MUCK

A history of muck in the IRL

- Description and Sources
- Depositional Locations
- Management Experience
- Prioritizing Locations

MUCK

Description and Sources

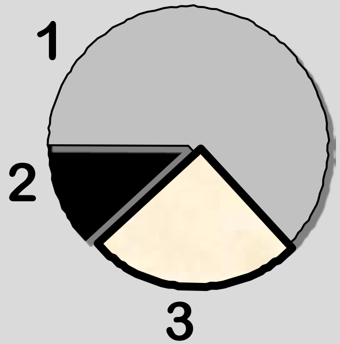
Definition

"…black, fine-grained…high water content, composed of partly decomposed organic matter and a considerable amount of admixed silt and clay material."

Trefry et al., 1987

1. Silt + clay >60% dry wt.
2. Organic matter >10% dry wt.
3. Sand + shell is the remainder

Trefry et al., 1990



Muck is mostly eroded upland soils (fines)

MAJOR Problems with MUCK

- Re-suspends, augments turbidity
- High O_2 demand, lowers benthic diversity
- Creeks are full, water column physically diminished
- A source of N and P loading

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Depositional Locations

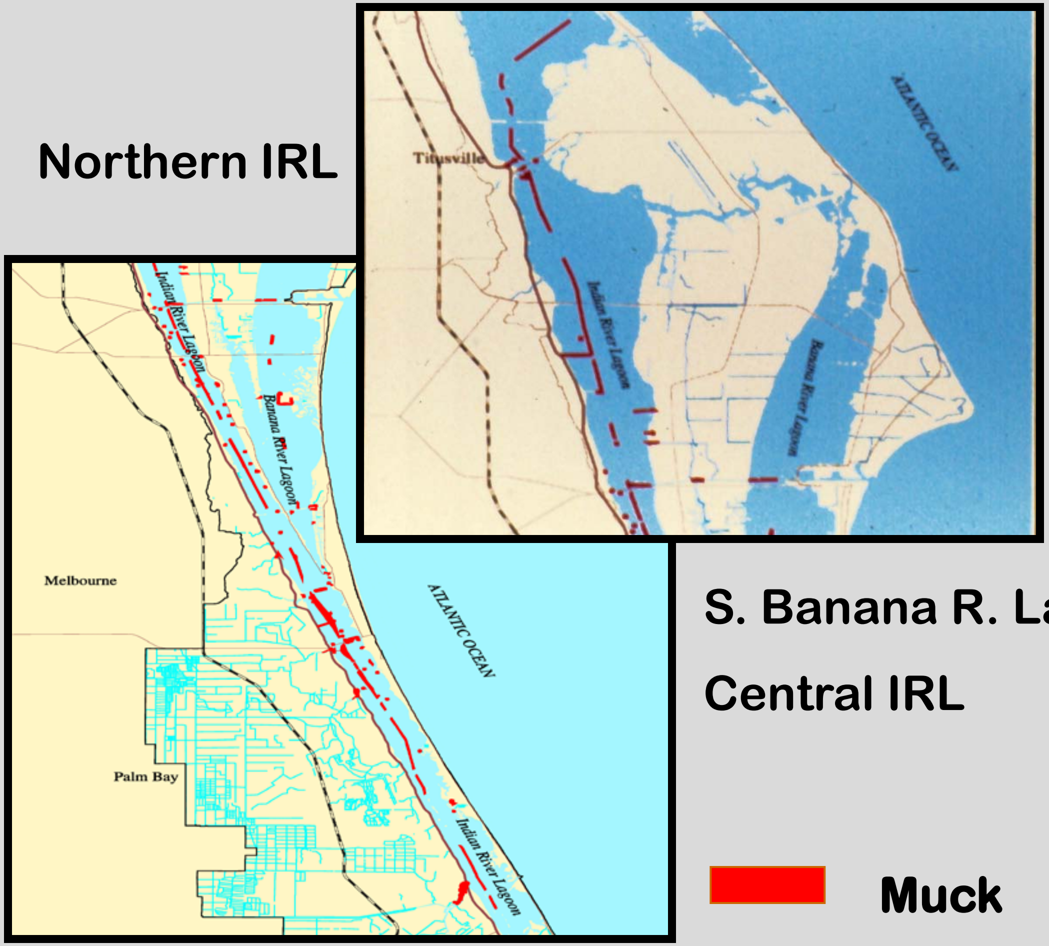
Estimated Amounts and Distribution in the IRL System

1989: 3 to 5 million cy in the Lagoon proper

0.2 to 1 cm/yr in Lagoon; up to 2 cm/yr in creeks

2006: closer to high value in the range (→ 5 million cy)

