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Descriptions and Preliminary Report on Sediment Cores from the Southwest Coastal Area, Part II: Collected July 2005, Everglades National Park, Florida

U.S. Geological Survey Open File Report 2006-1271

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ABSTRACT

Twelve cores were collected from six sites in the southwest coastal area of Everglades National Park, Florida, in July 2005. These six sites create transects up three river systems that are part of the complex network of channels and bays that form the mangrove and coastal glades – Lostmans River system, Harney River system, and Shark River system. The three transects are linked to two cores collected in 2004 from Big Lostmans Bay and Tarpon Bay. A preliminary model of changes in flow through the southwest coastal zone is proposed based on an examination of the sediments and an initial assessment of key indicator species of mollusks within the cores. Throughout the time period recorded by deposition of these cores, flow to the southwest coastal area has been predominantly through the Shark River channels, diminishing to the north toward the Lostmans River system. The Lostmans system was less influenced by freshwater flow and more emergent than the two systems to the south. Freshwater flow has periodically reached the mouths of the Harney and Shark River systems, but these areas have persistently been zones of mixed estuarine environments, typical of transition zones. Evidence for a substantial change in the flow regime is found in the mid-system cores from the Harney and Shark Rivers. The lower portions of both cores were deposited in freshwater environments, with no indication of estuarine influence; however, a shift towards more estuarine conditions occurs in the upper portions of the cores and a loss of the larger freshwater fauna. These results are preliminary. The next step will be to develop age models and to conduct quantitative analyses of the fauna, flora, and sediment geochemistry at these sites. Results of the quantitative analyses will provide information on the natural and anthropogenic changes that have occurred in the southwest coastal system that will allow resource managers to set targets for restoration.

INTRODUCTION

The greater Everglades ecosystem of south Florida exists because of a delicate balance between freshwater influx, low topographic gradient, underlying geology and sub-tropical climate. This combination has created a unique and diverse ecosystem, supporting many threatened and endangered species of plants and animals that rely on abundant freshwater. Historically, the Shark River Slough served as the primary conduit of freshwater through the central portion of the Everglades southwestward to the coastal region. This natural movement of water, however, has been dramatically reduced over the last century as construction of canals, water conservation areas and the Tamiami Trail either retained or diverted flow (Light and Dineen, 1994). The reduction in flow and changes in water quality through Shark River have had a significant effect on the freshwater marshes and the associated coastal ecosystems. Additionally, the flow reduction may have shifted the balance of fresh to salt-water inflow along coastal zones, resulting in an acceleration of the rate of inland migration of mangroves into the freshwater marshes.

South Florida is currently undergoing a massive restoration effort guided by the Comprehensive Everglades Restoration Plan (CERP, 1999). One of the primary goals of the CERP is to restore the natural flow of water through the terrestrial Everglades and into the coastal zones. Both the CERP and the Department of Interior Science Plan recognize the importance of understanding freshwater flow into south Florida's estuaries, and the changes incurred in the estuaries due to anthropogenic alterations of freshwater flow. One of the three primary objectives stated in the DOI Science Plan is to "ensure that hydrologic performance targets accurately reflect the natural predrainage hydrology and ecology" (DOI Science Plan, 2004, p. 14). A historical perspective can be obtained by examining the record of the hydrologic and biologic components of the natural system preserved in the sediments of south Florida. USGS researchers have utilized this method to provide restoration planners with information on the ecosystem history of Florida Bay and Biscayne Bay (Brewster-Wingard and others, 2001; Cronin and others, 2001; Ishman and others, 1998; Wingard and others, 2003, 2004).

The importance of Shark River Slough outflow to the health of the coastal ecosystem led the USGS Ecosystem History of South Florida's Estuaries Project to begin work in the southwest coastal area in 2004. A preliminary series of cores were collected in May 2004 (Wingard, et al., 2005). The cores collected in July 2005 and described in this report form transects with three of the 2004 cores, which allows us to examine changes in flow along a gradient moving towards the coast (Figure 1). The objectives of this research are to document impacts of changes in salinity, water quality, coastal plant and invertebrate communities and other critical ecosystem parameters on a decadal to centennial scale in the southwest coastal region, and to correlate these changes with natural events and resource management practices. Examination of these long-term (centennial scale) data sets will allow us to determine what the natural trends or cycles of change (such as rising sea-level or changes in climatic patterns) within the ecosystem were, and how anthropogenic alteration offset those natural cycles.

