westheimer	713-789-4962
Kaneyama *(Sushi)*	9527 Westheimer	713-784-5168
Miyako *(Sushi)*	6345 Westheimer	713-781-6300
PF Chang's	11685 Westheimer	281-920-3553
Pang Tai's	10811 Westheimer	713-975-7321
Yao Restaurant	9755 Westheimer	832-251-2588
RA *(Sushi)*	3908 Westheimer	713-621-5800
	SEAFOOD	
Landry's	8616 Westheimer	713-975-7873
Goode Co.	10211 Katy Freeway	713-464-7933
	STEAKHOUSES	
Taste of Texas	10505 Katy Freeway	713-932-6901
Lynn's	955 Dairy Ashford	281-870-0807
Perry's	9827 Katy Freeway	832-358-9000
Tommy's Seafood/ Steak	11660 Westheimer	281-679-1112
	ETHNIC CUISINES	
Fuegovivo *(Brazilan)*	11681 Westheimer	281-597-8108
Bistro Le Cep *(French)*	11112 Westheimer	713-783-3985
Bohemia *(Euro-Continental)*	10850 Westheimer	832-252-7600
Ashina *(Indian)*	12610 Briar Forest	281-679-5555
Churrasco's *(Latin)*	9705 Westheimer	713-952-1988
Fogo De Chao *(Brazlian)*	8250 Westheimer	713-978-6500
Rudi Lechner's *(Austrian)*	2503 Gessner	713-782-1180
Kasra *(Persian)*	9741 Westheimer	713-975-1801
	ITALIAN	
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Piatto	11693 Westheimer	281-759-7500
	MEXICAN	
Cantina Laredo	11129 Westheimer	713-952-3287
Las Alamedas	8516 Katy Freeway	713-461-1503
Molina's	7901 Westheimer	713-782-0861
Pappasito's	6445 Richmond	713-784-5253
	BARBECUE	
Goode Co. BBQ	8911 Katy Freeway	713-464-1901
Pappas BBQ	9797 Westheimer	713-780-0081

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WORKSHOP AGENDA

October 28-30, 2008

Agenda - Tuesday October 28, 2008

Meeting Objectives:

1. Demonstrate the quality and extent of research the JIP has supported so far and help inform decisions about future work.
2. Review each project using expert reviewers attending the Programme Review Meeting.
3. Review the full JIP research programme by asking the external advisory panels to gauge research projects against programme priorities.
4. Demonstrate JIP research to the international acoustic community and receive advice on future JIP research.

Agenda - Tuesday October 28, 2008

Time		Minutes	Discussion Topic	Abstract #	Presenter	Organization
Start	Finish					
7:00 AM	8:00 AM	60	**Breakfast** (Outside Salons A-E)			
8:00 AM	8:30 AM	30	Welcome, Agenda Review, Introductions & Kickoff, Safety Moment		Rebecca Nadel	JIP Member- Shell
8:30 AM	8:50 AM	20	Welcome: Background of JIP and Purpose of Meeting		John Young	JIP Member- ExxonMobil
8:50 AM	9:10 AM	20	Overview of JIP Programme		Roger Gentry	JIP- Programme Manager
			Sound Source Characterisation & Propagation			
9:10 AM	9:30 AM	20	Review of existing data on underwater sounds produced by the oil and gas industry	1	Roy Wyatt	Seiche Measurements Ltd, UK
9:30 AM	9:40 AM	10	Standardising Methods of Measuring Underwater Sound	2	Mike Jenkerson	JIP Member- ExxonMobil
9:40 AM	10:10 AM	30	**Break: PAMGUARD Demo (Optional)**			
10:10 AM	10:30 AM	20	Single airgun and cluster measurement project	3	Anders Mattsson	PGS
10:30 AM	11:20 AM	50	Source Characterisation Study (SCS) 07 - Measurements and Modeling for 3-D Characterisation of a Seismic Airgun Array Acoustic Field, Parts I and II	4, 5	Arslan Taskmukhambetov, Phil Summerfield, George Ioup	Univ. of New Orleans, US Navy, JIP Member- ExxonMobil, Univ. of New Orleans
11:20 AM	11:40 AM	20	Environmental Assessment of Marine Vibroseis	6	John Richardson	LGL
11:40 AM	12:25 PM	45	Facilitated Panel Discussion: Sound Source Characterisation & Propagation		Mike Jenkerson	JIP Member- ExxonMobil
12:30 PM	1:30 PM	60	**Lunch (Rosegarden Room)**			
			Physical, Physiological and Hearing Effects of Sound			
1:30 PM	1:50 PM	20	Marine mammal temporary threshold shift (TTS) tests with a seismic airgun sound source	7	Brian Branstetter	US SPAWAR Lab
1:50 PM	2:10 PM	20	Assessing the hearing capabilities of mysticte whales: a proposed research strategy for the Joint Industry Programme on Sound and Marine Life	8	Colleen Reichmuth	University of California Santa Cruz
2:10 PM	2:30 PM	20	Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations	9	Jeanette Thomas	Western Illinois University
2:30 PM	3:00 PM	30	**Break: PAMGUARD Demo (Optional)**			
3:00 PM	3:20 PM	20	Minke Whale Hearing: Micro to Macro Analyses Part 1: Cytoarchitecture and Head Anatomy	10	Darlene Ketten	WHOI
3:20 PM	3:40 PM	20	Modeling Mysticete Hearing	11	David Mountain	Boston University
3:40 PM	4:00 PM	20	Auditory Evoked Potential Audiogram, Seasonal Movement Measurements and Vocalization of Invidiual Minke Whales in Icelandic Waters	12	Paul Nachtigall	University of Hawaii
4:00 PM	6:30 PM	150	**AFTERNOON BREAK**			
6:30 PM	8:30 PM	120	**WELCOME RECEPTION AND NETWORKING** (Rosegarden Room)			

Agenda - Wednesday October 29, 2008

Agenda - Wednesday October 29, 2008						
Time		Minutes	Discussion Topic	Abstract #	Presenter	Organization
Start	Finish					
7:00 AM	8:00 AM	60	**Breakfast** (Outside Salons A-E)			
8:00 AM	8:30 AM	30	Safety Moment: Learnings from the field		Bruce Mate	Oregon State University
Physical, Physiological and Hearing Effects of Sound - continued from Day 1						
8:30 AM	8:50 AM	20	Hearing Capabilities of Loggerhead Sea Turtles (Caretta caretta) throughout Ontogeny: An Integrative Approach involving Behavioral and Electrophysiological Techniques	13	Soraya Moein Bartol	Virginia Wesleyan College
8:50 AM	9:10 AM	20	Blood Nitrogen Uptake and Distribution During Diving in Bottlenose Dolphins	14	Dorian Houser	Biomimetica
9:10 AM	9:30 AM	20	Model for predicting auditory tissue damage in fish	15	Mardi Hastings	Pennsylvania State University
9:30 AM	9:50 AM	20	Effects of Noise on Aquatic Life	16	Arthur Popper	University of Maryland
9:50 AM	10:30 AM	40	Facilitated Panel Discussion: Physical, Physiological and Hearing Effects of Sound		Roger Gentry, Jennifer Michael	JIP- Programme Manager, JIP Member- Chevron
10:30 AM	11:00 AM	30	**Break: PAMGUARD Demo (Optional)**			
Behavioural Reactions & Biological Significance						
11:00 AM	11:20 AM	20	Effects of sound exposure on the behavior of toothed whales	17	Ian Boyd	SMRU
11:20 AM	11:40 AM	20	Testing of developed GPS/Depth tags on sperm whales in the Sea of Cortez	18	Bruce Mate	Oregon State University
11:40 AM	12:00 PM	20	Cetacean stock assessment in relation to exploration and production industry sound: 1	19	Frank Thomsen	CEFAS
12:00 PM	12:20 PM	20	Cetacean stock assessment in relation to exploration and production industry sound: 2	20	Nathalie Patenaude	LGL
12:30 PM	1:30 PM	60	**Lunch** (Rosegarden Room)			
Behavioural Reactions & Biological Significance - continued						
1:30 PM	1:50 PM	20	Cetacean stock assessment in relation to Exploration and Production industry sound: 3	21	Len Thomas	SMRU
1:50 PM	2:10 PM	20	Cetacean stock assessment in relation to Exploration and Production industry sound: 4 (Northwest Europe)	22	Peter Evans	SEAWatch Foundation
2:10 PM	2:30 PM	20	Critical Review of the Literature on Marine Mammal Population Modeling	23	Edward Keith	Nova Southeastern Univ.
2:30 PM	2:50 PM	20	Critical Review of the Literature on Population Modelling	24	Len Thomas	SMRU
2:50 PM	3:15 PM	25	**Break: PAMGUARD Demo (Optional)**			
3:15 PM	3:35 PM	20	Field studies on seal foraging success as input to the PCAD model	25	Dan Costa	University of California, Santa Cruz
3:35 PM	4:15 PM	40	Application of Risk Assessment for Evaluating the Effects of Sound from E&P Operations on Marine Life	26	Judy Muir	LGL
		0	A review of literature to estimate PCAD related transfer functions	27	Lars Bejder	Murdoch University Cetacean Research Unit
4:15 PM	5:00 PM	45	Facilitated Panel Discussion: Behavioural Reactions & Biological Significance		Roger Gentry, Rodger Melton	JIP- Programme Manager, JIP Member- ExxonMobil
5:00 PM	7:00 PM	120	**EVENING BREAK** (Dinner on own)			
7:00 PM	9:00 PM	120	**WORKING SESSION: Future JIP Priorities** (Salons A-E)		Roger Gentry	JIP- Programme Manager

Agenda - Thursday October 30, 2008

Agenda - Thursday October 30, 2008						
Time		Minutes	Discussion Topic	Abstract #	Presenter	Organization
Start	Finish					
7:00 AM	8:00 AM	60	**Breakfast** (Outside Salons A-E)			
8:00 AM	8:30 AM	30	Safety Moment: Learnings from the field		Paul Nachtigall	University of Hawaii
			Mitigation & Monitoring			
8:30 AM	8:50 AM	20	Review of existing and future potential treatments for reducing underwater sound from oil & gas industry activities	28	Jesse Spence	Noise Control Engineering, Inc
8:50 AM	9:10 AM	20	Identification of potential utility of and collation of existing marine mammal observer data	29	Mike Mason	RSK Group
9:10 AM	9:30 AM	20	Integration and testing of an Acoustic Vector Sensor into 3-D tracking PAM Array to Resolve Left/Right Ambiguities	30	Aaron Thode	UCSD (SIO)
9:30 AM	10:00 AM	30	Semiautomated, Open Source Software for Real-Time Acoustic Detection and Localisation of Cetaceans	31	Doug Gillespie	SMRU
10:00 AM	10:30 AM	30	**Break: PAMGUARD Demo (Optional)**			
10:30 AM	10:50 AM	20	Development and Implementation of Automatic Classification of Odontoctes Within PAMGUARD	32	Doug Gillespie	SMRU
10:50 AM	11:10 AM	20	Passive Acoustic Detection and Localisation in PAMGUARD	33	Dave Mellinger	Oregon State University
11:10 AM	11:30 AM	20	PAM Mysticete Detection Algorithms and Performance - An improvement for PAMGUARD	34	Joe Hood	Akoostix Inc
11:30 AM	11:50 AM	20	Development (and PAMGUARD integration) of software for real-time acoustic identification of cetacean species	35	Julie Oswald	University of Hawaii
12:00 PM	1:00 PM	60	**Lunch** (Rosegarden Room)			
			Mitigation & Monitoring - continued			
		0	Health of the field - Fixed PAM technology/methodology Inventory	36	Dave Moretti	INSIG Inc
1:00 PM	1:20 PM	20	Review of fixed passive acoustic monitoring methods and technologies	37	Tom Norris	Bio-Waves Inc
1:20 PM	1:40 PM	20	DECAF: Density Estimation for Cetaceans from passive Acoustic Fixed sensors	38	Len Thomas	CREEM St. Andrews
1:40 PM	2:00 PM	20	Evaluation of fisheries sonar for whale detection in relation to seismic survey operations	39	Frank Reier Knudsen	Simrad
2:00 PM	2:20 PM	20	Mitigation and Monitoring: Review / Inventory of Current Active Acoustic Methods and Technologies	40	James Theriault	Defence R&D Canada - Atlantic
2:20 PM	2:50 PM	30	**Break: PAMGUARD Demo (Optional)**			
2:50 PM	3:45 PM	55	Facilitated Panel Discussion: Mitigation & Monitoring		David Hedgeland	JIP Member- IAGC
3:45 PM	4:00 PM	15	Closing Remarks		Charles Bowen	OGP

Abstracts

TUESDAY

October 28, 2008

Abstract 1

Tuesday, October 28, 2008 * 9:10 AM

Review of existing data on underwater sounds produced by the oil and gas industry

Presenter: Roy Wyatt

Principle Investigator, Collaborators and Affiliations: Roy Wyatt CEO of Seiche Measurements LTD

ABSTRACT

During the exploration, development, production and decommissioning phases of offshore oil and gas reserves, these activities contribute to the noise levels in the oceans, estuaries and rivers of the world. The purpose of this report is to catalogue and assess the available data that characterise the underwater sounds made by the oil and gas industries in all phases of their activities.

