DURIP—A Split-Beam System for Evaluating Sonar Target Strengths and Behaviors of Emergent Animals

Peter A. Jumars
Darling Marine Center
University of Maine
193 Clark's Cove Road
Walpole, ME 04573-3307
phone: (207) 5563-3146, x.242 fax: (207) 563-3119 email: jumars@maine.edu

Award #: N00014-06-1-0495
http://www.marine.maine.edu/~jumars/

LONG-TERM GOALS

Our long-term goals are to understand — to an extent that allows quantitative prediction — important interactions among acoustic propagation, marine organisms, particles (including sediments), solutes and moving fluids. The reason for these goals is to allow us to solve interesting forward and inverse problems in the marine environment.

OBJECTIVES

The primary objectives of this equipment procurement is to obtain clearer target-strength estimates for mysids and to resolve spatial and temporal features of their migrations.

APPROACH

The approach is to obtain and use a dual-frequency, split-beam system that can identify location and target strength of both mysids and their fish predators.

BioSonics (Seattle, WA) at this writing has completed construction of a dual-frequency (420 and 120 kHz) sonar. The company is currently working on the bottom mount for this system and the power and data cable. The bottom mount will be steerable (360˚ rotation plus 90˚ tilt)

WORK COMPLETED

BioSonics (Seattle, WA) at this writing has completed construction of a dual-frequency (420 and 120 kHz) sonar. The company is currently working on the bottom mount for this system and the power and data cable. The bottom mount will be steerable (360˚ rotation plus 90˚ tilt)

RESULTS

We will have no results to report until delivery of the unit (winter 2007) and we can get it into the water (likely April-May 2007).

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE **30 SEP 2006**	2. REPORT TYPE	3. DATES COVERED **00-00-2006 to 00-00-2006**

4. TITLE AND SUBTITLE **DURIP - A Split-Beam System for Evaluating Sonar Target Strengths and Behaviors of Emergent Animals**	5a. CONTRACT NUMBER 5b. GRANT NUMBER 5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER 5e. TASK NUMBER 5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **University of Maine,Darling Marine Center,193 Clark's Cove Road,Walpole,ME,04573-3307**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S) 11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**4**	

IMPACT/APPLICATIONS

Getting better target-strength estimates for mysids will allow conversion of abundance estimates obtained by other means to backscatter estimates. We also anticipate that the better resolution that we can achieve of mysid behaviors by using our existing TAPS-6 (Tracor Acoustic Profiling Systems) instruments in concert with the new BioSonics system will allow us to begin constructing individual-based models of mysid migration. Individual-based modeling (IBM) is a subset of agent-based modeling within complexity theory (Auyang 1998) and has several characteristics that distinguish

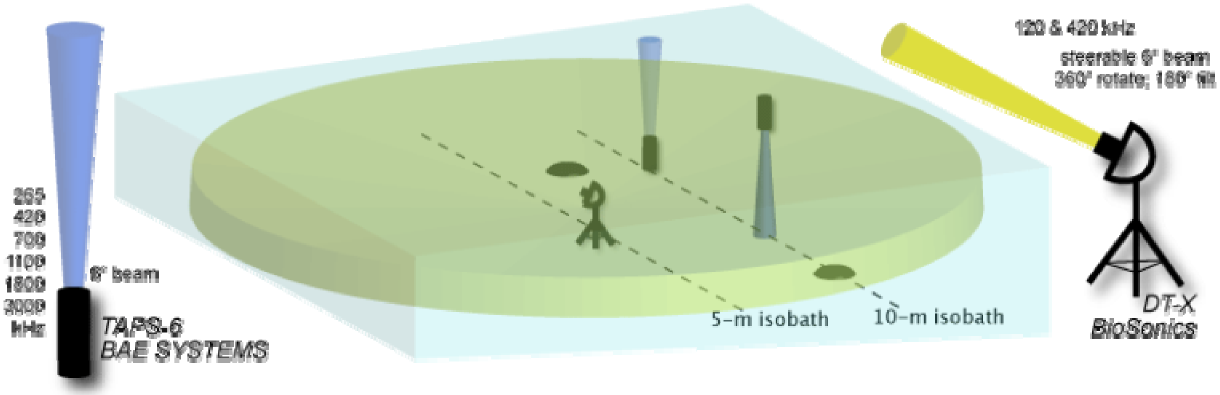

Fig. 1. Planned array design. The dark hemispheres represent ADCPs (beam patterns not shown). One TAPS will face downward to best resolve near-bottom water, whereas the other will face upward to best resolve near-surface water. ADCPs will be used to provide drift velocities to subtract from velocities indicated by successive particle positions in the DT-X returns. One radial scan for fish abundance is indicated by the yellow, indented disk centered on the DT-X. For velocity estimation of mysid migrations, the beam will be fixed successively in shore-orthogonal and -parallel positions.

