Ebb Delta Development at a “New” Old Inlet, Shark River Inlet, NJ

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Introduction

- Federally maintained; southernmost inlet in NY District
- Northernmost inlet on NJ coast; Atlantic Highland region (bluffs, historically steep nearshore)
- Small estuary; narrow inlet, small width:depth ratio
- Densely structured coast
  - Short north jetty with spur; longer south jetty
  - Groins recently notched (2000)
What is Unique about Shark River Inlet?

- Deep-draft channel maintained to 18 ft MLW, 150 ft across – width/depth = 17
- Historically efficient with little dredging necessary (every 7-10 years)
- 1997 & 2000 Beach Erosion Control Project (nourishment) added 2 million cy to north and to the south of the inlet
  - Nourished a severely sediment-starved system
  - District planned for increase of dredging interval of every 2-3 years
- CIRP also anticipated the increase in dredging, but did not anticipate the formation of an ebb shoal
Littoral Processes

- Angas (1960)
  - Up-drift (south) jetty impoundment
  - 1958-59 Sand Bypassing Project
    - 137,000 cy of the 225,000 cy projected in the first winter
- Others: USACE 1954, Caldwell 1956, Johnson 1956
- USACE NY District (2006)
  - 200,000 cy/year - net potential transport to north
  - 910,000 cy/year - potential gross transport
- Beck & Kraus (2009)
  - 235,000 cy/year – average net potential transport to north
Dredging History

- NY District increases condition survey interval following shoaling reports around north and south jetty tips

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- Volume is largely being controlled by frequent unanticipated dredging

![Graph showing volume change over time]
1995 & 2000 Ebb Delta Formation

Condition Survey
5 April 2000

Coastal Inlets Research Program
2002 & 2003 Ebb Delta Formation

After Dredge Survey
18 January 2003
2003 & 2006 Ebb Delta Formation

Condition Survey
23 May 2006

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Dredging Events & Volume Post 1999

Surveyed Channel Volume (Post 1999)

Dredged
2008 & 2009 Ebb Delta Formation

Before Dredge Survey
15 April 2009

Elevation, MLW (m)
-1 - 0.5  -2 - 1.5  -3 - 2.5  -4 - 3.5  -5 - 4.5  -6 - 5.5  -7 - 6.5  -8 - 7.5  -9 - 8.5  -10 - 9.5
-1.5 - 1  -2.5 - 2  -3.5 - 3  -4.5 - 4  -5.5 - 5  -6.5 - 6  -7.5 - 7  -8.5 - 8  -9.5 - 9  -10.5 - 10
2010 – Post Dredging

After Dredge Survey
January 2010

Elevation, MLW (m)
-1.0 - 0.5
-2.0 - 1.5
-3.0 - 2.5
-4.0 - 3.5
-5.0 - 4.5
-6.0 - 5.5
-7.0 - 6.5
-8.0 - 7.5
-9.0 - 8.5
-10.0 - 9.5
-10.5 - 10.0

NY District Survey

Photo: October 2006

Coastal Inlets Research Program
January 2009 & 2010 – After Dredging Survey

NY District Survey

Coastal Inlets Research Program
Coastal Modeling System (CMS)

- Finite Volume Method; explicit (HPC) or implicit (PC)
- Inline code: flow, waves, and sediment in a single program
- Fully unstructured telescoping (quadtree) mesh
  - Flexible
  - Computationally efficient
  - Backward compatible with previous CMS grids
- 10-30 times for faster than the explicit version of CMS-Flow
  - Typical speed - 1 year morphology change calculated in 1 day
- Robust, reliable
  - 5-30 min time step of for tidal circulation with waves
  - Wetting and drying
- Several choices for sediment transport rate formulas
Shark River Inlet Simulation

- CMS – Implicit Solution for Morphology Change
  - Short term to calibrate to dredging data (shorter cycle of 4-6 months)
  - Long term to test alternatives
    - General morphology characteristics: generate ebb delta, jetty-tip shoaling under dominant wave pattern
    - Engineering alternatives: dredging configuration (widen channel); jetty extension
  - Sediment Grain Size ($D_{50}$) – 0.20 to 0.30 mm
    - Variable $D_{50}$
    - Choose 0.26 mm for constant grain size (Kraus and Gravens, 1988)
  - Use Default Transport Coefficients
  - Applied Non-Equilibrium Transport Procedure
Defining the Modeling Domain

- Small estuary; Covers ~10 km of coastline
  - Resolve groin “circulation cells”
  - Lateral boundaries at relatively unstructured stretch

- Channels accurately represented
  - At least 10-15 cells across inlet
  - Federally maintained entrance and south channel (15 years of data)

- Ocean boundary
  - 3 or 4 times the ebb jet distance
  - Resolve the shallow transverse shoals; not too shallow on the edge
Results: CMS – Calculated Channel & Longshore Current

Bathymetry (m):
- 2.0
- 1.6
- 1.2
- 0.8
- 0.4
- 0.0

Current Velocity:
- 2.00 m/s
- 0.00 m/s
Selected Alternatives

Existing Condition – Jan 2009 (Post-dredging)

Alternative 1 - 30 m Channel Wideners

Alternative 2 - 75 m Jetty Extension

Additional 30 m each
Existing Condition (Jan 09 Post-Dredging)

1 Month 4 Months 7 Months 9 Months 1 Year

Consistent with volume removed during the next dredging (~10k m³)
Channel Infilling

Existing Condition
January 2009
(Post-dredging)

Alternative 1 - 30 m Channel Wideners

Alternative 2 - 75 m Jetty Extension

Coastal Inlets Research Program
Summary

- CMS calculations of circulation patterns and magnitudes agree with measurements of current and water level
- Morphology change agrees with expected trends
  - Jetty tip shoals; ebb delta shape (wave-dominated, Atlantic coast type); dominant shoaling along the south jetty
- Short-term simulations produce sedimentation volume within order of magnitude (uncertainty in wave input)
- NET captured channel infilling and development of shallow south jetty tip shoal
- 1-year simulation takes 30 hr to complete on a PC
- Next steps:
  - Engineering options (jetty modification, orientation change)
  - Nourishment impact
  - Long-term (decade) calculations
Thank You!

Any Questions?
Waves

- NOAA Buoy
- Wave Information Study (WIS)

Wind (Sandy Hook)

Height

Period

Coastal Inlets Research Program
Tide

- Forcing data from Sandy Hook gauge
  - Ocean gauge (located on pier)
- Belmar tide gauge (bay)
  - Tidal benchmark
  - Field measurements set to this gauge

Water Level Variation, m MSL

Date, August 2009

- Ocean
- Measured (Bay)
- Calculated (Bay)
Current Velocity

![Graph showing current velocity over time with annotations for Ebbing and Flooding phases.](image)

- Calculated Velocity - CS1
- Measured Velocity - CS1
- Calculated Velocity - CS2
- Measured Velocity - CS2
- Calculated Velocity - CS3
- Measured Velocity - CS3

**Time, LDT 20 August 2009**