Northern IRL



S. Banana R. Lagoon

Central IRL

Muck

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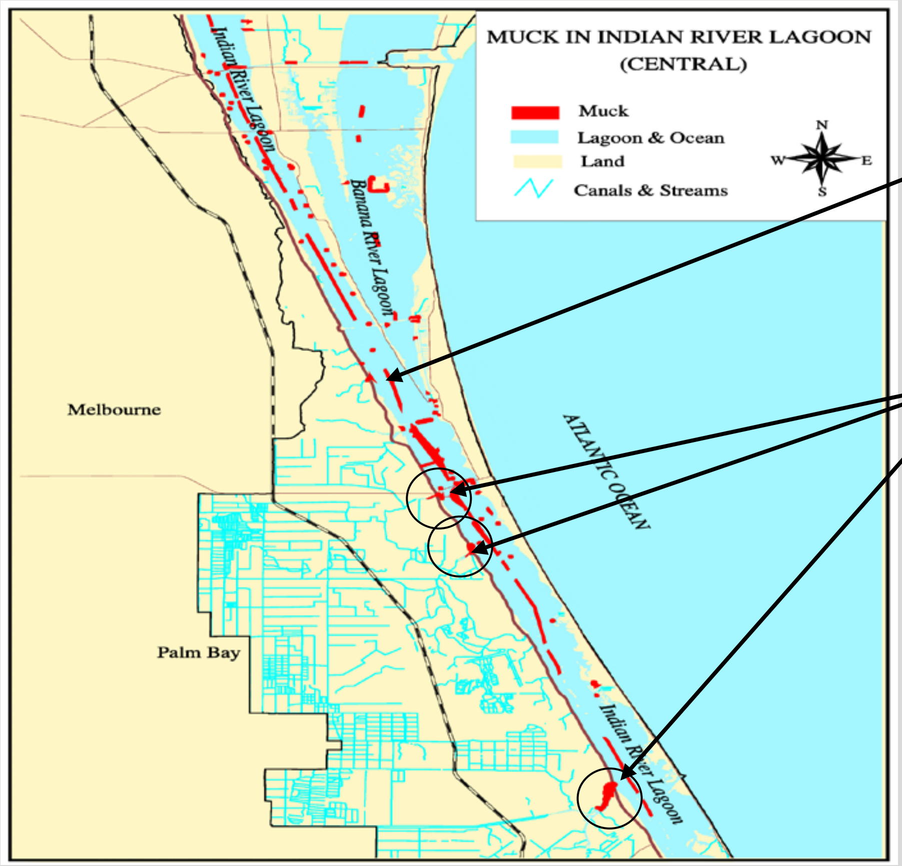
Major types of depositional areas

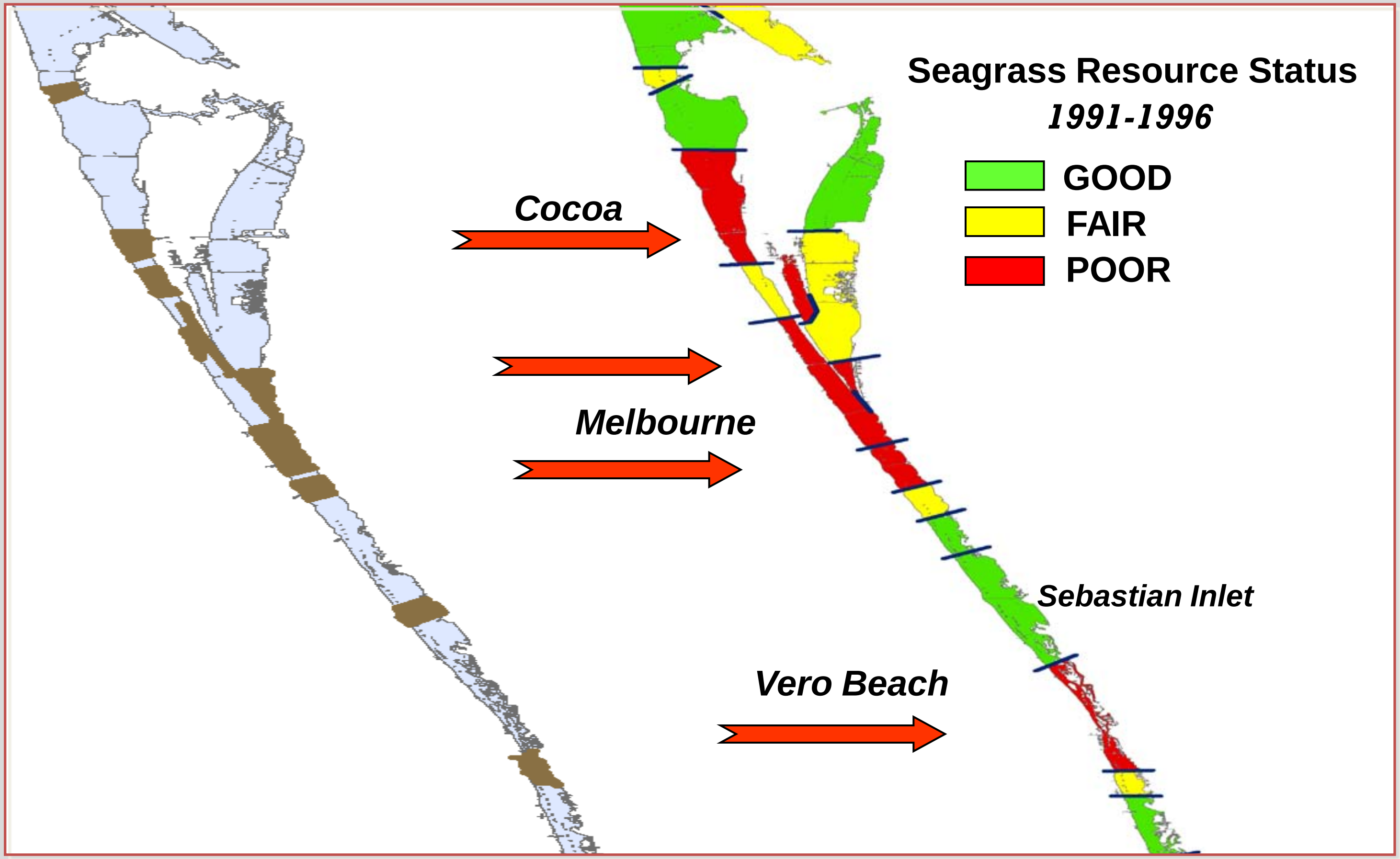


ICW channel

Creek mouths

Other deep bottom features (cswy borrow holes, finger canals, boat channels)

MUCK Zones vs. Seagrass Resource Status



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Management Experience

Research Implementation

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Research

1987: Initial research, problem i.d.