Few measurements have been made on underwater noise sources, and those that have been made are often limited in their scope to due to vessel time, operational and weather constraints. Comparison between measurements by different observers can be difficult due to the vast range of ever changing conditions encountered in the ocean seabed, and sea surface. Many metrics can be used to describe the acoustic properties of a sound source with little standardisation between experiments.

This report reviews the available data on noise in the oceans produced by the oil and gas industries, however; due to the scarcity of data in some areas, other noise sources are included for comparative purposes.

Project Objectives:

- Find existing published work on underwater noise.
- Review existing published work on underwater noise.
- Convert data into units and tabulate where possible.
- Report on findings.

Project Contract Dates: January 2007 to August 2008.

Notes

Abstract 2

Tuesday, October 28, 2008 * 9:30 AM

Standardizing methods of measuring underwater sound

Presenter: Mike Jenkerson - ExxonMobil

Principle Investigator, Collaborators and Affiliations: PSG members and outside experts

ABSTRACT

Further data collection for E&P sources will be required both for seismic and non-seismic sources. It is critical to develop equipment and methodologies (e.g., instruments, personnel, documented methods, data analysis techniques) that will allow new high quality data to be acquired. A standard consistent method for the acquisition and analysis of this data will facilitate a better assessment and comparison of E&P industry sounds. This project will define a standard methodology (and equipment specifications) for the acquisition and analysis of E&P acoustic data. This project will:

1. Conduct working groups on the acoustic acquisition equipment and methodology, standards and procedures.
2. Determine the key acoustic metrics relevant to biological exposure assessments and any estimation of biological significance.
3. Ensure that the results from JIP acoustic studies are reported using consistent metrics and that all required supporting data (e.g. window lengths, signal to noise) are appropriately recorded and reported, so studies can be appropriately compared. It will also discuss which metrics are most appropriate when discussing different features of an acoustic signal. This will include:
   a) Standard methodologies for the analysis of transient and continuous acoustic data.
   b) Standard methodologies for the analysis of velocity data.
   c) Treatment of calibrations. Should the calibrations be defined as part of the analysis?
   d) Where possible it will establish the relationships between any new analysis measures and metrics used in previous work, especially biological (e.g. damage or behaviour) studies, and determine any correction factors to be applied to data acquired or analyzed in a non-standard manner to bring it to the standard.
4. Provide standard metrics which can be referenced by consultants/contractors or researchers working on JIP and industry E&P projects to ensure reporting consistency.
5. If possible, the standard will be published in a peer reviewed publication or as a defined standard (SEG or ASA). The standard could also be integrated with another appropriate standard if the integrity of the work conducted under the JIP standard is maintained.

Project Objectives:

1. Standard for the acquisition of acoustic data (equipment and methodology).
2. Standard for the analysis of acoustic data (metrics, correction factors and calibrations)

Project Contract Dates: Both standards are expected to be available within 18 months.

Notes

Tuesday, October 28, 2008 * 10:10 AM

Single Airgun and Cluster Measurement Project

Presenter: **Anders Mattsson, PGS**

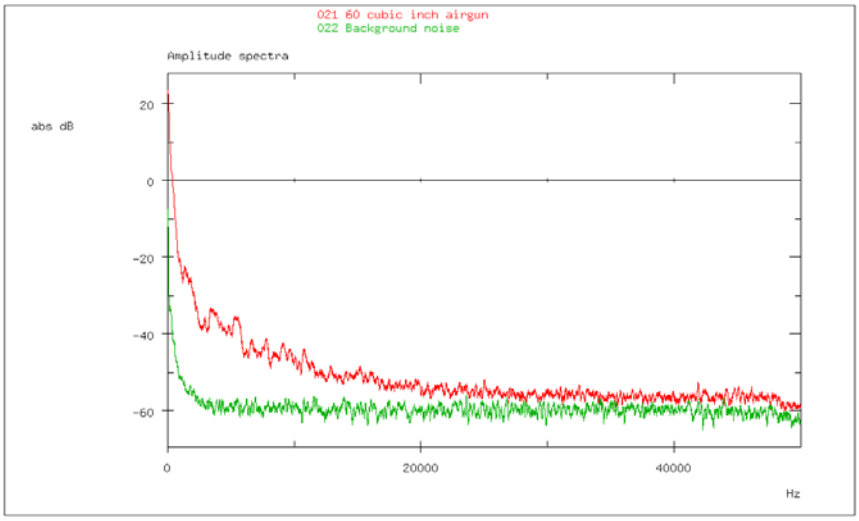
Principle Investigator, Collaborators and Affiliations:
Mike Jenkerson, ExxonMobil

ABSTRACT

The emission characteristics of a seismic airgun below ~200 Hz are well known and have been well documented by the industry. There has also been significant research at frequencies up to ~500Hz, however so far there has never been a thorough investigation at higher frequencies. Extensive new measurements, up to 50 kHz, have now been made of some of the different airgun types used in the industry. These new data will help improve the theoretical models of airguns, particularly at very high frequencies and will also greatly improve our understanding of how the seismic airgun might effect the marine environment.

A test site was built in a fjord on the west coast of Norway and near-field and far-field measurements of single airguns were conducted from June to October 2007. Airgun type, volume, pressure and firing depth were varied in the experiment. To ensure fish welfare in the nearby fish farms, the nearest fish farm (cod), at 14 km distance from the test site, was monitored by a local research group, using a video camera and hydrophone, at project start-up and after the longer breaks in the program. The same research group also monitored the daily routines of feeding, growth, mortality and health control at all the nearby fish farms.

The figure below shows a 60 cubic inch gun amplitude spectrum out to 50 kHz overlaid on the spectrum of the background noise.



Project Objectives:

- To conduct near-field and far-field measurements of airgun signatures up to 50 kHz. These measurements will serve as a foundation for development of a high frequency theoretical model of this seismic source.

Project Contract Dates: 1 April 2007 to 31 December 2009.

Notes

Tuesday, October 28, 2008 * 10:30 AM

Source Characterization Study 2007: Measurements and Analysis for 3-D Characterization of a Seismic Airgun Array Acoustic Field - Part I

Presenters: George E. Ioup, Arslan M. Tashmukhambetov, Phil Summerfield

Principal Investigators, Collaborators, and Affiliations: Joal J. Newcomb (NRL-SSC), George E. Ioup (UNO), Juliette W. Ioup (UNO), Arslan M. Tashmukhambetov (UNO), Natalia A. Sidorovskaia (UL Lafayette), James Stephens (USM), Grayson H. Rayborn (USM), Phil Summerfield (Exxon Mobil)

ABSTRACT

The Source Characterization Study, 2007 (SCS07), conducted by the Littoral Acoustic Demonstration Center (LADC), is being sponsored by the Joint Industry Project (JIP) through the International Association of Oil and Gas Producers (OGP). LADC is a consortium of scientists from the University of Southern Mississippi (USM), the University of New Orleans (UNO), the University of Louisiana at Lafayette (UL Lafayette), the Naval Research Laboratory at Stennis Space Center (NRL-SSC), and the University of Texas at Austin Applied Research Laboratories (ARL-UT) with technical guidance and support from the Naval Oceanographic Office at Stennis Space Center (NAVOCEANO). LADC made calibrated seismic airgun array measurements in the summer of 2003. The results and analysis are presented in Jour. Acoust. Soc. Am. 123, 4094-4108, 2008. Subsequently LADC was approached by the JIP to conduct full three-dimensional calibrated measurements of the airgun array acoustic field in the ocean. Initially it was planned to conduct these experiments during a normal seismic exploration survey, but this did not prove to be feasible. Instead a seismic vessel was dedicated to shoot the lines necessary for the measurements. An extensive experimental design exercise was carried out with important input from JIP scientists. Initially the design goal was complete solid angle coverage, which evolved to have added a requirement for close range shots into all the solid angles. All ranges having direct arrivals to the hydrophones were included. The lines were refined to reduce redundancy and minimize the time required to shoot them. Solid angle bins determined by the uncertainty in emission angle and azimuth were ultimately used to determine the adequacy of the coverage.

Project Objectives:

- To design and conduct an experiment to measure the three-dimensional acoustic field of a seismic airgun array in the water column with comprehensive solid angle and range coverage and accurate knowledge of source and hydrophone locations.
- To analyze the measured data for peak pressure, sound exposure level, spectral content, one-third octave bands, and array directional pattern.
- To model the sound propagation from the array using source signatures and a parabolic equation acoustic propagation program code modified to include multiple sources.

Project Contract Dates: 1 Aug 2006 to 31 Aug 2009.

Notes

Tuesday, October 28, 2008 * 10:30 AM

Source Characterization Study 2007: Measurements and Analysis for 3-D Characterization of a Seismic Airgun Array Acoustic Field - Part II

Presenters: George E. Ioup, Arslan M. Tashmukhambetov, Phil Summerfield

Principal Investigators, Collaborators, and Affiliations: Same as Part I

ABSTRACT

The experiment was performed from 2 September through 22 September 2007. The source ship was the M/V Fairfield ENDEAVOR with the M/V Veritas VANTAGE providing lines of opportunity as it was in the area of the experiment. The R/V CAPE HATTERAS was used to deploy, manage, and recover the receiving hydrophone arrays. The acquisition technology consisted of calibrated Environmental Acoustic Recording System (EARS) buoys developed by NAVOCEANO. A total of 48 hydrophones were deployed in co-located pairs consisting of one sensitive and one desensitized phone. The densensitized phones were needed to give unclipped measurements when the source array was nearby. Sixteen phones were on each of two long vertical mid-water column bottom-moored arrays and eight phones were on a deeper vertical bottom-moored array in approximately 1500 m water depth. An additional eight hydrophones were on a vertical array deployed from the HATTERAS near the surface. The ENDEAVOR shot a pattern of parallel lines over a small rectangle with closely spaced lines contained inside a larger rectangle with less closely spaced lines contained inside a still larger rectangle with even more spacing between the lines. Two long perpendicular lines extending outside the rectangles were shot for propagation analysis. The total data collected are about 3.5 TB.

An Ultra Short Baseline Localization (USBL) system was deployed with the EARS moorings. Each mooring was equipped with several USBL transponders to monitor the array declination and deformation in real time and were interrogated on a regular basis from the HATTERAS. After post analysis this will result in time-dependent depths of each of the acoustic sensors.

The data analysis plan includes isolating the direct arrival part of each shot. In future work, maximum zero-to-peak and peak-to-peak values will be calculated for these direct arrivals as well as the sound exposure levels including 95% of the energy. Spectral energy versus frequency will be calculated for each shot as well as the spectral energy analyzed into one-third octave bands. All these results will be displayed versus solid angle and range to give insight into understanding the three-dimensional acoustic field. The three-dimensional directional pattern of the array will be reconstructed for multiple frequencies. The experimental results will be modeled using source signatures generated by Gundalf and Nucleus and a range-dependent acoustic model (RAM) modified to include all the sources in the airgun array. Previous agreement of the model calculations with experimental measurements using this technique as reported in the above mentioned JASA reference has been good.

Project Objectives:

- To design and conduct an experiment to measure the three-dimensional acoustic field of a seismic airgun array in the water column with comprehensive solid angle and range coverage and accurate knowledge of source and hydrophone locations.
- To analyze the measured data for peak pressure, sound exposure level, spectral content, one-third octave bands, and array directional pattern.
- To model the sound propagation from the array using source signatures and a parabolic equation acoustic propagation program code modified to include multiple sources.

Project Contract Dates: 1 Aug 2006 to 31 Aug 2009.

Notes

Tuesday, October 28, 2008 * 11:20 AM

Environmental Assessment of Marine Vibroseis

Presenter: W. John Richardson[1]

Principal Investigator, Collaborators and Affiliations: M. Gilders, J. Christian, V.D. Moulton and W.J. Richardson (LGL) [1] **and W.T. Ellison, A.S. Frankel, S.J. Labak and D. Zeddies (MAI)** [2]

ABSTRACT

Marine vibroseis (MV) with marine vibrators as energy sources has been proposed and to a limited degree tested as a way of obtaining marine seismic data without using airguns. MV might have reduced environmental effects relative to airgun arrays. MVs would produce underwater signals with lower peak pressure, slower rise time, and proportionally less energy above 100–200 Hz. These differences in signal properties are, other factors being equal, expected to result in reduced effects of MVs (as compared to airguns) on marine animals. However, MV signals would also have longer durations and a higher duty cycle than airgun pulses, which might tend to offset (to an uncertain degree) the assumed benefits of MVs. Also, the tradeoffs may differ depending on type and activity of the animals, local sound propagation conditions, etc.