it from classical reductionist or holistic approaches (Grimm & Railsback 2005, p. 55):

- "Theory is neither holist (system-level) nor reductionist (individual-level). We do not assume that ecological systems can be understood from only the system level, but we also do not assume that a system is simply the sum of its individual parts. Systems have properties of completely different types than the properties of individuals, and theory must explain these system properties.

- Theory must therefore be multilevel, linking traits of individuals to properties of the system. We are not interested in understanding all aspects of individual behavior but instead are interested in developing models of individuals that explain important system properties.

- Observational and experimental science at both the individual and system level is the basis for theory development. Such empirical science is important both for discovering the phenomena driving the system and for testing theories."

IBM is also an obvious approach toward understanding of emergence because the constellation of traits associated with emergent mysids overlaps so broadly with published success stories of IBM in explaining and predicting schooling and foraging behaviors under varying risks, dispersal, habitat usage and local reproductive success (Grimm & Railsback 2005, Ch. 6). What is particularly promising about this approach is that it frequently predicts very different consequences in different environments, as would appear necessary in the case of *N. americana.* IBMs have already been used in other marine applications (Miller et al. 1998; Grimm et al. 1999; Crain & Miller 2001; Leising 2001). The variety of IBM that would appear appropriate to mysids assumes that individuals choose behaviors that on average enhance their fitness, and those behaviors are termed 'adaptive traits' (Zhivotovsky et al. 1996). A successful IBM is generally recognized through correct prediction of often-subtle spatial patterns of distribution and habitat usage (Dieckmann et al. 2000, Grimm & Railsback 2005). Both from the standpoint of understanding observations and making models, the words of Pearre (2003) resonate, "...without knowing the actual movements of individuals it seems unlikely that we will be able to understand their causes, nor the effects of vertical migrations on the environment or on the migrators themselves." The split-beam system will at last allow us this level of resolution.

REFERENCES

Auyang, S.Y. 1998. *Foundations of Complex System Theories in Economics,* Evolutionary Biology and Statistical Physics. Cambridge Univ. Press, New York.

Crain, J.A. & C.B. Miller 2001. Effects of starvation on intermolt development in Calanus finmarchicus copepodites: a comparison between theoretical models and field studies. *Deep-Sea Res. II.* **48:** 551-566.

Dieckmann, U., R. Law & J.A.J. Metz, Eds. 2000. *The Geometry of Ecological Interactions.* Cambridge Univ. Press, Cambridge.

Grimm, V. C.-P. Günther, S. Dittmann & H. Hildebrandt. 1999. Grid-based modelling of macrozoobenthos in the intertidal of the Wadden Sea: Potentials and limitations. pp. 207-226 In S. Dittmann, Ed., *The Wadden Sea.* Springer, Berlin.

Grimm, V., & S.F. Railsback. 2005. *Individual-Based Modeling in Ecology.* Princeton Univ. Press, Princeton, N.J.

Leising, A. W. 2001. Copepod foraging in patchy habitats and thin layers using a 2-D individual-based model. *Mar. Ecol. Progr. Ser.* **216:** 167-179.

Miller, C.B., D.R. Lynch, F. Carlotti, W. Gentleman & C.V.W. Lewis. 1998. Coupling of an individual-based population dynamic model of Calanus finmarchicus to a circulation model for the Georges Bank region. *Fisheries Oceanogr.* **7:** 219-234.

Pearre, S., Jr. 2003. Eat and run? The hunger/satiation hypothesis in vertical migration: history, evidence and consequences. *Biol. Rev.* **78:** 1-79.

Zhivotovsky, L.A. A. Bergman & M.W. Feldman. 1996. A model of individual adaptive behavior in a fluctuating environment. pp. 131-153 In R.K. Belew & M. Mitchell, Eds. *Adaptive Individuals in Evolving Populations.* Santa Fe Institute Studies in the Sciences of Complexity 26.