Trefry & Stauble, 1987

IRL Recon. Report (WMDs)

1989-’93: Lagoon-wide diagnostics

Trefry et al.,1990,92 – distribution & nutrient flux

Trocine & Trefry, 1993 – metals

Windsor & Surma, 1993 – organics

Trefry, Windsor, Trocine, 2008 – distribution, metals, organics

1994-’03: Feasibility, Pre- & Post-Dredge Studies

Creek Pre-dredge surveys, 1994-97 (Crane, Turkey, Sebastian)

M&P Assoc., BCI. 1996, Canal St. Cove, Beneficial uses

SJRWMD 1999, Muck Zone I.D. and prioritization

BCI, ’00 Dredge feasibility analyses (Eau Gallie R., etc.)

BCI & FIT, 1998-03, Crane Cr. post-dredge evaluation (water & sediment quality)

FWRI & Smithsonian, 2004-11, Sebastian R. Pre- & Post-Dredge (fish & benthic infauna)

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Lagoon-wide Diagnostics

Nutrient Flux (Trefry et al. 1992):

Methods:

Collection sites were in the mouths of Turkey Cr. and Sebastian R. and adjacent IRL.

Combined approaches: calculated flux (interstitial water gradients) & direct flux measurements (incubated cores).

Findings:

- General rule #1: Even under natural (sandy) conditions, sediment flux can constitute a significant % of total annual N & P loading.
- General rule #2: Between 2 and 5 cm muck thickness is sufficient to generate the ammonia and phosphate flux rates reported below
- IRL Muck Flux rates (Grand means for T.C./IRL reported):

  NO_3 -- undetectable

  Ammonia -- 8 ηmol cm^{-2} h^{-1}

  Phosphate -- 0.8 ηmol cm^{-2} h^{-1}

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Lagoon-wide Diagnostics

Application of Muck Ammonia (Am_m) Flux Rates

Example: Segments IR9-11 + 12 (Honeymoon Lake to Goat Cr.)

A. Area: ~83 km^2

B. **Assumption:** Sufficiently thick muck covers **15%** of area or 12.45 km^2

C. Am_m flux: 8 ηmol cm^{-2} h^{-1} or 12,000 kg km^{-2} yr^{-1}

D. Muck Area Total Flux: 148,000 kg yr^{-1} (B x C)

E. **Assumption:** Muck is dredged to natural substrate

F. Am_s (sandy) flux*: 250 to 1,230 kg km^{-2} yr^{-1}

G. Am_s Flux for dredged area: 3,100 to 15,300 kg yr^{-1}

F. NET flux from Muck Area (Am_m – Am_s): 132,700 to 144,900 kg yr^{-1}

* derived from literature values reported by Trefry et al. 1992

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Lagoon-wide Diagnostics

Application of Muck Ammonia Flux Rates *(cont.)*
Example: Segments IR9-11 + 12 (Honeymoon Lake to Goat Cr.)

NET flux from Muck Area ($Am_m - Am_s$): 132,700 to 144,900 kg yr^{-1}

"Current" N loading* from watershed (Pt. and Nonpt.): ~300,800 kg yr^{-1}

Required watershed load reduction: 152,400 kg yr^{-1}

It appears that complete removal of muck from segments IR9-11 +12 can remove an N load equivalent to 87% to 95% of the required reduction.

BUT, what about the ongoing supply of soils and detritus that accumulates as muck?

Answer: source control, iterative dredging, combination of both?

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* PLSM, 2000 L.U., avg. annual rainfall from 30-yr period

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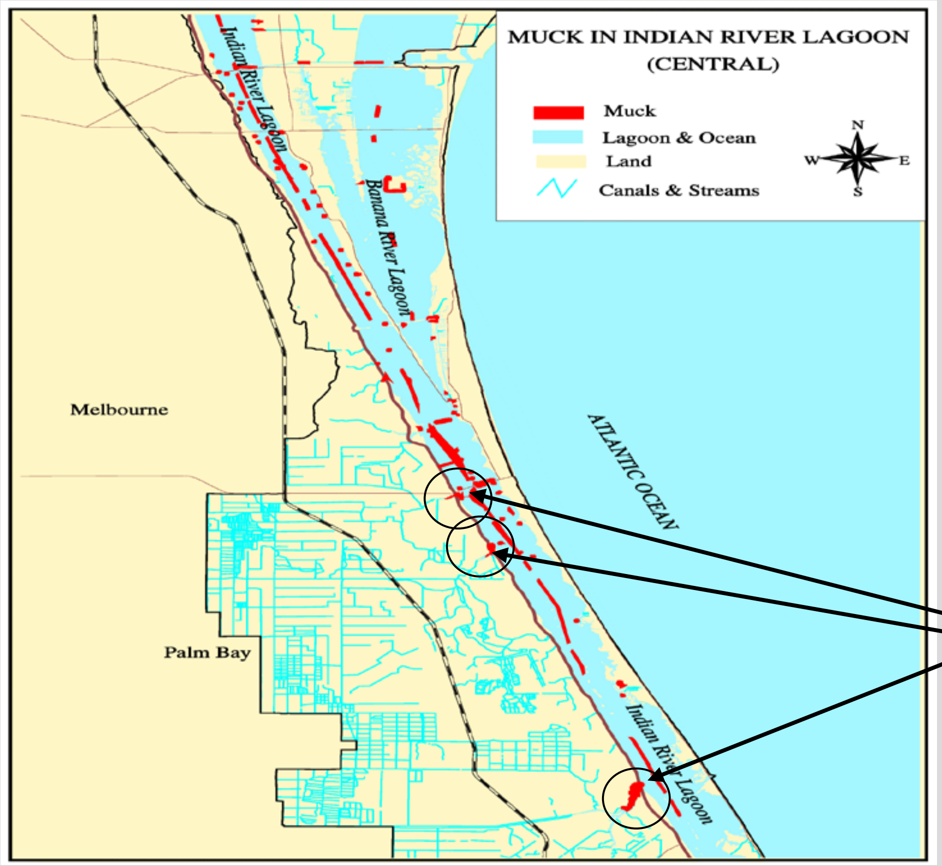
Implementation