This study, through review of available data for current and planned MV systems, a comparison with data for airguns, and acoustic modeling,

1. evaluates available technical data on MV;
2. conducts modeling to assess the acoustic and particle velocity footprints of MV sources;
3. assesses potential impact of MV units on key biological receptors, and compares impacts with those expected if airguns were used;
4. recommends mitigation measures appropriate to MV, including sweep properties; and
5. identifies data gaps and recommends future studies to address those data gaps.

Biota considered in the environmental assessment (EA) include invertebrates, fish, sea turtles, and marine mammals, with greatest emphasis on marine mammals. Types of effects being considered are behavioral disturbance, masking, potential auditory effects (temporary and permanent), and other possible physiological effects including resonance. The EA is generic rather than site- or equipment-specific. However, portions of the evaluation compare potential effects of exemplary MV or airgun configurations (with specific signal parameters) operating at specific Gulf of Mexico sites and water depths. For marine mammals, the Acoustic Integration Model developed by Marine Acoustics Inc.[2] is used to assess the potential for cumulative acoustic exposure to exceed levels at which auditory impairment might occur (*cf.* Southall et al. 2007, *Aquatic Mammals* 33[4]). Based on these approaches, the study assesses and compares impacts, identifies potential mitigation measures for MV, and suggests studies to address data gaps.

Project Objectives:

1. Evaluate available technical data on MV
2. Conduct modeling to assess the acoustic and particle velocity footprints of MV sources
3. Assess potential impact of MV units on key biological receptors, and compare impacts with those expected if airguns were used
4. Recommend mitigation measures appropriate to MV, including sweep properties
5. Identify data gaps and recommend future studies to address those data gaps

Project Contract Dates: Dec 2007 to ~Dec 2008

[1] LGL Ltd., environmental research associates, 22 Fisher St., POB 280, King City, Ont. L7B 1A6, Canada
[2] Marine Acoustics Inc., 4100 N. Fairfax Dr., Suite 730, Arlington, Virginia 22203, U.S.A.

Notes

Tuesday, October 28, 2008 * 1:30 PM

Marine mammal temporary threshold shift (TTS) tests with a seismic airgun sound source

Presenter: Brian K. Branstetter, US Navy Marine Mammal Program

Principle Investigator, Collaborators and Affiliations: James J. Finneran, US. Navy Marine Mammal Program

ABSTRACT

Anthropogenic (human-generated) underwater sound may adversely affect the hearing and behavior of many marine mammals, including dolphins and whales. Unfortunately, there are few direct data regarding the effects of intense sound on these mammals, making it extremely difficult to predict safe exposure levels. In addition, most of these studies have focused on exposure to long-duration noise (i.e., white-noise, pure tones) consistent with active sonar and marine vessel noise. Almost no data are available for the effects of high intensity, impulsive sounds, consistent with seismic exploration (seismic airguns) or military ordinance. The objective of this study is to determine levels at which seismic airguns begin to adversely affect the auditory systems of trained odontocetes in natural ocean waters by relating acoustic features of airgun impulses to acoustic overload thresholds for these marine mammals. Temporary threshold shift (TTS) measurements will be made to quantify the impact of underwater impulses produced by a representative airgun on these mammals. To date, the test subjects have been trained for the proposed experiments and baseline audiograms have been measured. Results obtained from this study will be used to establish the physiological auditory impact for each exposure condition. These data may then be used to develop damage risk criteria for wild marine mammals exposed to these devices. From such risk criteria, more accurate determinations can be made for any mitigation required to prevent injury to marine mammals

Project Objectives:

1. Measure TTS in odontocetes exposed to a seismic airgun sound source
2. Relate the physiological effects on hearing with acoustic variables related to the airgun sound source
3. Develop safe exposure criteria for mitigation purposes

Project Contract Dates: January 2008 to June 2011.

Notes

Tuesday, October 28, 2008 * 1:50 PM

Assessing the hearing capabilities of mysticte whales: a proposed research strategy for the Joint Industry Programme on Sound and Marine Life

Presenter: **Colleen Reichmuth**

Principle Investigator, Collaborators and Affiliations: Colleen Reichmuth

ABSTRACT

One of the most difficult problems faced by those charged with protecting animals from anthropoentic noise in marine environments is decision making in the absence of essential information. The mysticetes, or baleen whales, are species of particular concern with respect to this issue for several reasons, including their dependence on sound for social communication, their global distribution, and their vulnerable conservation status following massive human exploitation over the past several centuries. Presently, there is an immediate need for reliable estimates of hearing cabilities of mysticetes; however, scientists face numerous challenges in acquiring this information. A coodinated research stragey that identifies possible technical approaches to this problem, evaluates potential benefits and limitations of these approaches, prioritizes techology development and research efforts, and outlines funding and logistical requirements, is the vital first step towards addessing a topic of this scale and significance. This paper suggests such a research strategy for the Joint Industry Programme on Sound and Marine Life. The content is based on review of published and grey literature and discussion with experts in the field, as well as a survey of informal pre-proposals solicited to gain insight into possible novel approaches to this topic. The research problem is defined and placed in the context of available knowledge of mysticete sound production and communication, responses of free-ranging whales to sounds, neuro-physiological responses to sound, and anatomy and anatomy-based modeling. Overarching goals in the assessment of mysticete hearing capabilites are outlined, and specific knowldege gaps and general research needs are identified. Research priorities are established by topical area, and a "top-ten" list of pratical science and funding recommendations are provided. Significant challenges including some of the techonology requirements to support successful action on these recommendations are discussed.

A complete copy of the white paper can be accessed at:
http://www.soundandmarinelife.org/Site/Products/MysticeteHearingWhitePaper-Reichmuth.pdf

Project Objectives:

- To create a research strategy for measuring hearing in mysticete whales

Project Contract Dates: 13 Jan 2007 to 12 Sep 2007.

Notes

Tuesday, October 28, 2008 * 2:10 PM

Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations

Presenter: Dr. Jeanette Thomas, Editor of *Aquatic Mammals*

Principle Investigator, Collaborators and Affiliations: Brandon L. Southall, Ann E. Bowles, William T. Ellison, James J. Finneran, Roger L. Gentry, Charles R. Greene Jr., David Kastak, Darlene R. Ketten, James H. Miller, Paul E. Nachtigall, W. John Richardson, Jeanette A. Thomas, & Peter L. Tyack

ABSTRACT

These 13 authors compiled six years of information gathered at meetings and from the peer-reviewed literature directed at developing noise exposure criteria for marine mammals and published the results in a special issue of *Aquatic Mammals*, Volume 33, Number 4, pages 411- 521, 2007. The issue is also available online through *Ingenta* and on a CD. The intent of the issue was to summarize peer-reviewed literature to date, recommend noise exposure criteria, and provide a framework to which updates to the criteria could be applied as new research becomes available. The 110-page issue summarized available data on the effects of acoustic exposure(s) on marine mammals were well-documented; that is, exposure levels at the animal were documented and behavioral and/or physical responses were known. Data were organized into a matrix with five marine mammal groups (high-frequency odontocetes, mid-frequency odontocetes, low frequency mysticetes, pinnipeds in water, and pinnipeds in air). The second dimension of the matrix was three sound types: single pulse, multiple pulses, and non-pulsatile noise. For each cell in this matrix criteria were recommended for both physical *injury* and for *behavioral disturbance.* For the first time, an m-weighting function (marine mammal hearing curve) was suggested for each of the five marine mammals groups. For the first time, behavioral responses by marine mammals exposed to noise were rated on a scale of 0 to 9. An extensive Literature Cited section provides the up-to-date peer reviewed references through 2007. The issue did not provide criteria for noise exposure to polar bears, sea otters, manatees, or sea otters. The issue ends with Research Recommendations that can help direct research priorities to revise the criteria and especially to provide data in cells with no available data.

Project Objectives: (Bulleted list of no more than 5 entries)

1. Compile comments from 13 authors into a single issue of *Aquatic Mammals*
2. Edit and revise text for special issue of *Aquatic Mammals* on noise criteria for marine mammals
3. Format, print, and mail hard copies of special issue
4. Place special issue online through Ingenta and ProQuest
5. Make CDs available through *Aquatic Mammals*

Project Contract Dates: March 2007 to March 2008.

Notes

Tuesday, October 28, 2008 * 3:00 PM

Minke Whale Hearing: Micro to Macro Analyses
Part 1: Cytoarchitecture and Head Anatomy

Presenter: **D.R. Ketten**

Principle Investigator, Collaborators and Affiliations:

D.R. Ketten **Senior Scientist, Biology Department** **Woods Hole Oceanographic Institution** **Woods Hole, Mass. 02543** **dketten@whoi.edu**	**David Mountain, Ph. D.** **Professor, Biomedical Engineering** **Boston University** **Boston, MA 02215** **dcm@bu.edu**

ABSTRACT

This project is a preliminary study that applies techniques for modeling acoustic power flow from the middle to the inner ear based on anatomical and mechanical measurements in minke whales to estimate their audiogram. These techniques have previously been applied successfully to odontocete ears and found to provide accurate hearing curve estimates in comparison with published audiograms for both land and marine mammals. The proposed effort involves two integrated teams:
1) An Anatomical Analysis Team (WHOI) that has as its goal to characterize head, middle, and inner ear structures of the candidate species. 2) A Physiological Modeling Team (BU) led that formulates the species-specific model audiogram auditory response models using the anatomical data.

To date, under the JIP funding, 5 intact minke whale heads have been CT scanned. In addition, 14 ears from 7 animals and five brains with the auditory centers intact have been scanned and preserved for further analyses. Two intact ears and surrounding associated peribullar and fatty tissues have also been examined with MRI. These head and ear scans provided the first multi-individual, comprehensive, matrix-based, species-specific databases of head and ear anatomy and tissue density maps of a baleen species head with undisturbed internal anatomy. In addition, five middle and inner ears have been prepared for analysis by the BU Team, and two ears have been processed through histology.

From these tissues and techniques, mandibular fat bodies have been identified proximal to and in communication with the middle ear. These tissues are consistent in shape and volume across individuals and are similar in consistency and color to fats that are known to be an essential component of toothed whale auditory systems. Samples of these fats have been sent to Dr. Heather Koopman (UNC Wilmington) for biochemical analyses.

The histologic sections have also yielded the first data on longitudinal variations in basilar membrane dimensions for this species. The data show the inner ear to be consistent with a 9-10 octave hearing range that is primarily adapted for mid to lower frequencies and with cochlear ratios consistent with better propogation of lower frequencies than is common in odontocete ears.

Project Objectives:

- Development of a morphometric database for minke whale middle and inner ears;
- Direct stiffness measures of the middle ear and of representative points of the inner ear membrane;
- Completion, testing, and publication of a model, generic minke whale audiogram.

Project Contract Dates: 1 Jan 2007 through 31 Dec 2007 extended to 30 March 2008.

Notes

Tuesday, October 28, 2008 * 3:20 PM

Modeling Mysticete Hearing

Presenter: David C. Mountain, Ph.D.

Principle Investigator, Collaborators and Affiliations:

David C. Mountain, Seth Newburg, Andrew Tubelli, and Aleks Zosuls
Boston University Hearing Research Center

Darlene Ketten, Woods Hole Oceanographic Institution

ABSTRACT
The hearing capabilities of mammals are normally assessed through behavorial testing or using acute electrophysiological techniques such as the auditory brainstem response. These techniques, however, are not well suited for use in very large aquatic species such as Mysticetes. The goal of our work is to generalize biophysical models for middle ear and cochlear function in terrestrial mammals so that they can be used to predict hearing function in cetaceans in general and mysticetes in particular . Our approach is based on the acoustic power-flow model in which we model the flow of acoustic power from the external environment through the middle ear and into the cochlea and eventually to the sensory cells within the cochlea. To create models of the different subsystems in the auditory periphery we start with anatomical models derived from conventional and micro CT scans. These anatomical models are then used to generate finite-element or finite-difference computational models which then can be used how acoustic power flows through the system.

In order to estimate the material properties for the bones and tissues for these models, we have developed specialized systems for measuring the stiffnesses of different structures in the peripheral auditory system. The approach is to apply a sinusoidal displacement of known magnitude to a small probe and to measure the resulting force. The results from our experiments in several cetacean species support our hypothesis that the middle ear and cochlea in cetaceans function in a manner very similar to that in terrestrial mammals. We will present examples of our expeirmental measurements as well as results from preliminary modeling studies.

Project Objectives:

- Develop a database of anatomical models for the cetacean auditory periphery
- Develop a database of middle-ear stiffness measurements
- Develop a database of basilar membrane stiffness measurements
- Develop an acoustic power-flow model for cetaceans

Project Contract Dates: January 1, 2007 through September 01, 2008.