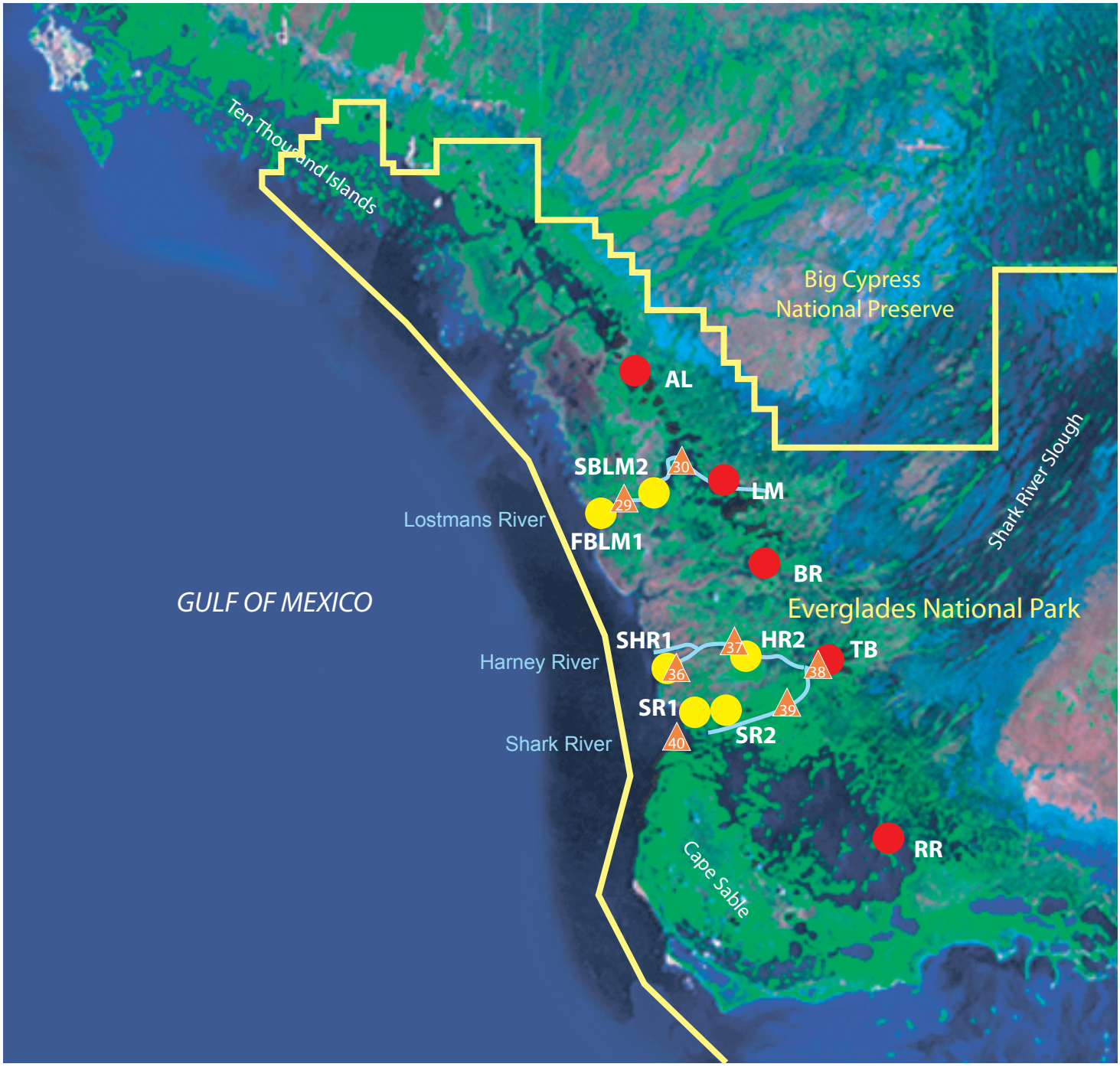


Figure 1. Satellite image of the southwest coast of Florida, showing general location of cores. Yellow line marks approximate boundary of Everglades National Park. Yellow dots indicate location of July 2005 core sites; SR1=Shark River, near entrance to Ponce de Leon Bay; SR2=Shark River system, north of main channel; SHR1=South Harney, near mouth of South Creeks; HR2=Harney River, near water station; FBLM1=First Bay of Lostmans River; SBLM2=Second Bay of Lostmans River. Red dots indicate location of May 2004 core sites (reported on in Wingard and others, 2005); AL=Alligator Bay Core; LM=Big Lostmans Bay Core; BR=Broad River Bay Core; TB=Tarpon Bay Core; and RR=Roberts River Core from river mouth. Orange numbered triangles correspond to South Florida Water Management District sites listed in Table 1. Blue lines trace the three river system transects discussed in this report: Lostmans, Harney, and Shark. Image cropped from John W. Jones and others (2001). Table 1 gives geographic coordinates of 2005 core locations and Figure 2 illustrates precise location of cores.

Setting

The Shark River Slough, flowing southward through Everglades National Park, delivers freshwater from Lake Okeechobee and the terrestrial ecosystem to the southwest coastal area of Florida. In addition, the Fakahatchee Strand and the Okaloacoooochee Slough provide freshwater to the Ten Thousand Islands area north of Lostmans River. The southwest coastal region is a complex network of channels, bays, coastal prairies, and mangroves (Figure 1). In 2004, a series of cores were collected from the inner bays that form the transition between the coastal and terrestrial ecosystems (cores described in Wingard, et al., 2005). The six sites cored in July 2005 and reported on here were collected downstream from 2004 cores, forming three transects from the inner bays out to the coast along Lostmans River, Harney River, and Shark River (Figure 1). This area receives the most direct influence of the overland flow from Shark River Slough.