ICW channel

USACE, FIND

Other deep bottom features (cswy borrow holes, finger canals, boat channels)

Local Gov'ts, FIND

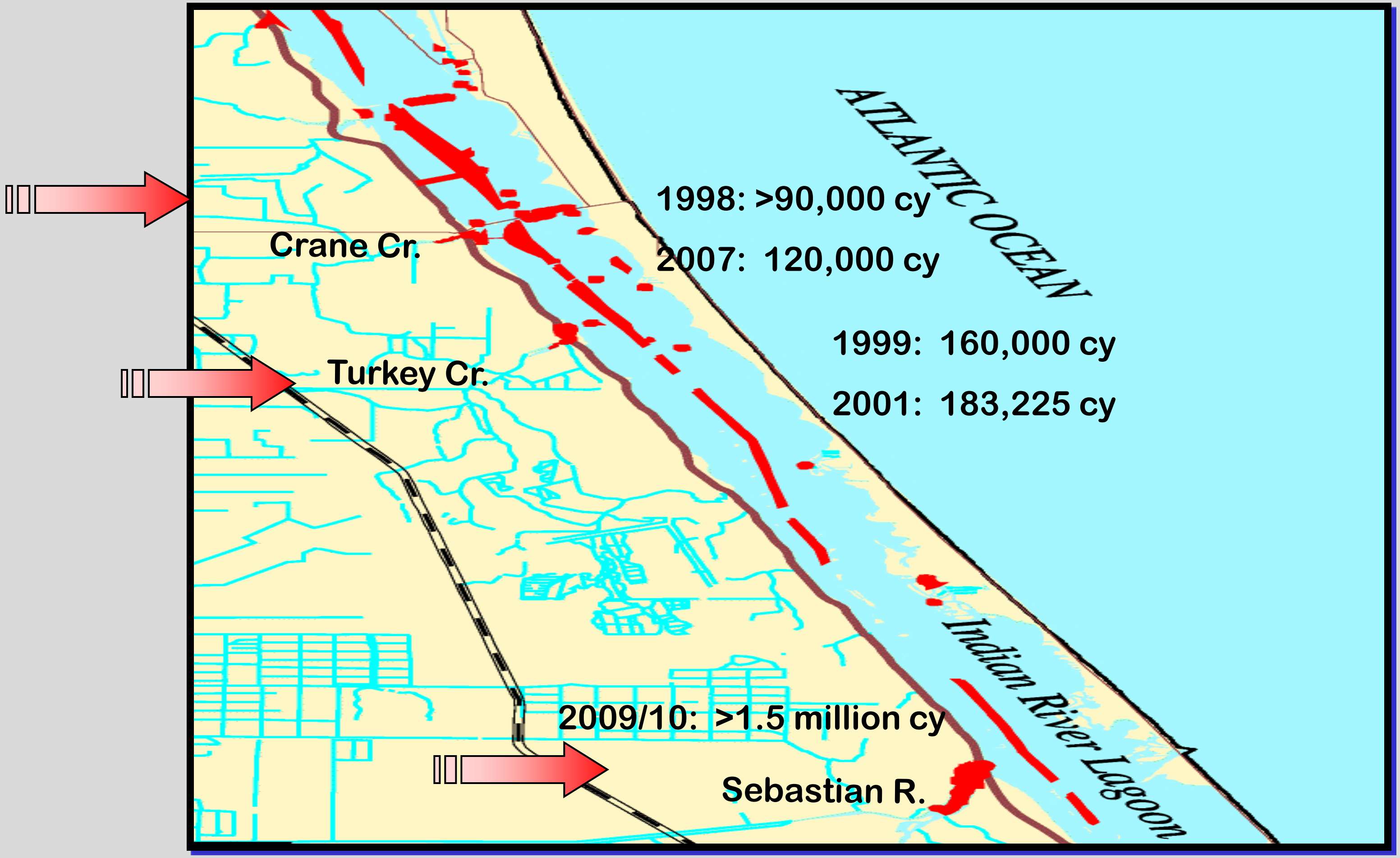
Creeks

FIND, WMD, IRLNEP

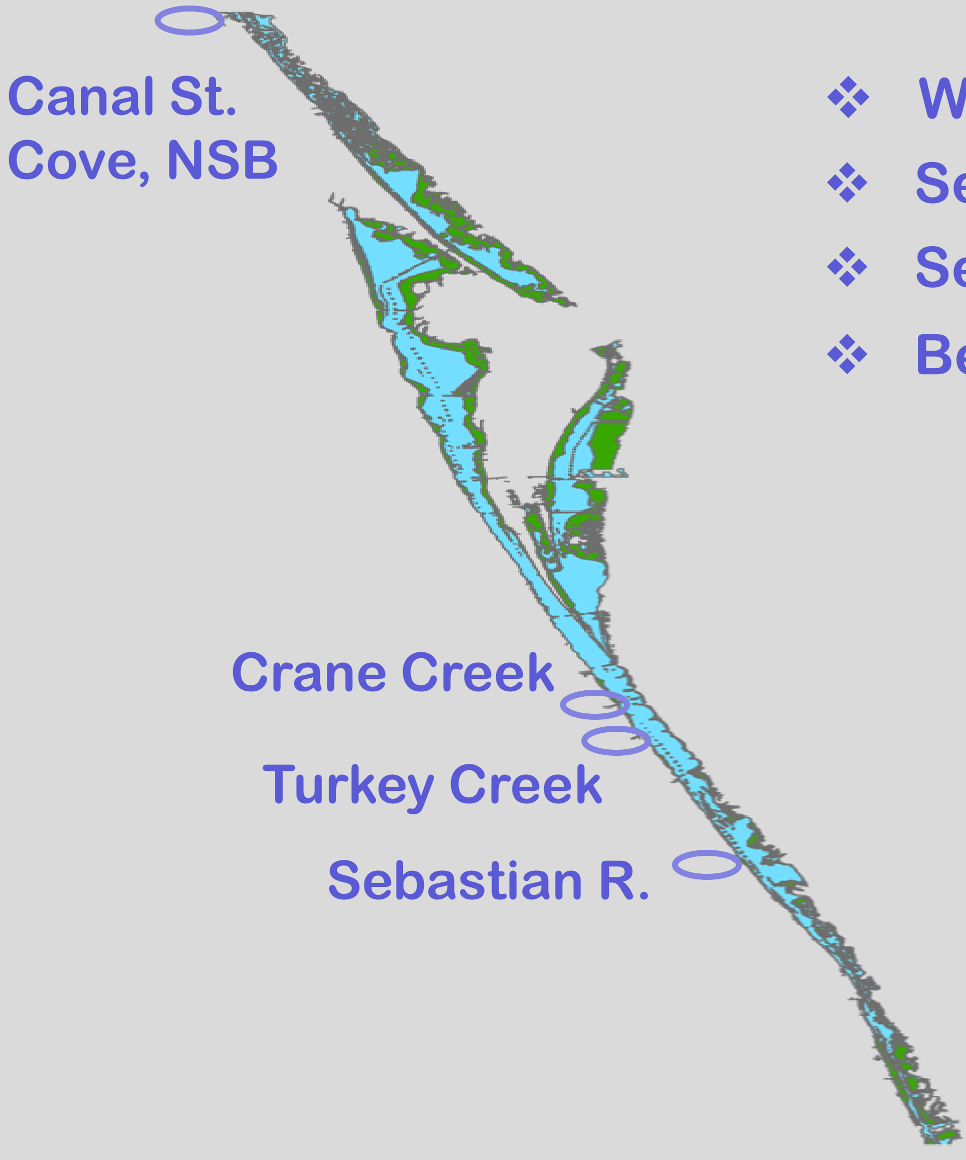
Implementation

Trib. "trap" cleaning & upland source control