Notes

Tuesday, October 28, 2008 * 3:40 PM

Auditory Evoked Potential Audiogram, Seasonal Movement Measurements and Vocalization of Invidiual Minke Whales in Icelandic Waters

Presenter: Paul E. Nachtigall, University of Hawaii

Principle Investigator, Collaborators and Affiliations: Lee Miller[1] Paul Nachtigall[2] , Tomonari Akamatsu[3], Takashi Iwata[4], Aran Mooney[2] , Aude Pacini[2], Alexander Supin[5], Robert Braun[2] , Jonas Teilmann [6], Katja V. Petersen[7], Marianne Rasmussen[8], Jeff Foster[9], Guðlaugur Bjarnason [10], Kristinn Guðlaugsson[10], Smari Hardarson[11], and Gisli Vikingsson [12]

ABSTRACT

Mysticete whales are believed to be low frequency hearing specialists but their hearing thresholds have never been measured. Minke whales, the smallest mysticetes, are abundant and available off the coast of Iceland during the summer. Based on our prior year's success at capture, testing, tagging and releasing white-beaked dolphins and observing minke whales, we outfitted an Icelandic purse-seining ship with a floatable pontoon whale stretcher and attempted to catch a minke whale and temporarily hold it while we measured its hearing thresholds across frequencies using auditory evoked potentials. While we saw 81 minke whales and set the net around whales multiple times, the whales escaped capture. We believe that the herring purse seine (600m by 100m deep, after modification) was not a suitable net for catching minke whales. The whales appeared to be experienced and net-wise and we were not fast, or experienced, enough. The mesh was too small and the net too heavy to enclose the fast whales. We did not have the opportunity to test a whale's hearing or place a tag on a whale.

Project Objectives:

1. Catch a minke whale with an Icelandic purse-seiner.
2 .Measure the hearing of a minke whale using auditory evoked potentials.
3. Tag the whale, release it, and track it to assure its survival and track its natural migratory patterns.

Project Contract Dates: 1 January 2007 to 31 December 2007.

[1] University of Southern Denmark [2] University of Hawaii [3] Fisheries Research, Japan
[4] Tokyo University [5] Russian Academy of Sciences [6] National Environmental Research Institute, Denmark [7] University of Copenhagen [8] University of Iceland, Húsavík
[9] Seattle Washington USA [10] Reykjavik, Iceland [11] Vestmannaeyjar, Iceland
[12] Hafro, Reykjavik, Iceland

Notes

Abstracts

WEDNESDAY

October 29, 2008

Wednesday, October 29, 2008 * 8:30 AM

Hearing Capabilities of Loggerhead Sea Turtles (*Caretta caretta)* throughout Ontogeny: An Integrative Approach involving Behavioral and Electrophysiological Techniques

Presenter: Soraya Moein Bartol

Principle Investigator, Collaborators and Affiliations: Co-PIs: Soraya Moein Bartol, Virginia Wesleyan College and Ian Kurt Bartol, Old Dominion University

ABSTRACT

Little is currently known about sea turtle auditory systems. According to a limited number of electrophysiological studies, sea turtles appear to be low frequency specialists. However, these electrophysiological studies have not been correlated with behavioral responses, a necessary step for comprehensive hearing assessment, and they do not explore hearing capabilities of sea turtles in multiple life history stages. For this project, we have proposed to collect both behavioral audiograms and auditory brainstem responses (ABRs) from loggerhead sea turtles *Caretta caretta* in three developmental stages: hatchlings, juveniles, and sub-adults/adults. We are in the first stage of a three-year project and have initiated behavioral and electrophysiological trials at the National Oceanic and Atmospheric Administration (NOAA) Fisheries Galveston Laboratory, TX. Behavioral audiograms are being recorded using a two-response, forced-choice approach, whereby the turtles are required to vary behavior according to small acoustic stimuli differences, permitting a behavioral measure of acoustic sensitivity. A fully automated stimulus delivery and data acquisition system has been developed in-house and is critical for these experiments. ABRs are being collected from all turtles considered in behavioral experiments so that direct sensitivity threshold comparisons can be performed. ABR experimentation involves implanting electrodes under the sea turtle's scutes and recording evoked neural responses while underwater acoustic stimuli are presented. Although loggerheads are the current focus of our study, we plan to collect behavioral and ABR data on other species as they become available at the NOAA Galveston research facility. Our integrated approach, which involves both behavioral and electrophysiological measures of hearing capabilities, will provide the first comprehensive assessment of sea turtle hearing throughout ontogeny. These data promise to serve as an integral component of future assessment plans that address potential impacts of sound on sea turtles.

Project Objectives:

- collect behavioral audiograms from hatchling, juvenile, and sub-adult/adult loggerhead sea turtles
- collect auditory brainstem responses (ABRs) from the same turtles considered in behavioral experiments
- determine if hearing frequency range and threshold recorded in behavioral and ABR experiments are consistent
- determine if hearing capabilities change during ontogeny

Project Contract Dates: April 1, 2008 to March 31, 2011.

Notes

Wednesday, October 29, 2008 * 8:50 AM

Blood Nitrogen Uptake and Distribution During Diving in Bottlenose Dolphins

Presenter: Dr. Dorian S. Houser

Principle Investigator, Collaborators and Affiliations: P. J. Ponganis[1], T. K. Stockard[1], L. A. Dankiewicz[2] and D. S. Houser[3]

ABSTRACT

In order to evaluate the hypothesis that blood nitrogen (N_2) supersaturation and venous gas emboli underlie the etiology of beaked whale strandings associated with the use of mid-frequency active sonar, heart rate (HR) responses, post-dive blood N_2 levels (partial pressure of N_2: P_{N2}), and asymptomatic intravascular bubble formation were assessed in a diving dolphin (*Tursiops truncatus*) with 1) the use of a backpack digital electrocardiogram (ECG) recorder, 2) Van Slyke analyses of serial post-dive blood samples taken from the peri-arterial venous rete of the fluke, and 3) post-dive ultrasound investigation of the portal and brachiocephalic veins. The dolphin was trained to perform a series of 10 dives to depths of 50, 70, or 100 m, during which ECG was recorded and after which either blood sampling or ultrasound studies were conducted. Surface intervals between dives were approximately one min in duration.

During pre-dive session periods (one min) and post-dive session periods (8-20 min), HRs oscillated in a sinus arrhythmia pattern between 40 and 140 beats min^{-1} (bpm), with mean HRs of 83-101 bpm, and 67-85 bpm, respectively. During all dives, heart rate consistently declined to < 30 bpm within 15 sec, and remained at 20-40 bpm until the ascent period, during which HR increased to 120-130 bpm. Mean dive and surface-interval HRs were 47 $\pm$ 3.5 and 121 $\pm$ 7.4 bpm, 50 $\pm$ 1.8 and 132 $\pm$ 4.8 bpm, 52 $\pm$ 2.7 and 137 $\pm$ 6.0 bpm for dive sessions to 50, 70, and 100 m, respectively. Serial post-dive blood P_{N2}s after dive sessions to each depth were indistinguishable from values of non-diving dolphins at rest. No bubbles were detected in the portal or brachiocephalic veins during post-dive ultrasound investigations.

The lack of elevated post-dive blood P_{N2} values and the absence of asymptomatic intravascular bubbles do not provide evidence to support the hypothesis that N_2 supersaturation during shallow diving contributes to the formation of venous gas emboli in cetaceans. In addition, HR profiles are consistent with a low cardiac output, a restricted volume of distribution for N_2 and a relative limitation of N_2 absorption during these dives until the ascent of the dive, during which the increased HR should promote N_2 transfer back into the lungs and also increase the volume of distribution for N_2. This dive HR pattern and the presumed high N_2 washout during the elevated HRs at the surface should minimize the accumulation of N_2 in the blood during these dive sessions.

Project Objectives:

- Determine heart rate responses in a diving dolphin.
- Measure blood nitrogen levels in a diving dolphin.
- Combine interpretation of 1 and 2 with Dr. Houser's ultrasound findings.
- Evaluate chest impedance signal as indicator of lung volume (inadequate signal).
- Obtain blood nitrogen samples during dives (technique development begun but judged infeasible for a free-diving dolphin at this time by staff veterinarians).

Project Contract Dates: 13Dec 2006 to 30 Sept 2007.

[1] Scripps Institution of Oceanography, UCSD; [2]Science Applications International Corporation, San Diego, CA; [3]Biomimetica, Santee, CA

Notes

Wednesday, October 29, 2008 * 9:10 AM

Model for Prediction of Auditory Tissue Damage in Fish

Presenter: Mardi Hastings

Principle Investigator, Collaborators and Affiliations: Mardi C. Hastings, Ph.D., Penn State University, Applied Research Laboratory, State College, PA 16804, USA

ABSTRACT

The relationships among peripheral auditory mechanics, acoustic signal characteristics, and effects on hearing and auditory systems in fishes are not understood. Several studies in the literature have reported damage to auditory hair cells from nonexistent to extensive in different species of fish exposed to different types of sounds; however, there appears to be no direct correlation between the sound exposure and observed damage. In effort to determine underlying mechanisms controlling the potential for hair cell damage and predict its occurrence, a biomechanical model of the peripheral auditory system in fishes was developed to study the dynamic response of the ear to an incident acoustic wave in five different species. The output of this model is the relative motion between the sensory epithelium and otolith in the inner ear, which bends the apical ciliary bundles of the hair cells. Excessive relative motion was correlated with hair cell damage based on results of studies reported in the literature. Variations in swim bladder geometry, otolith size, anatomical connection between swim bladder and inner ear, spectral characteristics of the received signal, and amplitude and duration of the sound were found to affect the potential for damage.

Project Objectives:

- Predict onset of auditory tissue damage in different species of fish exposed to different types of acoustic signals by developing a mathematical model of the peripheral auditory mechanics and correlating it with results of studies in the literature.
- Enhance understanding of mechanisms for auditory tissue damage in fishes.
- Enhance understanding of acoustic metrics associated with auditory tissue damage in fish.

Project Contract Dates: 1-April-2008 to 31 August 2008.

Notes

Wednesday, October 29, 2008 * 9:30 AM

Effects of Noise on Aquatic Life

Presenter: Arthur N. Popper

Principle Investigator, Collaborators and Affiliations: Arthur N. Popper, Department of Biology, University of Maryland, College Park, MD 20742 USA

ABSTRACT

Over the past several years JIP has provided funding for two meetings that have examined the effects of human-generated sound on marine organisms. One was an "International Conference on the Effects of Noise on Aquatic Life" that was organized by Arthur Popper (College Park, USA), Anthony Hawkins (Aberdeen, Scotland), and Magnus Wahlberg (Odense, Denmark). The conference took place in Nyborg, Denmark, August 13-17, 2007. About 300 participants from more than 20 countries presented over 130 papers that have now been published in the international journal *Bioacoustics* (2008, vol. 17, issues 1-3). The meeting brought together individuals with very diverse interests and approaches to questions about effects of human-generated sound on aquatic life. These included people who approach questions from the persepctive of biology, physics, engineering, policy, and conservation. Moreover, in addition to having presentations that considered data on effects of sound, a number of broader papers were presented that discussed basic principles of acoustics, biology, noise damage, shipping, and many other topics.

The meeting may have been the first international forum in which people with such diverse interests could share ideas and learn from one another. Thus, a major outcome of the meeitng was its substantial enhancement of communications among people from people who take very different perspectives on the effects of human generated sound on the aquatic environment.

The second JIP-supported meeting has been for an international group of scientists and engineers who are assessing what is known about the effects of underwater sound on fish and trutles. This group has been meeting for about three years, and is now developing a report that will examine what is known about effects of sound on fish and turtles, and make initial recommendations regarding criticial research questions for the future.

Project Objectives:

Bring together people from diverse disciplines to share data and ideas about effects of human-generated sound on aquatic organisms

- Provide opportunity for individuals working with different animal groups and taking different experimental approaches to share findings and ideas.
- Define major research questions for future studies.

Project Contract Dates: NA

Notes

Wednesday, October 29, 2008 * 11:00 AM

Effects of sound exposure on the behavior of toothed whales.

Presenter: Ian Boyd

Principle Investigator, Collaborators and Affiliations:
Peter L. Tyack,[1*] Walter MX Zimmer,[2] David Moretti,[3] Christopher Clark,[4] Diane Claridge,[5] Brandon L. Southall,[6] Ian Boyd[7]

ABSTRACT
Initial results are reported from a study designed to provide science-based approaches for mitigating risk of sonar to beaked and other odontocete whales. The study on beaked and other whale behavioral responses to mid-frequency sonar and other sounds was conducted at the Atlantic Undersea Test and Evaluation Center (AUTEC) range near Andros Island, Bahamas, where Blainville's beaked whales (*Mesoplodon densirostris*) can regularly be detected using passive acoustic monitoring of their echolocation clicks. Tags recorded sound at the whale and behavior of the whale. Data were collected from 10 tags; 6 on Blainville's beaked whales, 4 on pilot whales. 109 hours of data were collected from tags; 74h from beaked whales; 34h from pilot whales. Playbacks of mid-frequency sonar and killer whale sounds were performed on 1 tagged beaked whale and 2 tagged pilot whales. The tagged beaked whale responded to both sonar and killer whale sounds by premature cessation of clicking during foraging dives, with uncommonly slow and long ascents. The whale was exposed to a slowly increasing sonar signal resulting in a received level at the whale that varied from below ambient noise to 144 dB (re: 1μPa; all levels RMS). The whale stopped clicking after 9 min when the received level reached 136 dB (Fig. 1B). Following the two exposures, the beaked whale exhibited avoidance of the local area for at least 10h.