Characterized as a mangrove estuary (or mangrove and coastal glades (McPherson and Halley, 1996)), salinity increases downstream in the channels towards the coast, but can vary tremendously on a seasonal basis, and inter-annually with changes in rainfall, tide, and freshwater flow from the terrestrial Everglades (Davis and others, 2005). Measured salinity along these transects over the last decade shows a high range of variability from <5 ppt to >30 ppt at most sites (Table 1; data from South Florida Water Management District). Ponce de Leon Bay experiences slightly higher salinities; the minimum measured salinity there is 9.8 ppt over the last decade.

Topographic highs throughout the southwest mangrove estuarine zone are less than one meter in elevation (Desmond, 2005). Due to the low relief and the location of the region at the terminus of the freshwater drainage, the mangrove estuaries of the southwest coast are “particularly vulnerable to changes in sea level and freshwater flow” (Davis and others, 2005, p. 833). These two factors – sea level and freshwater flow – are the primary drivers controlling “all ecological processes and attributes in the mangrove coastline of the southern Everglades” (Davis and others, 2005, p. 833). A general comparison of 1940 aerial photos and digital orthophoto quadrangles (DOQs) from the 1990s (Figures 2 and 3) indicates that the area has not undergone large scale geomorphic changes in the latter half of the 20th century.

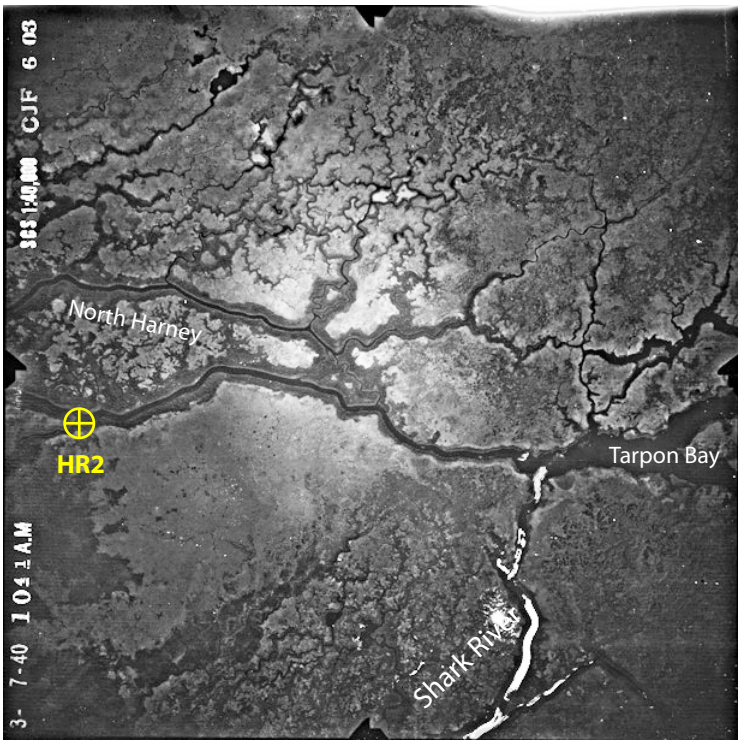
Acknowledgements

We would like to thank Everglades National Park for their cooperation in this study; the work described here was conducted under Study #EVER-00141 and permit #EVER-2004-SCI-0099. This work was funded by the U.S. Geological Survey (USGS) Greater Everglades Priority Ecosystems Studies. Marci Marot, USGS, assisted in the core collection; and supervised the core cutting process. We would like to thank our reviewers Debra Willard and Bruce Wardlaw, U.S. Geological Survey, for their thoughtful and thorough reviews of the manuscript.

Table 1: Summary of salinity data from river systems where cores were located. Data from South Florida Water Management District's Water Quality Monitoring Project (data from http://www.sfwmd.gov/org/ema/envmon/wqm/wqprojects.html, accessed August 2, 2006). Position of stations are shown on Figure 1 (orange triangles) Note: data were collected approximately once/month and generally two measurements were taken for each collection.

River System	Station ID	Station Location	Latitude	Longitude	Number of salinity measurements	Time frame of data collection	Average ppt	Standard Deviation	Minimum ppt	Maximum ppt	Median
Lostmans	FLAB29	First Bay	253316.31	811101.21	244	1/1995 to 1/2005	15.0	0.778	0.2	39.8	8.400
Lostmans	FLAB30	Third Bay	253448.61	810715.35	244	1/1995 to 1/2005	9.6	1.121	0.1	37.9	3.100
Harney	FLAB36	S. Mouth Harney River	252442.05	810829.22	244	1/1995 to 1/2005	22.6	0.311	2.8	36.4	4.800
Harney	FLAB37	Harney River Junct	252554.05	810456.57	243	1/1995 to 1/2005	11.2	0.840	0.4	35.0	5.700
Harney/Shark	FLAB38	Tarpon Bay	252502.21	805954.35	241	1/1995 to 1/2005	4.4	1.442	0.1	30.4	0.800
Shark	FLAB39	Gunboat Island	252244.11	810150.63	244	1/1995 to 1/2005	10.7	0.920	0.1	33.9	5.850
Shark	FLAB40	Ponce De Leon Bay	252058.99	810728.45	244	1/1995 to 1/2005	27.1	0.202	9.8	37.5	3.850

