

**REPORT DOCUMENTATION PAGE**

*Form Approved*  
OMB No. 0704-0188

The public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing the burden, to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

**PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.**

1. REPORT DATE (DD-MM-YYYY) 09-12-2008		2. REPORT TYPE Final Report		3. DATES COVERED (From - To) 1 Mar 2007 to 30 Sep 2008	
4. TITLE AND SUBTITLE Exploitation of Thermal Signal in a Tidal Flat Environment - Planning				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER N00014-07-1-0682	
				5c. PROGRAM ELEMENT NUMBER	
				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
6. AUTHOR(S) Jim Thomson, Chris Chickadel				8. PERFORMING ORGANIZATION REPORT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Applied Physics Laboratory - University of Washington 1013 NE 40th Street Seattle, WA 98105-6698				10. SPONSOR/MONITOR'S ACRONYM(S) ONR	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) Office of Naval Research (ONR 321) 875 North Randolph Street Arlington, VA 22203-1995				12. DISTRIBUTION/AVAILABILITY STATEMENT Approve for Public Release	
13. SUPPLEMENTARY NOTES None					
14. ABSTRACT Investigators participated within the planning phase of the Tidal Flats Department Research Initiative (DRI) to help design and site a series of large collaborative field experiments. The work included meetings and field trips to characterize potential sites, as well as logistical concerns. Emphasis was on integrating remote (infrared imagery) and in situ (thermistor) field sensing of thermal signals into the experiment plan.					
15. SUBJECT TERMS Tidal Flats, Infrared, Coastal Processes, Remote Sensing					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT UU	18. NUMBER OF PAGES 3	19a. NAME OF RESPONSIBLE PERSON Jim Thomson
a. REPORT U	b. ABSTRACT U	c. THIS PAGE U			19b. TELEPHONE NUMBER (Include area code) 206-616-0858

## *Final Report*

Office of Naval Research Award Number: N000140710682

### **Exploitation of Thermal Signals in a Tidal Flat Environment - Planning**

PI: Jim Thomson

Applied Physics Lab, University of Washington  
1013 NE 40<sup>th</sup> St, Seattle, WA 98105

Phone: (206) 616-0858 Fax: (206) 543-6785 Email: [jthomson@apl.washington.edu](mailto:jthomson@apl.washington.edu)

Co-PI: Chris Chickadel

Applied Physics Lab, University of Washington  
1013 NE 40<sup>th</sup> St, Seattle, WA 98105

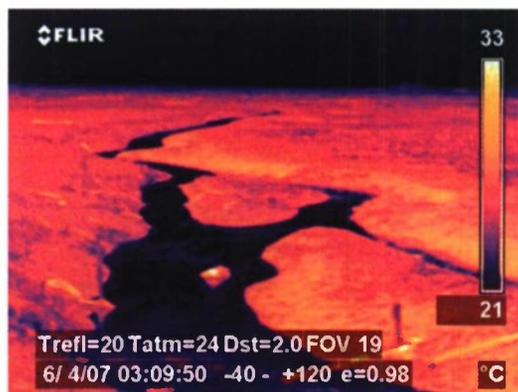
Phone: (206) 221-7673 Fax: (206) 543-6785 Email: [chickadel@apl.washington.edu](mailto:chickadel@apl.washington.edu)

#### **ABSTRACT**

Investigators participated within the planning phase of the Tidal Flats Department Research Initiative (DRI) to help design and site a series of large collaborative field experiments. The work included meetings and field trips to characterize potential sites, as well as logistical concerns. Emphasis was on integrating remote (infrared imagery) and in situ (thermistor) field sensing of thermal signals into the experiment plan.