Project Objectives:

- Establish, test and refine new protocols for studying beaked whales using established underwater sound playback experiment paradigms.
- Define responses of beaked whales, and other species of odontocete whales, to mid-frequency active (MFA) sonar and natural sounds such as those from killer whales.
- Measure exposure parameters for sounds that evoke a behavioral response.

Project Contract Dates: January 11, 2007 to December 31, 2007.

[1] Woods Hole Oceanographic Institution, Woods Hole, MA 02543, USA.
[2] NATO Undersea Research Centre, 19138 La Spezia, Italy.
[3]Naval Undersea Warfare Center Division, Code 71, Bldg. 1351, Newport, RI 02841, USA
[4] Bioacoustics Research Program, Cornell University, Ithaca NY. 14850, USA.
[5] Bahamas Marine Mammal Research Organization, Sandy Point, Abaco, Bahamas.
[6] National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Science and Technology, Ocean Acoustics Program, 1315 East-West Highway, Silver Spring, Maryland 20910-6233.
[7] Sea Mammal Research Unit, School of Biology, University of St. Andrews, Fife, Scotland, KY16, UK.

Notes

Wednesday, October 29, 2008 * 11:20 AM

Testing of developed GPS/Depth tags on sperm whales in the Sea of Cortez

Presenter: Bruce Mate, Oregon State University, Marine Mammal Institute

ABSTRACT:

The ability to collect detailed dive behavior and accurate movement information is important in order to plan, execute, and interpret a controlled-exposure experiment (CEE) for large whales. Obtaining such information over extended periods (weeks to months) from instrumented whales has been difficult from previous tag types, which have either been too short in attachment (suction cups) or have lacked adequate resolution (Argos). With JIP funding, Wildlife Computers TDR-PAT-MK-10 tags were modified to incorporate a Fastloc GPS receiver to achieve more accurate locations than Argos transmitters and acquire time-depth records, which were summarized in near-real time Argos messages and down-loadable from recovered tags operating up to 60 days. This duration was designed to evaluate behavioral responses before, during and after a 3-week long sound exposure CEE.

During spring field work on sperm whales in the Gulf of California in 2007 & 2008, 28 and 17 whales were equipped with GPS/TDR and location-only tags respectively, using deployment methods already successful for large whales (Mate et al., 2007). The GPS tags were programmed to detach after 60d, float to the surface, and relay updated GPS locations to facilitate their recovery. While still attached, the tags sent GPS locations (avg. acquisition time =1.2s) and dive summary data (shape, duration and depth) via Argos after dives >10min and >10m. The field team obtained GPS locations from tagged whales as Argos data via sat-phone linked Internet and also directly from tag transmissions using a vessel-based uplink receiver and data from the vessel's conventional GPS receiver. Whale locations were displayed on a laptop PC in an ADF-like manner showing the whale's location relative to the vessel to facilitate relocating tagged whales or recover released tags. During the field seasons, 9 tags were recovered this way, including 3 at night, demonstrating the precision of the integrated system.

Once retrieved, the high resolution TDR and GPS data provided insights into both dive- and surface-oriented behaviors (including resting, foraging, and traveling) for up to 32 days, which are much longer than any previously records. Problems were identified with release mechanisms and saltwater switches, which can be solved. Dive records with 1s and 2m resolution revealed lunges during the deepest portion of the dive, locations (avg.= 62m) likely reflecting foraging attempts on Humboldt squids, a local year-round fishery. Some whales demonstrated amazingly consistent deep dive depths, while most were much more variable. There was good general agreement in the periods of active diving for whales, which stayed close together over extended periods (close association), although they did not exhibit routine dive synchrony in either durations or depths of dives. Instead, they seemed to take turns taking the deepest dives, strongly suggestive of group feeding behavior to keep a "bait ball" intact and sharing the most demanding role of the deep diver. These data emphasize the importance of understanding individual variability to interpret "normal" and behavioral responses. GPS tags require greater power and have a shorter operational "life" than conventional location-only Argos tags, so they are not well suited to address longer-term seasonal distributions issues. The tag must be recovered to obtain the highest resolution data, but even summary data are likely adequate to detect significant near-real time changes in behavior during a CEE and make appropriate adjustments to the experimental protocol. The duration of tag operation is close to what is sufficient for a CEE with pre- and post-CEE control periods to define individual norms, develop a dose-response relationship and explore habituation and recovery issues.

Project Objectives:

- Demonstrate GPS locations can be acquired from a whale tag and relayed via Argos.
- Demonstrate GPS/TDR tag can be released from the whale and retrieved at sea.
- Determine the accuracy of GPS locations & can lead to tag recovery
- Recover dive behavior summary data via Argos messages and TDR records from recovered tags
- Demonstrate that satellite-acquired data can be evaluated in the field for adjusting a future CEE
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Project Contract Dates: Phase 1 (01/01/07-02/28/80); Phase 2 (12/01/07-06/30/09).

Notes

Wednesday, October 29, 2008 * 11:40 AM

Cetacean stock assessment in relation to exploration and production industry sound

Presenter: Frank Thomsen

Principle Investigator, Collaborators and Affiliations: Frank Thomsen, Sophy Rose McCully, Laura Weiss, Daniel Wood, Karema Warr, Mark Kirby, Laurence Kell & Robin Law Centre for Environment, Fisheries and Aquaculture Science (Cefas, Lowestoft Laboratory Pakefield Road, Lowestoft, Suffolk NR33 0HT (frank.thomsen@cefas.co.uk)

ABSTRACT

The E&P industry generates underwater sound potentially affecting individual cetaceans. However, the relationship between E&P industry activities and trends in cetacean stocks has rarely been investigated. In case studies we quantified the E&P activity in a specific region, investigated the status and trends of cetacean stocks therein, and assessed other factors presumably influencing the population in question. Two of the investigated stocks have been increasing in numbers (Californian humpback whales, and North Sea minke whales). Three seem to at least hold their own (northern bottlenose whales off Nova Scotia, harbour porpoises off the UK east coast, fin whales off California). One stock appears to remain unchanged, although trends are difficult to assess due to the magnitude of error in abundance estimates (Gulf of Mexico sperm whales). One stock (blue whales off California) shows a clear decrease in numbers of sighted animals, which is probably due to a shift in distribution that is in turn related to shifts in prey. There are at least three explanations for the predominant lack of negative population trends documented in our study. First, the apparent variability in cetacean abundance estimates is too high to document population trends in many cases. It is also possible that effects are either not severe enough, or that individuals are able to adapt to compensate for negative effects. Finally, the benefits that come with staying in an area might outweigh the costs caused by human disturbance. It is likely that none of the factors identified is harmful enough to cause a decline in cetacean stocks, yet, together they may create conditions leading to reduced productivity and survival in some cases. It is evident that potential impacts of sound have to be placed in a wider context, addressing the consequences of acoustic disturbance on cetacean populations in conjunction with other factors.

Project Objectives:

- Investigating he relationships between E&P industry sounds and cetacean stock trends;
- Assessing the relationship between recovery rates and sound exposure by the E&P industry;
- Identification of factors affecting cetacean population growth rates, and
- Suggestions for more detailed empirical analysis.

Project Contract Dates: November 2007 to July 2008.

Notes

Wednesday, October 29, 2008 * 12:00 PM

Cetacean Stock Assessment in Relation to E & P Industry Sound

Presenter: Nathalie Patenaude

Principle Investigator, Collaborators, and Affiliations: Michelle Gilders[3], Sonya Meier[1], Nathalie Patenaude[2], Sergei Yazvenko[1] and Frances Robertson[1]

ABSTRACT

We investigated the relationship between oil industry offshore E&P activities and trends in the distribution, abundance, and rates of increase of key cetacean stocks in three areas of interest: western and northern Alaska (Bering, Chukchi, and Beaufort seas); Sakhalin Island, Russia; and western and southeastern Australia. We compared the status and population trends of stocks of key cetacean species in these three areas with corresponding parameters for stocks of the same species (where possible) in areas where E&P activities were absent or greatly reduced. The key species assessed were (for Alaska) bowhead, eastern gray, and North Pacific right whales; beluga and killer whales; and harbour porpoise; (for Sakhalin Island) western gray, North Pacific right, and bowhead whales; and (for Australia) humpback, pygmy blue, and southern right whales.

For each area, historical and current E&P activities (including the number of seismic surveys, lines of 2-D and 3-D seismic shot, and number of wells drilled) were quantified where possible within the key species habitat. Other anthropogenic activities likely to impact cetaceans were also assessed for each stock. These included shipping, whale-watching, fisheries, oil spills, recreational boating, and subsistence whaling. We assessed whether it is possible to relate information on cetacean stocks to E&P activities meaningfully using this comparative approach, and addressed the relevance of this approach to the Population Consequences of Acoustic Disturbance model.

Project Objectives:

1. Summarize existing and historical stock data for key cetacean populations in the areas of interest.
2. Identify and quantify historical and current E&P activities in the areas of interest.
3. Identify non-industry related factors that may influence key population abundance and distribution in the areas of interest.
4. Correlate the data obtained on E&P activities with the historical cetacean stock assessment data for each species.
5. Evaluate how the information collated and assessed may be used in the Population Consequences of Acoustic Disturbance (PCAD) model

Project Contract Dates: 1 November 2007 to 30 November 2008.

[1] LGL Ltd., environmental research associates, 9768 Second St., Sidney, BC V8L 3Y8, Canada
[2] LGL Ltd., environmental research associates, 22 Fisher St., POB 280, King City, ON L7B 1A6, Canada

Notes

Wednesday, October 29, 2008 * 1:30 PM

Cetacean stock assessment in relation to Exploration and Production industry sound

Presenter: Dr. Len Thomas

Principle Investigator, Collaborators and Affiliations: Prof. Philip Hammond[1], Dr. Sinéad Murphy[1], Dr. Kelly Macleod[1], Dr. Gordon Hastie[2], Dr. Kristin Kaschner[3], Dr. Nicola Quick[2], Dr. Jonathan Gordon[1], Prof. Ian L Boyd[1, 2], Dr. Len Thomas[3]

ABSTRACT

Cetacean populations are inherently difficult to assess. They are wide-ranging and not easily observed at sea; this has resulted in the development of specialized techniques for estimating their abundance. The objective of this project is to identify cetacean populations for which trends can be detected and subsequently to explore the relationship between those trends and sound generated by oil and gas exploration and production.

A database of abundance estimates was constructed following an extensive review of the primary literature. A global analysis, based on 1035 abundance estimates for 34 species, investigated how estimates of cetacean density varied with species, geographical area, methodology and time. Generalised additive models (GAMs) were used to fit flexible smooth functions to the response variable, which was weighted for survey size and precision. Cetacean density varied most among species, suggesting that to reveal trends species should be considered individually. The density of the seven most data rich species (minke, fin, sperm, humpback and long-finned pilot whale, striped dolphin and harbour porpoise) was therefore modelled separately. The most significant explanatory covariates varied between species and area. Power analysis showed that the probability of detecting anything but the largest trends in density was low. For the seven species, the mean estimated CV for the index of population trend was 0.85, at which level of precision a decline or increase in abundance of half an order of magnitude would be detectable with a power of 0.8.

The next step is to investigate relationships between any population trends detected and available data on sound generated by oil and gas exploration and production using the model framework. Knowledge of population trends is vital for informing management decisions, particularly those relating to conservation and the mitigation of anthropogenic impacts. Behavioural and physiological responses of cetaceans to seismic surveys will be considered and recommendations will be made to ensure future data collection methods increase ability to assess population trends.

Project Objectives:

1. Collate current information on global cetacean stocks within Areas of Relevance (AOR).
2. Use available data to determine trends in cetacean stocks within AOR.
3. Identify key factors which control or influence cetacean stocks in AOR.
4. Relate cetacean stock trends to oil and gas exploration and production sound data.
5. Identify species and regions suitable for more detailed analysis or data collection.

Project Contract Dates: December 2007 to November 2008.

[1]Sea Mammal Research Unit (SMRU), Gatty Marine Laboratory, University of St Andrews, St Andrews, Fife, KY16 8LB, UK
[2]SMRU Ltd, 7 Woodburn Place, St Andrews, Fife, KY16 8LA, UK
[3]Centre for Research into Ecological and Environmental Modelling (CREEM), The Observatory, Buchanan Gardens, University of St Andrews, St Andrews, Fife, KY16 9LZ, UK

Notes

Wednesday, October 29, 2008 * 1:50 PM

Cetacean Stock Assessment in relation to Exploration and Production Industry Sound: 4 (Northwest Europe)

Presenter: Dr Peter G.H. Evans

Principle Investigator, Collaborators and Affiliations: Principal Investigator (Sea Watch Foundation, UK / School of Ocean Sciences, University of Wales Bangor)

ABSTRACT

Project Objectives: The general aim of this project is to review the available information in order to assess whether it is possible to determine if the offshore E&P industry has had any long-term influence upon status changes in cetacean stocks.