A



B

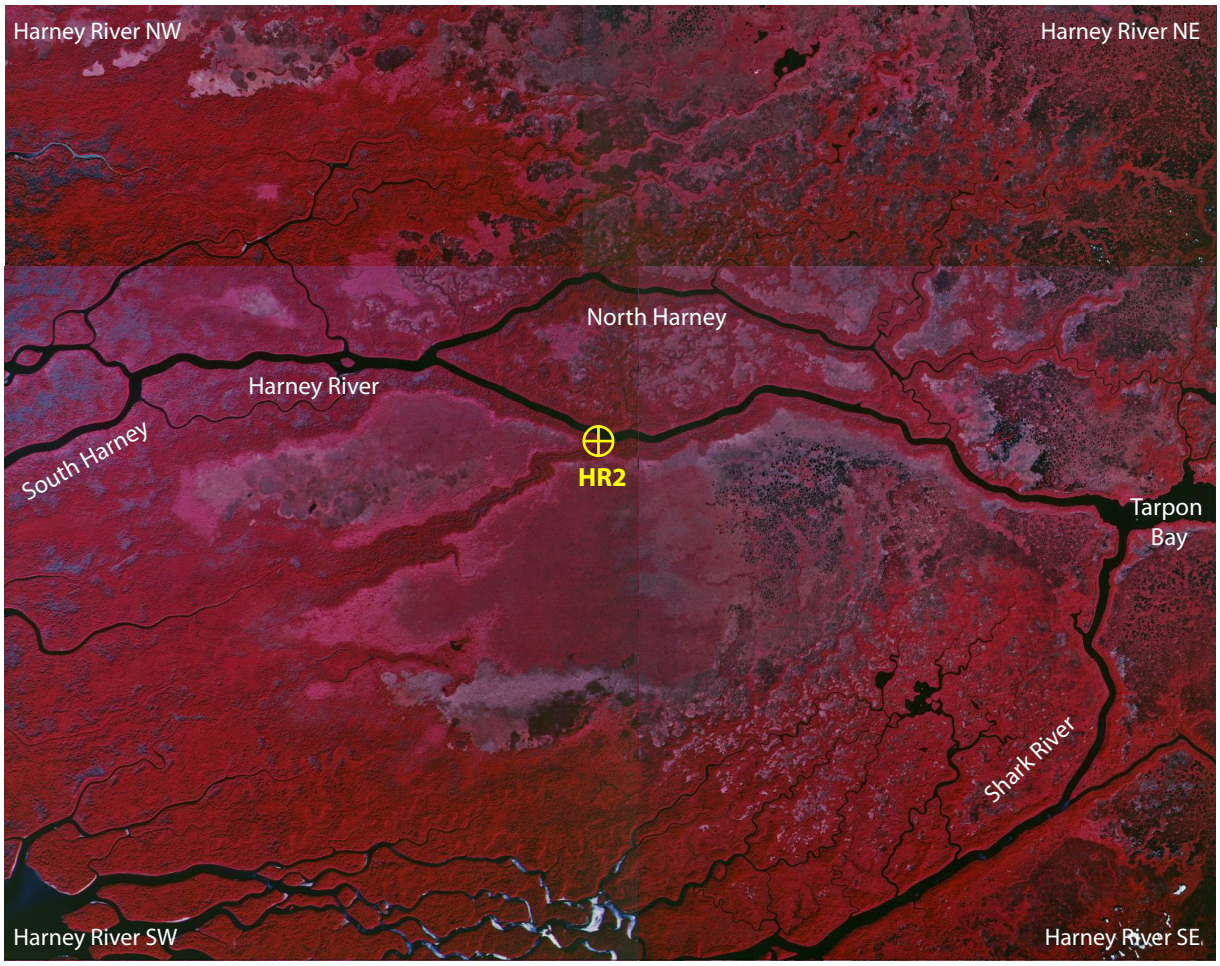


Figure 2. Comparsion of 1940 and 1995 landscape for region near Tarpon Bay and Harney River. Yellow X on map shows location of Harney River core (GLW705-HR2) from near water monitoring station on both images. A. 1940 aerial photo obtained from Smith and others (2002; section 34, line 6, image 3; available at http://sofia.usgs.gov/exchange/aerial-photos/). B. Composite of four 1995 Digital Orthophoto Quadrangles (DOQs) from Harney River area. DOQ images obtained from http://edcsns17.cr.usgs.gov/EarthExplorer/