1995: Canal St. Cove, New Smyrna Beach, Mosquito Lagoon; 1,350 cy

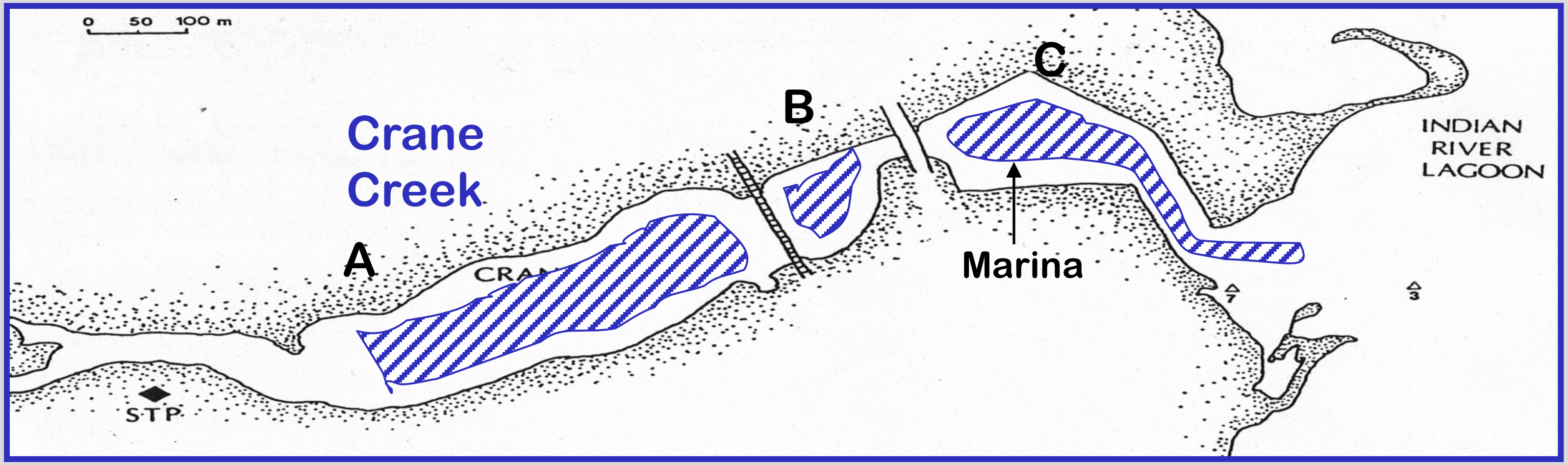


Applied Research at Dredge Locations



- Water Quality & Biology
- Sediment quality
- Sediment trapping
- Beneficial use feasibility

Crane Creek Dredge Project, (1998)