Specific aims

i. Using available cetacean stock data, examine the relationships between E&P industry operation sounds and cetacean stock trends. This requires assessing whether existing data will allow meaningful analysis, and reviewing the literature relating to interaction of cetacean stocks with E&P activity.
ii. Review the current status and trends of different cetacean stocks that are potentially exposed to sound generated by the oil and gas industry in the marine environment.
iii. Examine the extent to which status changes occur following major anthropogenic influences (e.g. whaling) and differ between species; and then to determine how this relates to sound exposures, particularly for stocks whose habitats are spatially relevant to the E&P industry.
iv. Identify factors that are key to controlling or influencing cetacean population growth rates of various stocks (e.g. anthropogenic sound, by-catch, El Niño & North Atlantic Oscillation, whale watching, etc).
v. Determine whether there are key species or regions that would lend themselves to more detailed analyses or data collection and if so, what species, analyses or data collection would be appropriate.

Deliverables will include:

- A table listing all cetacean species recorded, together with their status for the EEZs of all Northwest European countries
- A summary of all major sightings data holders in Northwest Europe with meta-database details
- A report detailing the results of analyses of long-term cetacean sightings data in relation to E&P Industry and other anthropogenic activities, and review of the literature relating to interaction of cetacean stocks and E&P activity
- A review of information gaps with recommendations for future work.

Project Contract Dates: May 2008 to April 2009.

Notes

Wednesday, October 29, 2008 * 2:10 PM

Critical Review of the Literature on Marine Mammal Population Modeling

Presenter: Edward O. Keith, Ph.D.

Principle Investigator, Collaborators and Affiliations: Nova Southeastern University

ABSTRACT

A literature review and modeling effort was conducted to determine which vital rates are most important to the growth of marine mammal populations, and to conduct a risk assessment of the potential impacts of ocean noise on them. The primary concern was how much each vital parameter can change before a change in population trend would be expected. An analysis of the elasticity and sensitivity of marine mammal matrix population models suggested that most whale populations appear to be highly sensitive to changes in adult female survival and least sensitive to calf survival. Sensitivities of population growth rate to changes in juvenile survival and growth and female fecundity were intermediate between these. Adult female whales may be sensitive to changes in foraging success that limit their ability to acquire sufficient body stores of energy to sustain gestation, parturition, and lactation. The risk assessment concluded that any increase in anthropogenic noise in the marine environment that reduces adult female survival, for whatever reason, should be avoided. Additionally, it may be impossible to detect the impact of a change in a population vital rate on population growth because such a change may be less than the confidence interval around the estimates of the rate of growth of most marine mammal populations. Sensitivity and elasticity analyses are limited because they predict linear changes in population growth rates caused by linear changes in vital rates, and do not reveal thresholds within which vital rates can change without altering population growth rates. Future research should focus on the relationship between marine noise adult female and juvenile survival, and efforts to increase the precision and decrease the uncertainty of marine mammal population and vital rate estimates. More knowledge of marine mammal activity budgets is needed, as is a further elucidation of the roles of marine mammals in their ecosystems, and their importance as sentinels of ecosystem health. The concept of potential biological removal (PBR) should be expanded to reflect cumulative mortality impacts and to incorporate the effects of noise.

Project Objectives:

- To conduct a thorough review of the scientific literature on marine mammal population dynamics and to determine which vital rates most influence the growth and sustainability of marine mammal populations.
- To evaluate the influence of life-history, ecological, and genetic variation on vital rates and population sustainability and to determine how much each vital parameter can change before a change in population trend would be expected.
- To examine the influence of ecological energetics and foraging strategies on vital rates and their limits of sustainable change, and explore how an increase in sound in the marine environment might influence marine mammal behavior, and thus life functions, vital rates, and population sustainability.

Project Contract Dates: 1 March to 30 June 2008.

Notes

Wednesday, October 29, 2008 * 2:30 PM

Critical Review of the Literature on Population Modelling

Presenter: Len Thomas

Principle Investigator, Collaborators and Affiliations:
John Harwood (PI), Jason Matthiopoulos, Abigail Cabrelli
Centre for Research into Ecological and Environmental Modelling, University of St Andrews, St Andrews, Fife KY16 9LZ, UK

ABSTRACT
The common currency of all population models is the intrinsic rate of increase in population size (λ). We show how the effect of the transfer functions that make up the Population Consequences of Acoustic Disturbance (PCAD) framework developed by the US National Research Council's Committee on Characterizing Biologically Significant Marine Mammal Behavior on λ can be evaluated. We also describe how variation in this rate can be used to determine the conservation status of a population, and how the rate itself provides a measure of Darwinian fitness that can be used to determine PCAD. Finally, we describe the data that is required to estimate the magnitude and variability of λ .

Project Objectives:

1. Summarise current scientific understanding of the relationships between demographic characteristics and trends in the abundance of marine mammal and fish population.
2. Describe the way in which current regulations and other limits on the "take" of marine organisms are related to these population characteristics.
3. Indicate how these practices might be modified to apply to the concept of Biological Significance and incorporated into the PCAD approach developed by U.S. National Academy of Sciences.

Project Contract Dates: 1 April 2008 to 30 November 2008.

Notes

Wednesday, October 29, 2008 * 3:15 PM

Field studies on seal foraging success as input to the PCAD model

Presenter: Daniel Costa

Principle Investigator, Collaborators and Affiliations: Daniel P. Costa, A. Marm Kilpatrick, Samantha Simmons, University of California, Santa Cruz, Ca. 95060, Michael Goebel, Antarctic Ecosystems Program, Southwest Fisheries Science Center, La Jolla, CA, C. Allen Atkinson, Information & Simulation Systems, Redondo Beach, CA

ABSTRACT

Key to assessing the risk of short term sound exposure of marine mammals to offshore exploration and production (E&P) operations is A) an understanding of where animals occur, their temporal habitat utilization; and B) to know if and when measurable short term responses of marine mammals result in biologically meaningful changes in their populations. The first part of this project will develop analytical approaches to 1) identify and map focal feeding, breeding, and migration routes, 2) model and map spatial-temporal oceanographic habitat utilization, and 3) predict regions of animal occupancy and use based on oceanographic features. To address B), the second part of this project will use a combination of analysis of existing data, modeling, and an experimental manipulation of two well studied marine mammal species to understand 1) how constrained are marine mammals in their ability to accommodate short terms changes in their foraging behavior and or success? 2) How closely coupled are short term changes in foraging behavior to reproductive success and adult survival? 3) Does the linkage between foraging behavior, reproductive success and adult survival vary relative to environmental perturbations? Using existing data and analytical tools we will create spatially explicit time-activity budgets, a crucial first step to determine whether a loss of foraging time or habitat will have a detrimental effect on a marine mammal population. Synergy of the two parts of this project will result in a framework of predictive models of critical marine mammal habitat utilization and a rigorous risk assessment tool in the form of time-energy budgets, which will be invaluable as a generic template for the ecological risk assessment of E&P operations worldwide.

Project Objectives:

- Development of analytical approaches to elucidate temporal and spatial distributions of critical (foraging, breeding migration) marine mammal habitat.
- Development of time-activity budgets for two model marine mammal species.
- Experimental manipulation of two model species to quantitatively assess increased foraging effort (anthropogenic disturbance or 'poor' environmental conditions).
- Demographic modeling of variables in the time-activity budget and experimental manipulations to assess impacts at the level of the population on multiple time scales.

Project Contract Dates: Oct 1, 2008 to September 31, 2010.

Notes

Wednesday, October 29, 2008 * 3:35 PM

Application of Risk Assessment for Evaluating the Effects of Sound from E&P Operations on Marine Life

Presenter: Judy E. Muir

Principal Investigator, Collaborators and Affiliations:
Judy E. Muir[1], Michelle Gilders[1], Yury Bychkov[1]

ABSTRACT
Increases in underwater sound levels due to offshore exploration and production (E&P) operations raise concerns regarding potential impacts to marine mammals that are highly dependent on sound to carry out their life functions. Sound-related effects that have been observed or suggested include behavioral disturbance, noise-induced hearing threshold shifts, physical injury, mortality, reduction in productivity and shifts in distribution. However, our ability to assess the likelihood and consequences of such effects is hampered by the paucity of knowledge about the importance of natural underwater sounds to marine mammals and the hearing sensitivity of most species. In addition, there is substantial variability in an animal's response to a given type and level of anthropogenic noise, which studies suggest is highly dependent on factors such as the animal's activity, habituation and sound duration. Given these data gaps and levels of uncertainty, a useful approach is to conduct a risk assessment that considers the nature and magnitude of the E&P operational sound and the probability that effects will result from that sound. We developed a methodology that builds on the PCAD framework (NRC 2005) and uses the criteria developed by Southall et al. (2007) to assess the risk to cetaceans and pinnipeds from sound resulting from offshore E&P activities. The methodology allows quantitative, semi-quantitative and qualitative risk assessment depending on the assessment endpoints selected by the risk manager and the level of uncertainty inherent in the available data sets. We also developed an extendable prototype software application that provides links to useful resources and acts as an interactive tool that guides a user through the steps of the proposed methodology.

Project Objectives:

- Develop a comprehensive methodology to assess risk to cetaceans and pinnipeds from a variety of sound sources associated with offshore E&P activities.
- Summarize key sound criteria for impacts on marine mammals;
- Assess existing risk assessment tools to determine their application to sound exposure; and
- Modify existing risk assessment tools, if feasible, to meet specific sound-related criteria.

Project Contract Dates: 14 December 2007 to 15 December 2008.

Notes

Abstract 27

- No presentation -

A review of literature to estimate PCAD related transfer functions

Principle Investigator, Collaborators and Affiliations: Drs. Lars Bejder and Douglas Nowacek

ABSTRACT

At the "Effects of Noise of Aquatic Life" conference in Nyborg, Denmark, results from a few studies were presented (Bejder and Lusseau, 2007; Bejder et al., 2006a; Bejder et al., 2006b; Lusseau et al., 2006) that were deemed helpful in the understanding of transfer functions between variables in the Population Consequences of Acoustic Disturbance (PCAD) model (NRC 2005). These studies did not specifically evaluate possible impacts of *sound* on cetaceans – but they did identify long-term population level effects of an apparent benign human activity on cetacean populations, i.e., cetacean watch tourism. Whether or not the documented impacts had an acoustic component was not investigated. The documented impacts were recently acknowledged by the International Whaling Commission's Scientific Committee (2006): "[t]here is new compelling evidence that the fitness of individual odontocetes repeatedly exposed to whalewatching vessel traffic can be compromised and that this can lead to population hang level effects." Detecting population-level effects (which is the main aim of the PCAD model) was based on long-term population monitoring and availability of information on cumulative exposure on individuals. The influence of these impacts on population viability was inferred using the dose-response relationships these studies describe. Early individual-based models show that the documented impacts are highly likely to endanger the viability of small populations which have restricted immigration/emigration because of the increased cumulative exposure they incur. As such, we are conducting a novel literature review, which considers literature from cetaceans, pinnipeds and sirenians that, preferably, contain information about acoustic exposure but, more importantly, information that can be used to generate transfer functions relevant to the PCAD model. Nowacek et al. (2007) recently reviewed the behavioural responses of cetaceans to noise, and as such provided for this group of animals an update to the seminal work by Richardson et al. (1995) on the topic. The review we are conducting here would not simply revisit these reviews, but instead would explore the literature from the perspective of the PCAD model and its transfer functions. Some published data may not be related to sound exposure, but instead may provide critical links between life functions described in the PCAD model, e.g., foraging rates/success and reproductive output. We believe that these data sources are very important in the early use of the PCAD model for understanding the effects of noise on marine mammals. Particularly useful for our review will be both long-term data sets on marine mammals as well as terrestrial animals, and we are consulting both. Our review of applicable data sets for marine mammals will be exhaustive, but for terrestrial animals we will choose the most applicable.

Project Objectives:

- To review literature relevant to the PCAD model for guidance in developing transfer functions

Project Contract Dates : Aug 2008 to Aug 2009.

Notes

Abstracts

THURSDAY

October 30, 2008

Thursday, October 30, 2008 * 8:30 AM

Review of existing and future potential treatments for reducing underwater sound from oil & gas industry activities.

Presenter: Jesse Spence

Principle Investigator, Collaborators and Affiliations: Jesse Spence, Noise Control Engineering

ABSTRACT

A year-long research effort into identifying existing and future potential methods of reducing underwater sound levels created by nearly all oil and gas industry related activities has been undertaken. The effort has focused on those activities that produce the loudest sounds, namely seismic exploration, pile driving, and explosives use, though other acoustic sources have been included such as vessels, platforms, dredges, post trenching / jetting, cutting tools, aircraft, and hoverraft. Information was collected from various sources including technical and trade journal articles, contacts with representatives of companies that make or own noise control products and technologies, contacts with members of academia, and data provided directly by members of the International Association of Oil and Gas Producers. Furthermore, a workshop was held on June 4-5, 2007 to discuss initial findings and further develop ideas for feasible sound reduction approaches and future methods. This presentation provides an overview of some of the sound reduction methods and technologies that have been identified. A full report of all treatments identified as part of this effort is available through the Joint Industry Programme website.