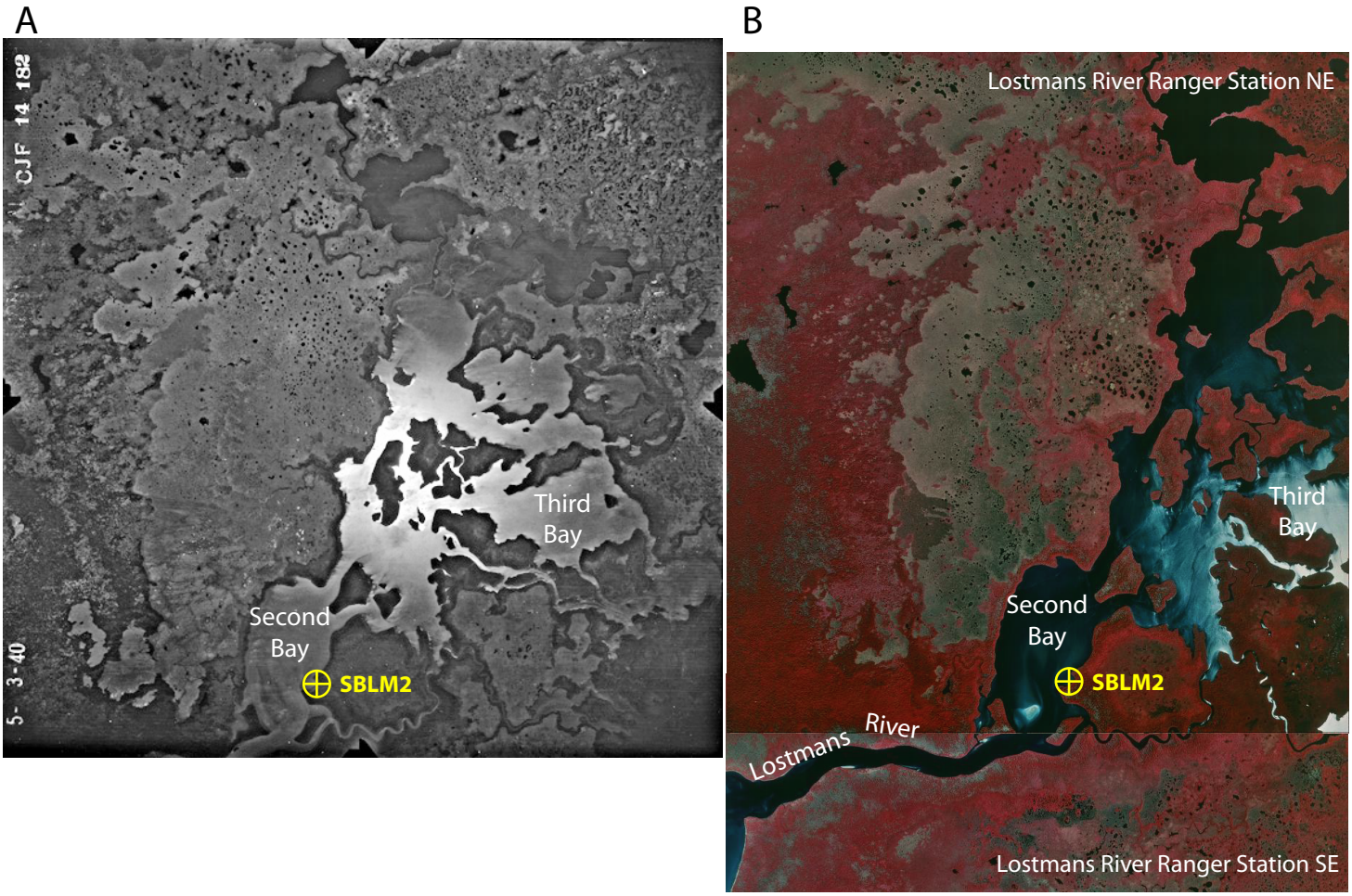


Figure 3. Comparsion of 1940 and 1994 landscape for region near Lostmans River. Yellow X on map shows location of Lostmans River, Second Bay core (GLW705-SBLM2) on both images. A. 1940 aerial photo obtained from Smith and others (2002; section 27, line 14, image 182; available at http://sofia.usgs.gov/exchange/aerial-photos/). B. Composite of two 1994 Digital Orthophoto Quadrangles (DOQs) from Lostmans River area. DOQ images obtained from http://edcsns17.cr.usgs.gov/EarthExplorer/

METHODS

Twelve piston cores were collected from six sites in Everglades National Park on July 12 and 14, 2006 (Table 2; Figures 1 and 4) under ENP Permit # EVER- 2004-SCI-0099. Duplicate cores, A and B, were taken side by side at each site (10-20 cm apart for most cores, ~1m apart for GLW705-SBLMA & B). X-radiographs of the A cores were made, and the upper 20 cm of each A core were cut vertically into 1-cm segments for analyses; below 20 cm the samples were cut into 2-cm segments. The subset A cores are currently undergoing analysis for faunal remains (ostracodes, foraminifers and mollusks), pollen, radiometric dating, and sedimentary and shell geochemistry. The B cores will be sliced vertically, digitally scanned, and sub-sampled for microbial DNA where appropriate. Portions of the subset B cores will be archived for future additional analyses.