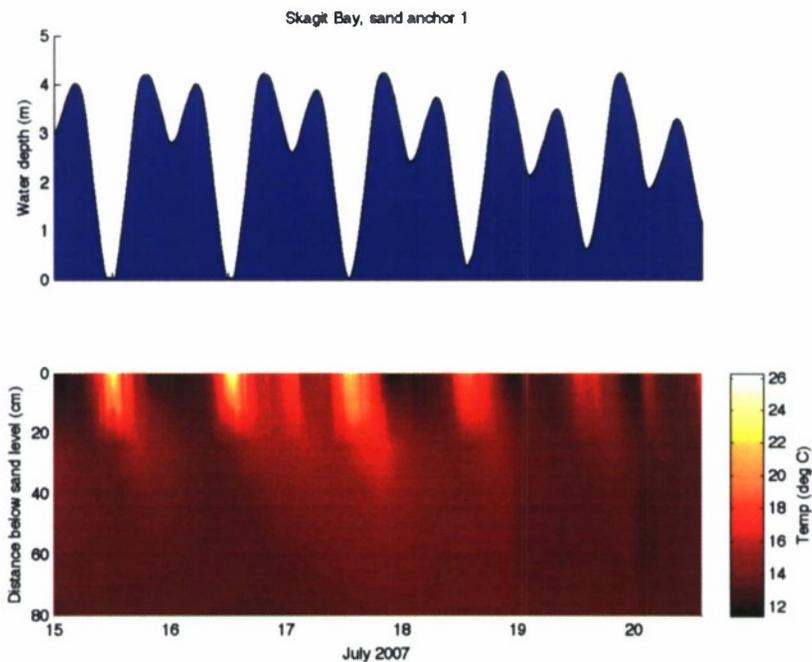
#### **WORK COMPLETED**

Investigators attended DRI planning meetings in Hawaii and South Korea, scouted field sites Washington State, begun development of new methods, and collected preliminary data. The preliminary data include infrared images from Korean sites (Figure 1), and sediment temperature profiles from Washington State sites (Figure 2).



*Figure 1. Infrared image of a tidal flat (warm signal) and channel (cold signal) at Marisan Beach, South Korea. Such thermal signals are common on tidal flats.*

# 20081215178



**Figure 2. Tide (upper panel) and sediment temperature profiles (lower panel) recorded near English Boom Park, Skagit Bay, WA. At low tide the upper layer of sediment is heated by solar radiation, and this heat is conducted downwards over time.**

## RESULTS

Two local field sites were selected for the Tidal Flats DRI. Figure 3 shows satellite images of the Skagit Bay and Willapa Bay, both of which have been documented through field trips and collection of existing resources (i.e., data, publications, personal communications). This information has been prepared for distribution the DRI community at large via a website [www.tidalflats.org](http://www.tidalflats.org). Additional results include the confirmation of significant thermal signals (eg, Figures 1 & 2) at each field site.

The Skagit Bay site is a predominately sandy tidal flat with active braided channels, although pockets of mud suggest that fine particles (i.e., mud and silt) are present in the system and being transported through the flats to deeper regions [McBride *et al.*, 2006]. The river input is large, with an average peak flow of 71,310 cfs (north and south forks combined, <http://waterdata.usgs.gov/nwis/uv?12200500>). At the northern end of the bay, there is a region of relic (eroding) mud, possibly owing to the construction of a breakwater. Along the southern perimeter of the bay, an active depositional band of mud exists within a few hundred meters of the shoreline. The spring tidal range is 4 m (<http://www.cfdnet.com:8080/locations/3237.html>).

The Willapa Bay site is predominantly muddy tidal flat with stable meandering channels, although a few sandy areas are present at the seaward edges [Ferraro and Cole, 2007].

River input is small, with an average annual peak flow of 14,680 cfs (Naselle and Willapa Rivers combined, <http://waterdata.usgs.gov/nwis/uv?12200500> , <http://waterdata.usgs.gov/nwis/uv?12013500> ). The southern portion of the bay is extremely muddy and difficult to traverse. The spring tidal range is 4 m (<http://www.cfdnet.com:8080/locations/4603.html> ).



**Figure 5. Tidal Flats DRI domestic field sites. The Skagit Bay (left image) is an approximately 15 x 15 km site centered at 48°18'52.43"N 122°27'33.97"W. The Willapa Bay (right image) is an approximately 10 x 10 km site centered at 46°25'14.67"N 123°57'34.46"W.**

## REFERENCES

- Ferraro, S.P. and F.A. Cole, 2007, Benthic macrofauna-habitat associations in Willapa Bay, WA, USA, *Estuarine, Coastal, and Shelf Science*, 71.
- McBride, A., K. Wolf, and E.M. Beamer, 2006, Skagit Bay Nearshore Habitat Mapping.