Project Objectives:

- To identify current and future methods of reducing underwater sound from all aspects of oil and gas industry activities

Project Contract Dates: January 5, 2007 to December 31, 2007.

Notes

Thursday, October 30, 2008 * 8:50 AM

Identification of potential utility of and collation of existing marine mammal observer data

Presenter: Mike Mason (RSK)

Principle Investigator, Collaborators and Affiliations: Carolyn Barton, Rob Jaques (RSK) and Mike Mason (RSK)

ABSTRACT

This project identified available MMO data, most of which were from military operations and seismic surveys, and examined the utility of these data. Historically there have been few analyses of MMO data, especially of data pooled from multiple clients. A workshop examining the potential utility of MMO data identified key questions that could be answered, considering areas such as regulatory compliance, risk assessment, effectiveness of mitigation measures, the impact of sound on marine mammals and the biology of marine mammals. Utility of the data is hindered by the diversity of existing data recording practices, so new recording forms were designed as a global standard, containing the types of information identified as necessary to answer the key questions. Some regulators have already agreed to adopt these new forms. A design for a central MMO database that data would feed into was based on these standard forms. The proposed design of the MMO database uses a web-based portal which will provide a front-end which is easy to update, provides a user-friendly interface, and will support many of the required functions such as user registration, document libraries, etc. Built into this portal will be data query and management functions, with safeguards protecting sensitive data. A prototype of this web portal has been created. Any future phase of the project would include development of this database, populating it with available data and performing analyses to answer some of the identified key questions.

Project Objectives:

- Identification of available MMO data
- Investigation of existing databases and analyses performed
- Identification of key questions that could be addressed with these data
- Modification and standardisation of MMO data recording sheets to improve future utility of MMO data
- Design a database to handle preferred MMO data

Project Contract Dates: June 2007 to 31st May 2008.

Notes

Thursday, October 30, 2008 * 9:10 AM

Integration and testing of an Acoustic Vector Sensor into 3-D tracking PAM Array to Resolve Left/Right Ambiguities

Presenter: Aaron Thode

Principle Investigator, Collaborators and Affiliations:
Aaron Thode[1], Jeff Skinner[1], Pam Scott[1], Jeremy Roswell[1], Kendall Folkert[2], Janice Straley[3].

ABSTRACT
Passive acoustic towed array systems are a popular configuration for current marine mammal mitigation efforts. Typical systems use an array of linearly-arranged hydrophones to measure the difference in arrival times of an acoustic pressure wave across the array. This measurement can then be converted into a bearing estimate. Unfortunately, such a scheme cannot distinguish between a signal arriving from port or starboard, unless the array is turned and can reacquire a signal from the same source, or unless a second array is deployed laterally from the same or other vessels. Neither approach is logistically desirable for seismic mitigation efforts.

The technology for measuring the acoustic particle velocity of a sound wave has existed for decades, but only recently have sensors been developed that are compact and robust enough to fit in a towed array system. Since the particle velocity is a vector quantity, the arrival direction of a sound wave can be resolved immediately and unambiguously by these "vector" sensors.

In 2007 a 1.5 m vector sensor towed array module was built using a WilcoxonVS-205 vector sensor, and tested of the coast of Sitka, AK, in July 2008. The ability to detect and resolve the bearing of sperm whale sounds was demonstrated. The system also demonstrated an unexpected ability to eliminate noise contamination from the towing vessel, an important advantage that may eventually enhance the practicality of towed mitigation systems.

Project Objectives:

- Design and construct a towed array vector sensor module.
- Demonstrate ability to distinguish port from starboard without turning towed array.
- Demonstrate ability to eliminate interference from towing vessel.

Project Contract Dates: December, 2006 through 30 November 2008.

[1]Marine Physical Laboratory, Scripps Institution of Oceanography, University of California, San Diego, La Jolla, California 92093-0402, USA
[2]University of Alaska, Southeast, Sitka, Alaska, 99835
[3]P.O. Box 6497, Sitka, Alaska, 99835

Notes

Abstract 31

Thursday, October 30, 2008 * 9:30 AM

Semiautomated, Open Source Software for Real-Time Acoustic Detection and Localisation of Cetaceans

Presenter: Douglas Gillespie

Principle Investigator, Collaborators and Affiliations:
Douglas Gillespie[1], Jonathan Gordon[1,2], David McLaren[3], David Mellinger[4], Paul Redmond[3], Aaron Thode[5], Ron McHugh[3], Phil Trinder[3], Xiao Yan Deng[3].

ABSTRACT
Regulators in many regions require mitigation involving the real-time detection of marine mammals during activities emitting intense sound. Visual monitoring is the default method for detecting marine mammals. However, these animals are difficult to sight and passive acoustic monitoring (PAM), whether conducted alone or in conjunction with visual effort, can greatly enhance the overall detection capability for many species. This is reflected in the increasingly important role that PAM is acquiring in population monitoring and mitigation. However, marine mammals make a wide variety of vocalisation types, varying from infrasonic 'moans' to ultrasonic 'clicks' and significant challenges relating to detection and localisation remain.

PAMGUARD is an initiative to provide standard software both to developers and to users of PAM systems. For developers of PAM systems, an Application Programming Interface (API) has been developed which contains standard classes for the efficient handling of many types of data, interfaces to acquisition hardware and to databases, and provides a GUI framework for data display. For the PAM operator, PAMGUARD provides a flexible and easy to use suite of data management, signal processing and display modules which provide a standard interface across different platforms with the flexibility to allow multiple detectors to be configured according to the species of interest and the hardware configuration on a particular project.

Project Objectives:

- To develop a real time infrastructure for the development of PAM systems
- To implement functionality from already existing, commonly used, PAM systems
- To develop and implement new detection and tracking modules.

Project Contract Dates: Start: 2004, Ongoing maintenance and development.

[1]Sea Mammal Research Unit, University of St Andrews, KY16 8lB, Scotland, UK
[2]Ecologic UK, 7 Beechwood Terrace West, Newport on Tay, Fife, DD6 8JH
[3]Hydroacoustics Research Group, Ocean Systems Laboratory, Heriot-Watt University, Edinburgh
[4]Oregon State University, 2030 Marine Science Drive, Newport, OR 97365 USA
[5]Scripps Institution of Oceanography, University of California, San Diego, La Jolla, California 92093-0402, USA

Notes

Thursday, October 30, 2008 * 10:30 AM

Development and Implementation of Automatic Classification of Odontoctes Within PAMGUARD

Presenter: Douglas Gillespie

Principle Investigator, Collaborators and Affiliations:
Douglas Gillespie[1], Marjolaine Caillat[1], Paul white[2], Jonathan Gordon[1,3],

ABSTRACT
Marine mammal species vary enormously in their acoustic sensitivity and in their conservation status and vulnerability. Species specific regulation requires that Passive Acoustic Monitoring (PAM) systems can not only detect and localise, but also classify vocalisations to species.

All odontocetes produce transients, or clicks, and many also produce whistles. Whistles have seemed to offer the most promising cues for species ID but in contrast to species such as some baleen whales and birds that produce stereotyped calls, whistling odontocetes produce calls that are complex and highly variable. Previous attempts to classify species on the basis of whistles have involved a high level of user input in identifying whistles and measuring parameters from them. Our emphasis has been on developing a fully automated classification system using the output from automatic detectors. The PAMGUARD software already contains a fully automatic whistle contour extractor, and a new improved contour extractor has also been developed as part of this project. A whistle classification scheme is being developed and tested in which statistics are accumulated for many whistles over a period of time and the classification decision is made based on general statistical descriptions of many whistles rather than a single whistle.

Some species produce few tonal vocalisations and for these, classification of clicks is the only option. Beaked whales are one such example and are also a species known to be particularly vulnerable to intense noise. Click classifiers for beaked whales and other clicking odontocetes are being developed which use descriptive parameters of individual clicks and of click trains detected by the PAMGUARD click detector.

Project Objectives:

- To develop new whistle contour extraction methods.
- To develop new statistical classification methods for clicks and whistle contours
- To implement new algorithms into PAMGUARD.

Project Contract Dates: 1 Jan, 2008 to 31 December, 2008.

[1]Sea Mammal Research Unit, University of St Andrews, KY16 8lB, Scotland, UK
[2]Institute of Sound and Vibration Research, University Road, Highfield, Southampton S017 1BJ, UK
[3]Ecologic UK, 7 Beechwood Terrace West, Newport on Tay, Fife, DD6 8JH

Notes

Thursday, October 30, 2008 * 10:50 AM

Passive Acoustic Detection and Localization in PAMGUARD

Presenter: David K. Mellinger

Principal Investigator, Collaborators and Affiliations:

David K. Mellinger
Cooperative Institute for Marine Resources Studies, Oregon State University

Douglas Gillespie
Sea Mammal Research Unit, University of St. Andrews

ABSTRACT
Marine mammal monitoring and mitigation are becoming more common during oil and gas exploration and production projects. PAMGUARD software is a tool for acosutic monitoring that allows, among many other tasks, passive acoustic detection and localization of marine mammal calls. Here we review the methods that were imported from another widely-used software package, Ishmael, for acosutic detection and localization. The "energy sum" detection method is the simplest and the most general, able to detect many types of calls but not able to discriminate between calls of different species. It consists of summing of the acoustical energy within a given frequency band in a spectrogram. The result is a "detection function" that represents the likelihood that a call is present at any one time. The "spectrogram correlation" method uses a two-dimensional kernel cross-correlated with a spectrogram to produce its detection function. This method allows much more specificity in the call type that is detected, and also allows for some amount of variation in the types of call detected. Another method, matched filtering, also uses a kernel, but this time in the time domain, to produce a detection function. This method is the optimum detector for the case of a known signal in white Gaussian noise, but handles variation the least well of any of the methods. These detection methods produce a detection function; when that function exceeds a threshold, a call detection is triggered. Two- or three-dimensional localization can be done using a least-squares solution method commonly known as "hyperbolic localization". In this method, time delays between sounds from multiple hydrophones are measured using cross-correlation peaks. The time delays are used in a least-squares method to determine the most likely location for an animal call. Call locations -- that is, animal locations -- may then be used to assess the possible risk to marine mammals from an activity that potential disturbs them.

Project Objectives:

- Implement detection methods in PAMGUARD
- Implement localization methods in PAMGUARD
- Provide user and developer documentation for these methods

Project Contract Dates: Feb. 1, 2005 to May 31, 2008.

Notes

Thursday, October 30, 2008 * 11:10 AM

PAM Mysticete Detection Algorithms and Performance - An improvement for PAMGUARD

Presenter: Joe Hood

Principle Investigator, Collaborators and Affiliations: Joe Hood, Derek Burnett, Jason McInnis, George Ryan, and Dave Flogeras; Akoostix Inc.

ABSTRACT

The Akoostix team has provided underwater acoustics support to the Canadian Defence and Defence Research Communities for over eight years. Composed of retired military acoustic operators with advanced academic training and senior software and DSP engineers, Akoostix develops algorithms, reusable software libraries, and applications both collaboratively and independantly. One focus of their R&D work is PAM for marine mammals. Akoostix was contracted by the JIP to develop a flexible maximum likelihood detector for PAMGUARD that would enhance overall capability and provide improved Mysticete detection. This new module would provide one of the building blocks required to create a reliable user-friendly PAM capability and complement existing modules. This work was conducted in two phases.

During the first phase an existing detection approach was further tested against mysticetes and improvements were suggested, implemented, and tested against synthetic and real data. The detector generates both signal and noise estimates based on band-limited spectral data using a variety of user-selected methods. An initial detection test is performed based on a threshold test of the estimated signal-to-noise ratio. In addition, a second test is performed to ensure that detections are indeed band-limited by comparing the signal estimates of the main band to one or more guard bands. This second test is believed to be unique to this detector and significantly reduces false alarms with little affect on detection performance for the test data. The proposed enhancement was to provide a split-window block-average estimator in addition to the exponentially averaged estimator, using an optimized implementation. Again detector performance improved for the test data with no significant effect on processing load.

The second phase involved implementing the detector in PAMGUARD. This included the provision of an intuitive user interface for configuration, and connection to existing detection displays and loggers. Following a structured engineering process, requirements were defined and approved, a design was generated, user and Javadoc developer documentation was created, and formal testing was proposed. Tests are composed of built-in unit tests for detector modules and structured manual tests to prove successful integration. These tests can be used by future developers to ensure capability is preserved. Other developers are encouraged to adopt this approach to improve the overall reliability of PAMGUARD. A number of useability improvements are also suggested.

Project Objectives:

- Improve and implement flexible maximum-likelihood detector in PAMGUARD
- Reliable well-documented software module using structured engineering processes
- Suggest user interface and usability improvements for PAMGUARD

Project Contract Dates: December 2007 to December 2008.