Processing of faunal and floral remains within the cores is currently underway and will follow the procedures described in Cronin and others (2001), Brewster-Wingard and others (2001), Ishman and others (1998), and Willard and others (2001). In order to provide a quick overview of significant environmental changes taking place within these cores for this report, samples were scanned for their molluscan faunal content. These scans are quick visual identifications of the observable mollusks and do not constitute a thorough or quantitative examination. The observed presence of key environmental and/or salinity-indicator molluscan species is noted in Table 3.

LITHOLOGIC DESCRIPTION OF CORES

Sediment core descriptions were based on examination of core samples under a binocular microscope in a laboratory setting. Grain size is based on the Wentworth classification. Sediment color is based on the Munsell Rock Color Chart and was made on wet sediments. The following descriptions are arranged by river system moving from river mouth upstream and in a northwest to southeast transect (see Figure 1 for general location).

Lostmans River First Bay Core (GLW705-FBLM1A) (Figure 5)

Depth (cm)	Description
0-16	Sandy organic mud intermixed with a muddy very fine quartz sand to silt. Darker organic mud interlayered with lighter sandy material, forming fine laminae and layers up to 2 cm thick. Very high water content in upper 3 cm, becoming fairly cohesive below 3 cm. Shell fragments and whole shells scattered throughout with occasional pockets of dense shell fragments (10-11 cm). Abundant plant material (decayed wood, leaves, bark, fibers). (Ranges from Pale yellowish brown – 10YR 6/2 to dark yellowish brown – 10YR 4/2 to dusky yellowish brown – 10YR 2/2)

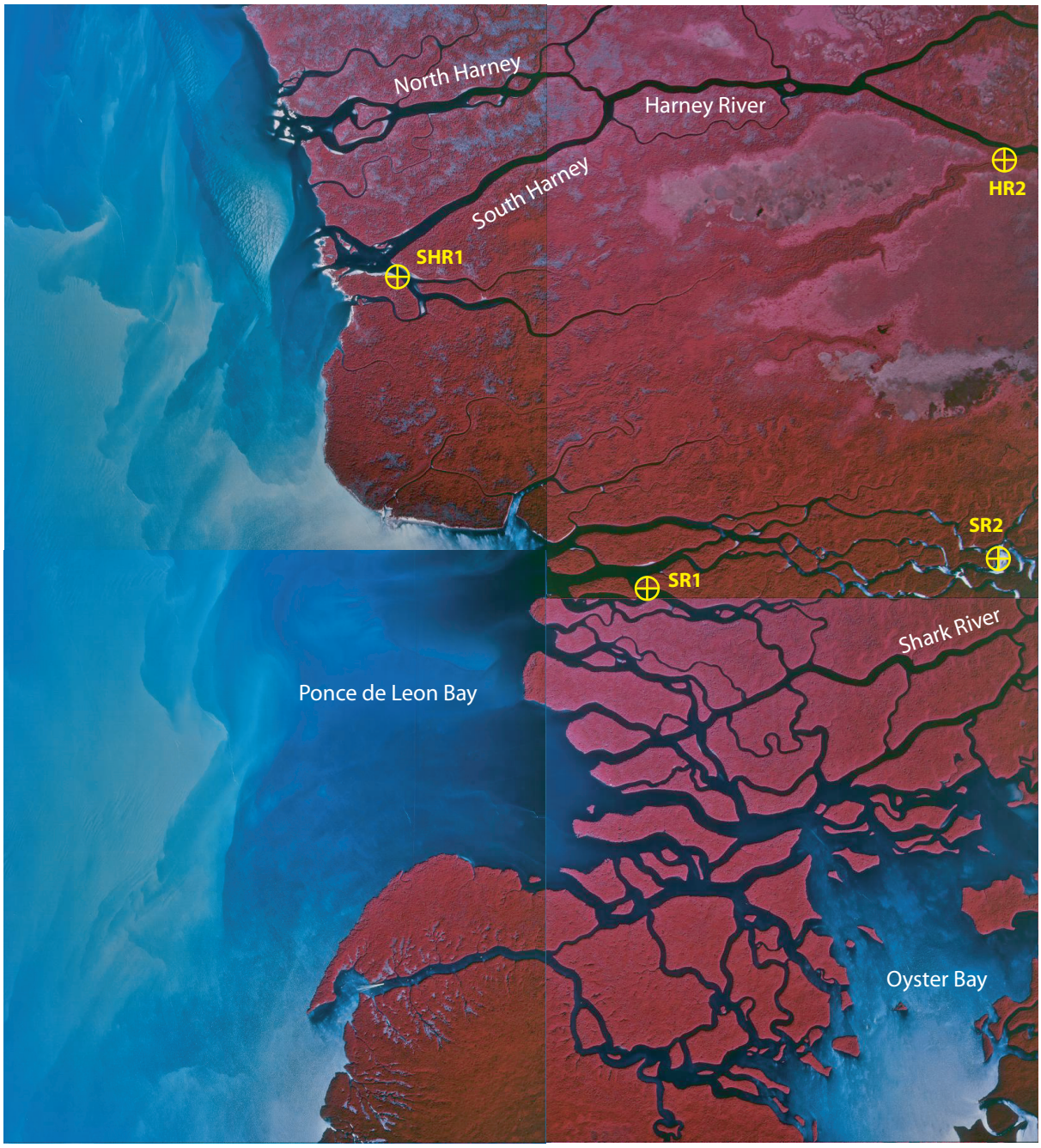
Table 2: List of cores collected in July 2005 in the southwest coastal area of Everglades National Park. See Figures 1 and 2 for locations.