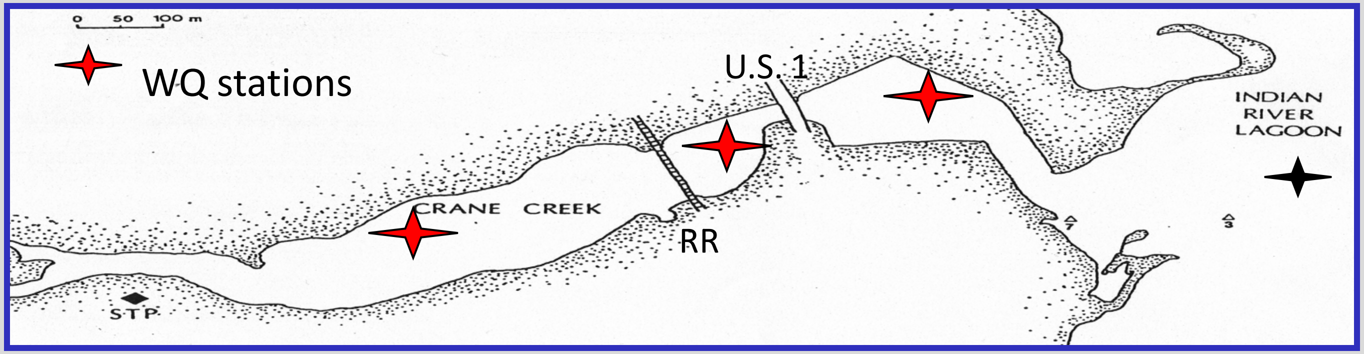


Dredge footprint

- Confined to navigational channel in marina; ≥50' from shoreline and structures
- Initial depths and dredge depths by area:
  A. ~0.5 to 1 m B. ~1 to >4 m C. ~2 to 4 m
- ~90,000 c.y. removed – met Phase I volume and depth targets

…but an appreciable amount of muck remained

Dredging Effects on Water Quality – Crane Creek



<u>Salinity</u>: ***General Increase***

0 – 27 ppt pre-dredge

0.2 – 35 ppt post-dredge

due to increased depths and upstream migration of salt wedge

<u>Dissolved Oxygen</u>: ***Improvement***

Additional 1 m of oxygenated <u>surface</u> water; however bottom anoxia/hypoxia still exists

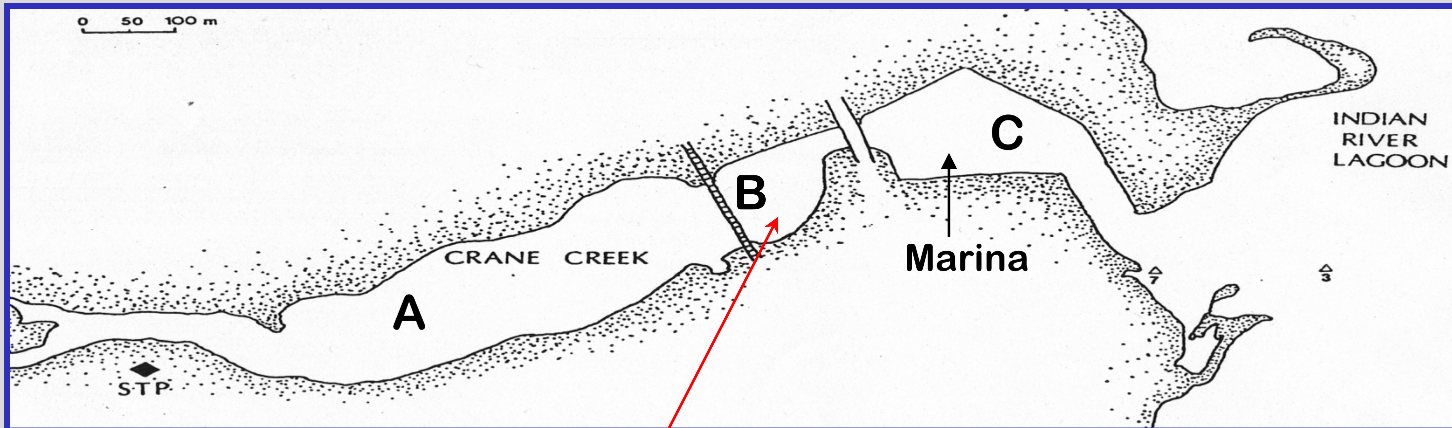
<u>Suspended Solids</u>: ***Slight Decrease***

Improved trapping efficiency

<u>Turbidity and Secchi Depth</u>: ***No Change***

Influenced by meteorological conditions

Dredging Effects on Sediment Quality – ORGANICS
Crane Creek



- **Polycyclic Aromatic Hydrocarbons** (PAH; µg/g, dry wt.)

	A	B	C
1992:	>7	3 – 6	2 – 29
2003:	3 – 9	7 – 16	0.5 – 7

--- No Source Reduction; re-dist. of muck ---

- **Phthalate Esters** (µg/g, dry wt.)

1992: ~3 – 27

2003: Below Detection

--- Sediment content & source reduction ---

Dredging Effects on Sediment Quality – METALS
Crane Creek

Target Metals: Ag, Cd, Cr, Cu, Hg, Pb, Zn, As, Ni, and V

1950s – '60s may be peak input years (Cd, An, Pb, Ag, Hg)

2003 (post-dredge) metal concentrations were not significantly different than in 1992 (pre-dredge).

2003 Ag and Hg levels in most samples >ERL, and some samples (near WWTP) >ERM

2007 (post-dredge, Phase II), Hg, Zn, Pb > ERL in Melb. Hrbr

-- redistribution of remaining muck may have exposed higher concentrations --

Dredging Effects on Sediment Trapping
Crane Creek

- Creek appears to be a good trap.
- Sands should be removed 100% of the time, silts 50%, and clays 10%
- Trap's longevity may be ~50 years

Future Design consideration:

Trapping efficiencies for clays & silts need to be improved – consider strategically placed & sized upper reach trap(s) that can be maintained

Beneficial Uses

Canal St. Cove and Turkey Creek

- Good soil amendment to establish ground cover – especially Bermuda grass.