Notes

Thursday, October 30, 2008 * 11:30 AM

Development (and PAMGUARD integration) of software for real-time acoustic identification of cetacean species

Presenter: Julie Oswald

Principle Investigator, Collaborators and Affiliations:
PI: Whitlow W.L. Au, PhD, Hawaii Institute of Marine Biology, Kaneohe, Hawaii
Co-PI: Julie N. Oswald, PhD, Hawaii Instistute of Marine Biology, Kaneohe, Hawaii

ABSTRACT
Mitigation measures to reduce the risk of acoustic impacts of offshore oil and gas operations on marine mammals generally involve shipboard visual and acoustic monitoring. Visual detection and identification of cetaceans can be challenging as these animals spend much of their lives completely under water. Because many cetaceans produce characteristic calls that propagate well under water, passive acoustic techniques can be used to detect and identify them. New software is currently being developed for real-time acoustic identification of cetacean species. This software, ROCCA (Real-time Odontocete Call Classification Algorithm), automatically extracts variables from calls manually selected from a real-time scrolling spectrograph (ISHMAEL software) and runs classification statistics (classification tree analysis and discriminant function analysis). Output includes predicted species identification with a certainty score and alternate identifications with certainty scores. Initial tests of ROCCA in the eastern tropical Pacific Ocean resulted in schools of dolphins being correctly classified significantly more often than expected by chance ($p<0.001$), however correct classification was lower than the usual standards applied to visual identification during shipboard surveys (near certainty). The next steps in the development of ROCCA include exploring alternate call parameters and classification techniques in order to increase classification success, expanding the capabilities of ROCCA to include additional species, streamlining ROCCA, making it more user-friendly, and incorporating it into PAMGUARD.

With increased classification success, ROCCA will be a valuable tool, providing a method for identifying cetaceans that are difficult to approach and observe and allowing monitoring when visual efforts are compromised or unavailable. In addition, ROCCA reduces processing time and will therefore make it feasible to run classification analyses on the large amounts of data collected using seafloor-mounted acoustic recorders.

Project Objectives:

- Improve the classification success of species identification software (ROCCA)
- Expand capabilities of ROCCA to include additional species
- Make ROCCA more streamlined and user-friendly
- Incorporate ROCCA into PAMGUARD

Project Contract Dates: Oct 1, 2008 to Oct 1, 2010.

Notes

- No presentation -

Measuring the Health of the Field: Fixed Passive Acoustic Marine Mammal Monitoring for Estimating Species Abundance and Mitigating the Effect of Operations on the Marine Environment

Presenter: David Moretti

Principal Investigator: Mr. David Moretti
Collaborators: Dr. David Mellinger,
Mr. Thomas Casey

ABSTRACT
Industries that operate in marine environments are under increasing pressure to document the effect of their activities on marine mammals and to evaluate the long-term environmental consequences of such activities. Although Non-Governmental Organizations (NGOs) drive public sentiment with definitive statements, little is actually known as to the direct effect of such activities on marine mammal populations and their environment. It is therefore critical to document these populations before, during, and after field development by providing long-term, on-going monitoring over the life of the field. Acoustic monitoring has proven highly effective at detecting vocalizing marine mammals. Marine mammal vocalizations vary widely from low-frequency songs of humpback whales to high-frequency echolocation clicks of Cuvier's beaked whales and porpoises. These vocalizations can be readily detected using widely spaced bottom-mounted sensors. This analysis will document and validate fixed PAM requirements. Salient design specifications are highly driven by system requirements such as location, localization accuracy, detection area, and the range of species monitored. The effect of these specifications on system design with cost as an independent variable will be examined. Risk associated with design trade-offs will be highlighted.

Project Objectives:

- Identify and assess currently available and emerging fixed PAM technologies capable of detecting, classifying and localizing marine mammals and identify their performance specifications.
- Provide an assessment of the logistics involved with developing and operating a PAM capability using the identified technologies.
- Provide recommendations for technologies requiring further development.
- Provide a road map for development of a fixed PAM capability.

Project Contract Date: 1 July to 31 December, 2008.

Notes

Thursday, October 30, 2008 * 1:00 PM

Review of Fixed Passive Acoustic Monitoring Methods & Technologies

Presenter: Tom Norris

Principle Investigator, Collaborators and Affiliations:
Tom Norris, Bio-Waves Inc.,
Julie Oswald, Oceanwide Science Institute and University of Hawaii,
Renata Sousa-Lima, Cornell University – Bioacoustic Research Program.

ABSTRACT
Fixed Passive Acoustic Monitoring (PAM) systems have the capability to acoustically monitor marine mammals over large areas and for extended time periods. These systems can be categorized in three types: 1) Cabled systems; 2) Radio-linked systems, and; 3) Autonomous recorders. Automated detection, classification and localization techniques will be needed to analyze the large volumes of data that are generated using these three types of fixed PAM systems.

The main goals of our project are:
1) To review and inventory past, existing, and planned fixed cabled, radio-linked and autonomous PAM systems that can be used monitor and assess potential effects of the oil exploration and production (E&P) industry to on marine mammals.
2) To review automated detection, classification, and localization techniques that can be used to process and analyze data that are collected using these three fixed PAM systems.
3) To provide recommendations for areas of future research and technological development that would be useful to the E&P industry for investigating, monitoring and mitigating potential effects of E&P activities on marine mammals.

Our general approach will consist of researching and compiling information on these fixed PAM technologies from the gray and peer-reviewed literature. Relevant commercial products and government (e.g. military) assets will be included. Three review papers are planned for submission to a peer-reviewed journal. The reviews will focus on technologies and methods that will be useful to the E&P industry. However, this information will also be useful for other applications and users in areas such as conservation, resource management, and research. Preliminary findings and work completed thus far will be presented.

Project Objectives

I. Compile a detailed inventory of:
    1. Fixed PAM technologies and methods that are currently available.
    2. Potential new technologies and methods that are currently being developed.
II. Conduct a critical review and assessment of fixed PAM capabilities and their application during E&P activities offshore.
III. Identify potential areas of further development in order to improve both effectiveness and accuracy of detecting/classifying/localizing marine mammals at sea.

Project Contract Dates: 1 August 2008 to 7 March 2009.

Notes

Thursday, October 30, 2008 * 1:20 PM

DECAF – Density Estimation for Cetaceans from passive Acoustic Fixed sensors

Presenter: Len Thomas

Principle Investigator, Collaborators and Affiliations:
PI: Len Thomas, University of St Andrews, Scotland.

Collaborators: Dr. David L. Borchers[1], Mr. Tiago A. Marques[1], Mr. Stephen W. Martin[2], Dr. David K. Mellinger[3], Mr. David Moretti[4], Mr. Ronald Morrissey[4], Dr. Peter L. Tyack[5], Dr. Catriona M. Stephenson[1], Ms. Jessica A. Ward[4]

ABSTRACT
DECAF is a 3-year research project aimed at developing and implementing statistical methods for estimating cetacean density from fixed passive acoustic sensors. Passive acoustics is increasingly being recognized as a useful and practical modality for gathering information about cetaceans, and there is a growing body of research on the use of towed acoustic arrays to estimate density, either alone or in conjunction with more traditional visual surveys. However, fixed hydrophones present additional challenges: issues include animal movement, lack of random placement of detectors and inability under some circumstances to localize the animal vocalizations. In this research, we aim to provide a sound statistical framework to address these issues in ways that will have very general applicability. Our approach is to proceed via a series of linked case studies, using data from US Navy instrumented testing ranges. To date we have focused largely on the estimation of beaked whale density from the Atlantic Undersea test and Evaluation Center (AUTEC, located in the Bahamas). We have also begun working on estimation of sperm whale density at AUTEC and minke whale density at the Pacific Missile Range Facility (PMRF, located off the east coast of Kaua'i, Hawai'i). Further details of our work and research outputs is given at our project web site: http://www.creem.st-and.ac.uk/decaf

Project Objectives:

- Develop methods for estimating the density of cetacean species from fixed passive acoustic devices.
- Demonstrate the utility and generality of the methods by implementing them in a set of key test case studies.
- Promote adoption of the new methods in the marine mammal research community by (a) publishing results in the peer-reviewed literature, (b) archiving data and results in publicly available electronic storehouses, (c) holding workshops open to all interested researchers.

Project Contract Dates: May 1 2007 to May 31 2010.

[1]University of St. Andrews, St. Andrews, Scotland
[2]Space and Naval Warfare Systems Center, San Diego, CA
[3]Oregon State University, Newport, OR
[4]Naval Undersea Warfare Center Division, Newport, RI
[5]Woods Hole Oceanographic Institution, Woods Hole, MA

Notes

Thursday, October 30, 2008 * 1:40 PM

Evaluation of Fisheries Sonar for Whale Detection in Relation to Seismic Survey Operations

Presenter: Frank Reier Knudsen, PhD

Principle Investigator, Collaborators and Affiliations:
Frank R. Knudsen[1], Ole B. Gammelsæter[1], Petter H. Kvadsheim[2], And Leif Nøttestad[3]

ABSTRACT
We have evaluated the ability of traditional fisheries sonars to detect killer whales within the proposed safety zones for marine seismic surveys. A commercial fishing vessel equipped with sonar was used to survey an area with a large number of killer whales in the northern part of Norway in November 2006. Two fisheries sonar systems were used: Simrad SP90 and SH80 operating at 20-30 kHz and 110-120 kHz, respectively. The sonar transmitted both horizontally (omnidirectionally) and vertically. The fishing vessel was searching randomly in the survey area during the day, and whale detections were always verified by visual observations. Sound-speed profiles were collected to model ray traces, sound transmission loss, and detection probability.

Whales appeared as distinct echoes on both sonar systems. The detection range on the SP90 sonar was at least 1,500 m, and for the SH80, reliable detections were obtained up to 400 m. In addition to the direct echo from the whale, vocalization was picked up on the sonar. It was easy to discriminate whistles and calls (long tones) from clicks, the fundamental social tones in killer whales. Killer whale vocalization frequencies are within the operating frequency range of the SP90 sonar (>20 kHz), but not within the range for the SH80. The pickup on the sonar should therefore be both the fundamental vocalization frequencies and the harmonics. Wakes from swimming whales (surfacing) were also picked up by the sonar systems. The source of the wake is most likely echoes from whale air release and air being mixed into the water during surfacing.

Whales were detected during dives with no effect of water depth as one would assume due to lung volume compression and resulting reduction in whale echo strength. The whales did not show any apparent behavioral reactions during sonar operations, but this could be due to previous sonar transmission exposure from other fishing vessels in the area.

Simulations of ray tracing, transmission loss, and detection probability was in good agreement with actual observations. Sonar is not limited by visibility, darkness, or sea state and is not dependent on whale vocalization as passive listening methods (hydrophones) would be.

Project Objectives:

- Evaluate if traditional fisheries sonar can be used to detect whales within the proposed safety zones for marine seismic surveys.

Project Contract Dates: 9 November 2006 to 28 February 2007.

[1]Simrad, PO Box 111, 3191 Horten, Norway. frank.reier.knudsen@simrad.com
[2]Norwegian Defence Research Establishment (FFI), PO Box 115, Karjohansvern, 3191 Horten, Norway. phk@ffi.no
[3]Institute of Marine Research, PO Box 1879, Nordnes, 5817 Bergen, Norway. leif.noettestad@imr.no

Notes

Thursday, October 30, 2008 * 2:00 PM

Mitigation and Monitoring: Review / Inventory of Current Active Acoustic Methods and Technologies

Presenter: James A. Theriault

Principle Investigator, Collaborators and Affiliations:
James A. Theriault; Defence R&D Canada – Atlantic
E. MacNeil, B. Maranda, and L. Gilroy; Defence R&D Canada - Atlantic
J. Hood, G. Ryan; Akoostix, Inc.
R. Burke; Canadian Seabed Research, Ltd
P. Brodie; Balaena Dynamics, Ltd.

ABSTRACT
The overall objective of the OGP JIP (Joint Industry Programme) is to develop a capability that will address environmental impact mitigation requirements and allow continued E&P (Exploration and Production) operations in sensitive areas. Starting in October, 2008, this study will survey, record, and analyze the capabilities of production and experimental systems that may be used for Active Acoustic Monitoring (AAM). The current and projected capabilities will be compared with E&P requirements for marine mammal detection, classification, and localization. This presentation will outline the planned methodology and highlight some of the anticipated scientific challenges in characterizing AAM performance. Challenges anticipated are associated with the limited knowledgebase on marine mammal active target strength data, the likely limitations on system specifications, and the identification of relevant E&P operations. An early comparison of measured target strength with modeled results will be presented.

Project Objectives:

- Survey, record, and analyze the capabilities of current and experimental AAM Systems,
- Compare current and experimental systems with generalized E&P requirements, and
- Identify knowledge deficiencies and define a broad development plan.

Project Contract Dates: October 2008 to May 2009.

Notes