Core Location	Date Collected	Core ID	Latitude	Longitude	Water Depth (cm) at Collection	Salinity at Collection (ppt)	Initial Core Length (cm)	Core Length when cut (cm)	Total loss from compression, compaction and drying (cm)*
Lostmans River - First Bay	7/14/2005	GLW705-FBLM1A	N 25° 32.828	W 81° 12.364	45	14.75	119.0	114.5	-21.5
		GLW705-FBLM1B	"	"	"	"	125.0	Not cut	
Lostmans River - Second Bay	7/14/2005	GLW705-SBLM2A	N 25° 33.877	W 81° 09.171	82	2.52	114.0	110.5	-4.5
		GLW705-SBLM2B	"	"	72	"	85.0	Not cut	
South Harney River near mouth	7/12/2005	GLW705-SHR1A	N 25° 24.580	W 81° 08.491	30	17.02	170.0	165.5	-53.5
		GLW705-SHR1B	"	"	"	"	147.0	Not cut	
Harney River near water monitoring station	7/12/2005	GLW705-HR2A	N 25° 25.411	W 81° 03.802	47	3.52	106.0	98.7	-55.3
		GLW705-HR2B	"	"	"	"	125.5	Not cut	
Shark River near entrance to Ponce de Leon Bay	7/12/2005	GLW705-SR1A	N 25° 22.462	W 81° 06.588	50	25.29	115.0	113.5	-26.5
		GLW705-SR1B	"	"	"	"	110.0	Not cut	
Shark River north of main channel	7/12/2005	GLW705-SR2A	N 25° 22.649	W 81° 03.849	74	10.23	145.0	144.0	-27.0
		GLW705-SR2B	"	"	"	"	131.0	Not cut	

* Compression during coring process was calculated by measuring the distance from the sediment/water interface to the top of the core barrel outside the barrel, prior to withdrawing the core, then measuring the distance from the sediment/water interface to the top of the barrel inside the barrel after coring, and subtracting. Additional loss occurs due to compaction during transport and drying, and during the cutting process. This is calculated by the difference in initial core length and the final cut core length. Total loss is a combination of all these factors.

