Instrumented Ballast Tank Studies to Examine Ballast Management Practices

Tom Johengen, CILER-U.Michigan
David Reid, NOAA-GLERL
Phil Jenkins, Jenkins & Assoc.
Hugh MacIsaac, U. Windsor
Greg Ruiz, SERC
Fred Dobbs, Old Dominion Univ.

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Identifying, Verifying, and Establishing Options for Best Management Practices for NOBOB Vessels

Sponsors:

- Great Lakes Protection Fund
- U.S. Coast Guard
- NOAA

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Identifying, Verifying, and Establishing Options for Best Management Practices for NOBOB Vessels

Objectives:

- Assess the effectiveness of specific ballast management practices on sediment accumulation and characteristics within ballast tanks.
- Assess the effectiveness of specific ballast management practices to reduce the density and viability of organisms and resting stages.
- Characterize source invertebrate populations and assess salinity toxicity as a barrier to prevent transfers of “high risk” species to the Great Lakes in ballast tanks.

Record of Instrumented Voyages

- 4 ships
- 9 voyages

- (latest not shown)

Ship	Start Date	End Date	Tank	Location
Irma	7/28/2004	11/30/2004	4S	Bellmouth
			5S	Bellmouth
			hand-held	Over-the-side
Irma	4/26/2005	9/6/2005	4S	Bellmouth
			5S	Bellmouth
Irma	9/6/2005	12/2/2005	4S	Bellmouth
			5S	Bellmouth
Irma	12/2/2005	4/28/06	4S	Bellmouth
			5S	Bellmouth
			5S	Mid-tank, inner, floor
			5S	Aft, outer bilge, floor
			5S	Aft, outer bilge, high
			5S	Forward, outer bilge, floor
			5S	Forward, outer bilge, high
Irma	4/28/06	7/8/06	5S	Aft, outer bilge, floor
			5S	Mid-tank, inner, floor
			5S	Forward, outer bilge, floor
Lady Hamilton	6/3/2005	8/17/2005	3S	Bellmouth
			5S	Bellmouth
			5S	Mid-tank, inner, floor
			5S	Mid-tank, inner, high
			5S	Mid-tank, outer bilge, floor
			5S	Mid-tank, outer bilge, high
Lady Hamilton	8/17/2005	11/10/2005	3S	Bellmouth
			3S	Mid-tank, outer bilge, floor
			3S	Mid-tank, outer bilge, high
			5S	Bellmouth
(added to existing)	9/2/2005	11/10/2005	5S	Mid-tank, outer bilge, floor
			5S	Mid-tank, outer bilge, high
Federal Ems	9/29/2005	12/28/2005	5S	Aft ladder, by traps
(IETrap Experiment)			5P	Aft ladder, by traps

Sediment Distribution

Foreward, Outer Bilge

Aft, Outer Bilge

Sediment Distribution

Inner Bays

Outer Bays

Instrumented Ballast Tank

Schematics of Instrument Spacing within the Ballast Tank

Ballasting History for MV/IRMA for voyage period July 2004 – Nov 2004

Sonde Data				Ship Ballast History			
Date	**Time**	**Depth**	**SpCond**	**Date**	**Local Time**	**Port**	**Ballast Activity**
7/29/04		Instruments Started		29-Jul		Cleveland, US	
8/2/04	9:01	33.5	0				
8/2/04	11:01	50.2	748	2-Aug	0800 - 0930	Burns Harbor, US	Ballast FW
8/3/04	11:01	50	662				
8/3/04	11:31	80.6	390	3-Aug		Burns Harbor, US	Ballast FW
8/5/04	23:31	83.5	381				
8/6/04	1:01	33.6	0	6-Aug	0015 - 0130	Thunder Bay, Canada	Deballast
9/9/04	1:31	34.4	0				
9/9/04	6:01	83.2	57134	9-Sep	0730 - 0850	Manfredonia, Italy	Ballast SW
9/11/05	0:31	84.8	56966				
9/11/05	1:31	41.1	57020	12-Sep	0510 - 0815	Mid-ocean	Exchange
9/11/05	3:01	85.6	57310				
9/19/04	13:31	86.7	57882				
9/19/04	17:01	34.2	166	19-Sep	2050 - 2245	Ashdod, Israel	Deballast
10/5/04	14:31	34.1	66				
10/5/04	15:01	35.8	53269	5-Oct	1640 - 1700	Mid-ocean	SW Flushing
10/5/04	18:01	33.3	53649				130T
10/5/04	18:31	34.2	134				
11/2/04	7:01	34.2	66				
11/3/04	20:01	37.4	53708	2-Nov	1735 - 1920	Aratu, Brazil	Ballast SW
11/3/04	22:31	83.2	53265	2-Nov	1735 - 1920	Aratu, Brazil	Ballast SW
11/6/04	3:31	85.8	53768				
11/6/04	8:01	34.2	254	6-Nov	0435 - 0640	Maceo, Brazil	Deballast
11/30.04		End Deployment		30-Nov		Cleveland, US	

Characterize timing, amount, and chemistry of ballast activity and source water

Characterize water quality variation in source water and storage effects

Spatial Variation in Resuspension of Residual Sediment

Ballasting Event
Depth
6
5
4
3
2
1
0
12/8
12/9
12/10
12/11
12/12
Date

Ballasting Event
Turbdity
60
50
40
30
20
10
0
12/8
12/9
12/10
12/11
12/12
Date

Ballasting Event : Seawater
Depth
18
16
14
12
10
8
6
4
2
0
19:12
0:00
4:48
9:36
14:24
19:12
0:00
Date

Ballasting Event : Seawater
Turbidity
8
7
6
5
4
3
2
1
0
19:12
0:00
4:48
9:36
14:24
19:12
0:00
Date

Ballasting Event
Depth
14
12
10
8
6
4
2
0
4:48
9:36
14:24
19:12
0:00
4:48
9:36
14:24
Date

Ballasting Event
Turbidity
30
25
20
15
10
5
0
4:48
9:36
14:24
19:12
0:00
4:48
9:36
14:24
Date

Ballasting Event
Depth
16
14
12
10
8
6
4
2
0
1/5/06 0:00
1/5/06 12:00
1/6/06 0:00
1/6/06 12:00
1/7/06 0:00
1/7/06 12:00
1/8/06 0:00
1/8/06 12:00
Date

Ballasting Event
Turbidity
250
200
150
100
50
0
1/5/06 0:00
1/5/06 12:00
1/6/06 0:00
1/6/06 12:00
1/7/06 0:00
1/7/06 12:00
1/8/06 0:00
1/8/06 12:00
Date

Deballasting Event
Depth
10
9
8
7
6
5
4
3
2
1
0
22:48
0:00
1:12
2:24
3:36
4:48
Date

Deballasting Event
Turbidity
25
20
15
10
5
0
22:48
0:00
1:12
2:24
3:36
4:48
Date

Instrumented Trap Experiment

Stbd. Exchanged Tank
- ambient
- with sediment
- without sediment

Port Control Tank
- ambient

Instrumented Trap Experiment

Instrumented Trap Experiment

Conclusions

Although ballast tanks are generally a lousy place to deploy water quality instruments:

- Instrumentation can be effective for helping to determine timing, amounts, and chemistry of ballasting

- Instrumentation can be used to help understand water quality changes that occur in ballast water during voyages

- Instrumentation has helped verify sedimentation rates and the potential for sediment resuspension and redistribution or flushing from the tank

- There may be promise, with improved sensor technology, to use in-tank instrumentation to help verify compliance with future ballast treatment requirements and standards.