- Salt content can be managed
  - ✓ rain-leached prior to land application
  - ✓ plant selection is critical

- Public use of Turkey Creek Muck

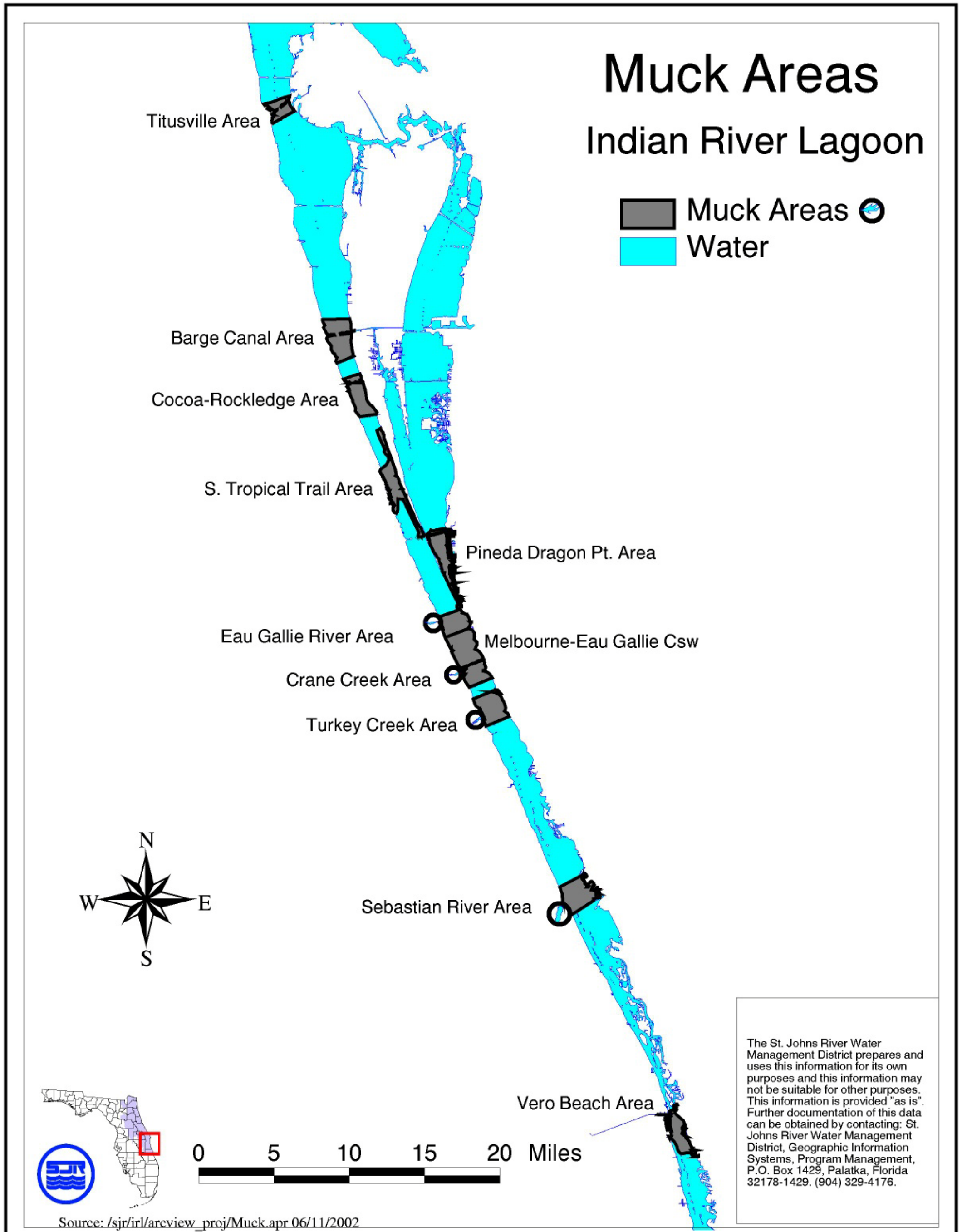
Comparison of IRL Muck to EPA Stds & Milorganite™

	EPA 40 CFR Part 503	Milorganite™	IRL Muck
Trace Metals (ppm)	limits	mean conc.	range
Cd	39	2.3	<0.01 - 0.75
Cu	1500	248	40 - 100
Hg	17	0.88	0.004 - 0.749
Pb	300	75	0.9 - 41.5
Zn	2800	451	80 - 175
Macronutrients (%)	limits	mean conc.	range
N (C/N)	nr	6% (7)	0.1 - 0.5% (8)
P	nr	2% as P_2O_5	~0.1% as P

New... and Years Ahead
IRL-organite!
Recycled Top Soil
from the Indian River Lagoon
For use as:
Soil Amendments
Time Released Fertilizer
Packed with Nutrients!
IRL-Organite
Reclaimed Topsoil

MUCK

Prioritizing Locations


Muck Areas
Indian River Lagoon
Muck Areas
Water
Titusville Area
Barge Canal Area
Cocoa-Rockledge Area
S. Tropical Trail Area
Pineda Dragon Pt. Area
Eau Gallie River Area
Melbourne-Eau Gallie Csw
Crane Creek Area
Turkey Creek Area
Sebastian River Area
Vero Beach Area
N
W
E
S
0 5 10 15 20 Miles
The St. Johns River Water Management District prepares and uses this information for its own purposes and this information may not be suitable for other purposes. This information is provided "as is". Further documentation of this data can be obtained by contacting: St. Johns River Water Management District, Geographic Information Systems, Program Management, P.O. Box 1429, Palatka, Florida 32178-1429. (904) 329-4176.
Source: /sjr/irl/arcview_proj/Muck.apr 06/11/2002

Prioritizing Locations (zones)

Relative Ranking Criteria (1998/99)

1. WQ as % departure from baseline for TSS, turbidity, and D.O.
2. Water Depth to Muck

   zone's ranking value based on modal value of all its muck deposits
3. Seagrass change (% loss):

   1994 vs. 1943

   1994 vs. 1.7 m coverage

Prioritizing Locations (zones)

Ranking Results (1998/99)

Vero Beach ?? ('04 scouring reported)

Crane, Turkey, Eau Gallie creeks

Barge Canal – Magnolia Pt. (N. IRL)

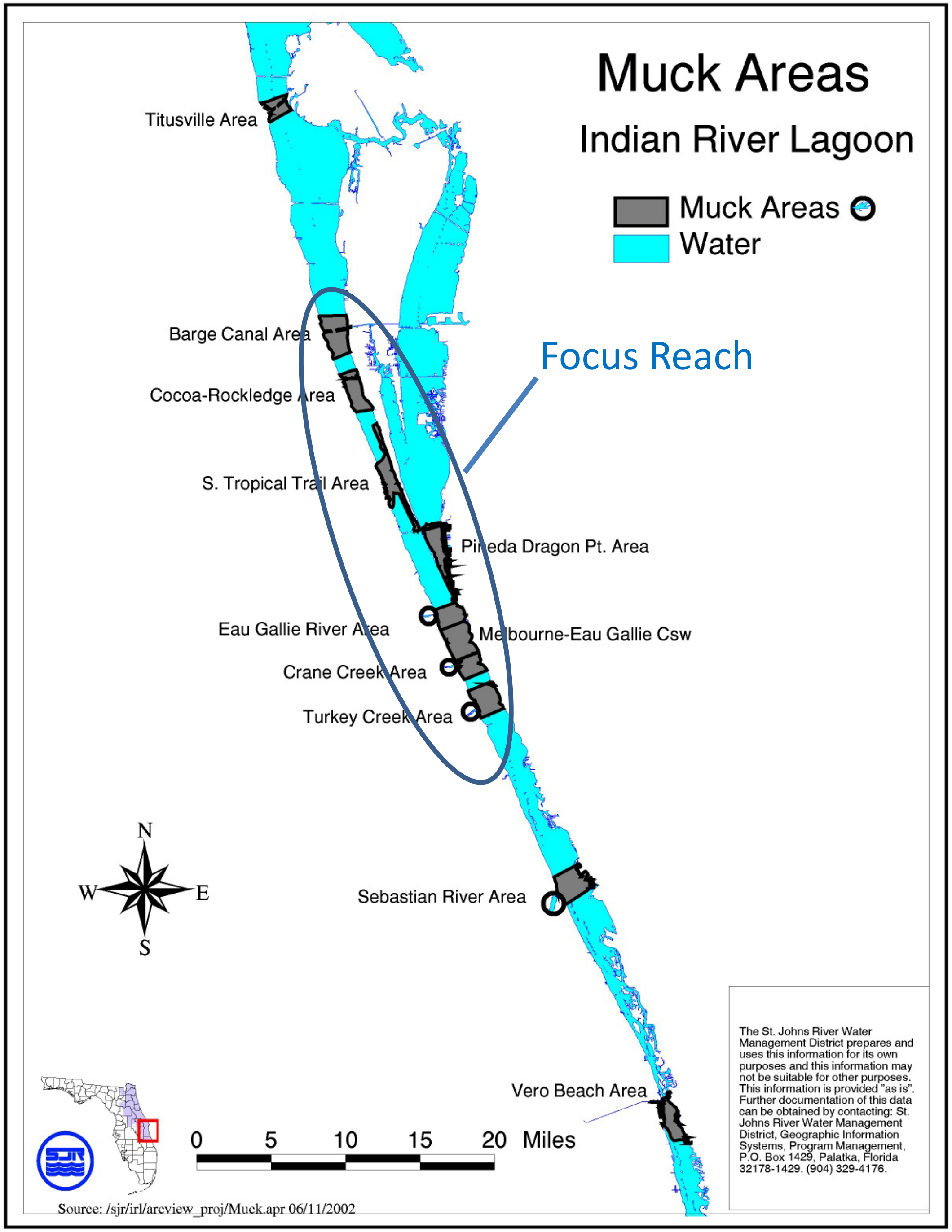
Eau Gallie Cswy – just south of Melb. Cswy

S. Banana R. Lagoon (did not include finger canals)

Sebastian River

Titusville

Cocoa Rockledge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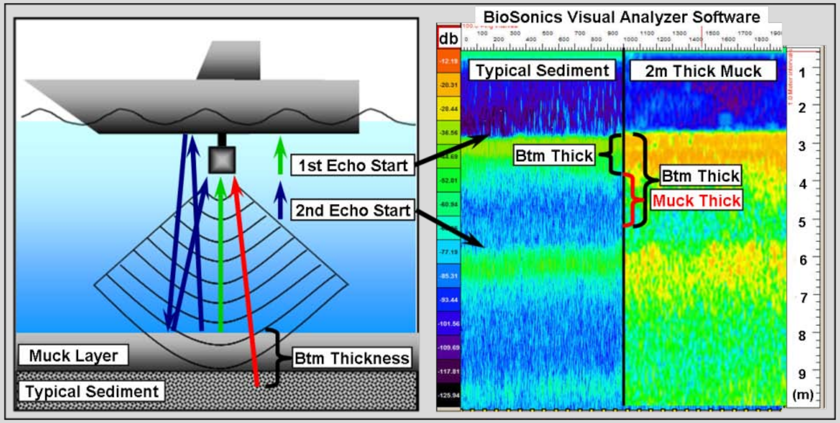
Summary

- Select environmental objectives with care
- Source control!
- Plan for complete muck removal; avoid over-dredging
- Maintenance dredging – not if, but how often
- Muck is basically displaced soil; generally safe for land application
  (exceptions possible, but not the rule)
- Consider beneficial applications
- Priority region is Cocoa to Melbourne & S. BRL
- Site-specific surveys are important, pre- & post-dredge



Nova Southeastern University
Oceanographic Center & NCRI
Dania Beach, FL

Hydroacoustics shows promise as a Muck Survey tool