A. Shark Point SE

Harney River SW

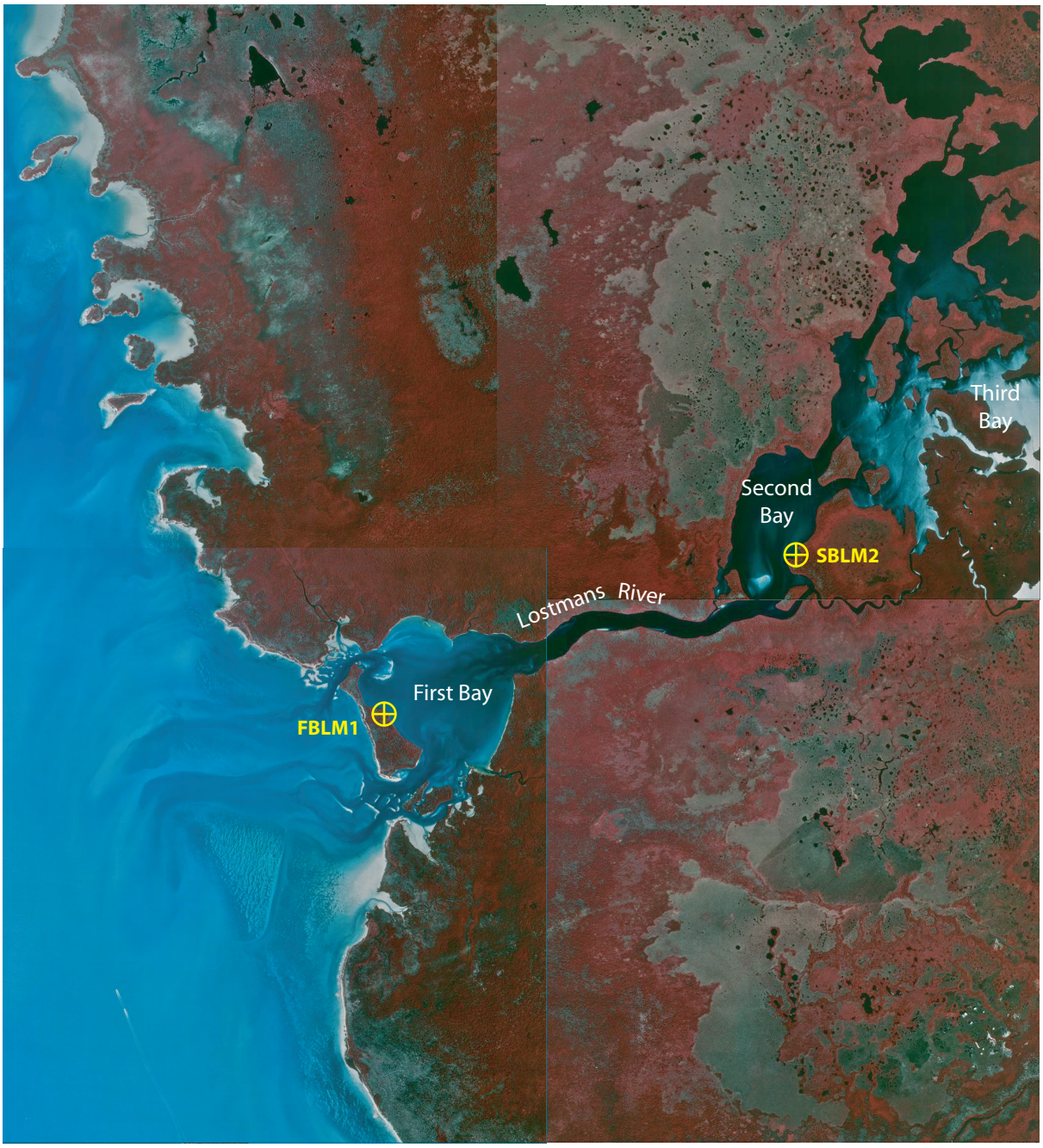


Shark River Island NE

Whitewater Bay W NW

Figure 4. Digital Orthophoto Quadrangles (DOQs) showing July 2005 core locations. A. Composite of four DOQs from Shark River and Harney River areas. SR1=Shark River, near entrance to Ponce de Leon Bay plotted on overlap between Whitewater Bay W NW and Harney River SW DOQs. SR2=Shark River system, north of main channel plotted on Harney River SW DOQ. SHR1=South Harney, near mouth of South Creeks plotted on Shark Point SE DOQ. HR1=Harney River, near water station plotted on Harney River SW DOQ.
All images obtained from http://edcsns17.cr.usgs.gov/EarthExplorer/

B. Lostmans River Ranger Station NW Lostmans River Ranger Station NE



Lostmans River Ranger Station SW Lostmans River Ranger Station SE

Figure 4. (Continued) B. Composite of four DOQs from the Lostmans River area. FBLM1=First Bay of Lostmans River plotted on Lostmans Ranger Station SW DOQ. SBLM2=Second Bay of Lostmans River plotted on Lostmans Ranger Station NE DOQ.
All images obtained from http://edcsns17.cr.usgs.gov/EarthExplorer/

Table 3. Presence (P) of mollusks that serve as key salinity and/or environmental indicators is shown on table. Note: this list does not represent all mollusks present in the samples. Also, three cores were not processed (Lostmans River, First and Second Bay cores and Harney core near water monitoring station); mollusks were examined in the samples during description, and are therefore biased towards the larger taxa. "No visible shell material" means no obvious molluscan shell material present. Closer examination of samples may indicate occurrences of mollusks.

Core	Depth (in cm)	Examined but no identifications	Freshwater Mollusks		Estuarine Mollusks →									Estuarine to Marine	
			Minute - easily "rafted" on freshwater currents	Adult stages large	Very low salinity (0-12 ppt)	Common in Mesohaline (5-18 ppt)		Euryhaline - Tolerant of wide range of salinities but common in transition zones between fresh and estuarine waters in south Florida						Polyhaline to Euhaline	
			Hydrobiid-like	Physidae, Lymnaeidae, *Planorbella, Elimia*-like	*Polymesoda* and/or *Cyrenoida*	*Melampus*	*Tagelus*	Ostreids	*Teredo*	*Anomalocardia*	*Lucina pectinata*	Tellinidae	*Acteocina*	*Bittiolum, Bulla*	Columbellids, *Carditimera*	*Parastarte*
Lostmans River First Bay (GLW705-FBLM1A) *																
	0-8	Fragments														
	8-9				P											
	9-15	Fragments														
	15-16						P	P								
	16-52	Fragments or no visible mollusk material														
	52-62		P (Rare)			P	P		P			P	P			
	62-92	Fragments or no visible mollusk material														
	92-100	Fragments														
	100-114.5							P			P	P				
Lostmans River Second Bay (GLW705-SBLM2A)																
	0-9		P		P		P	P	P			P	P	P		
	9-22		P			P	P	P								
	22-42	Fragments or no visible mollusk material				P										
	42-44															
	44-72	Fragments or no visible mollusk material														
	72-76				P	P										
	76-110.5	Fragments or no visible mollusk material														

Core	Depth (in cm)	Examined but no identifications	Freshwater Mollusks		Estuarine Mollusks →									Estuarine to Marine	
			Minute - easily "rafted" on freshwater currents	Adult stages large	Very low salinity (0-12 ppt)	Common in Mesohaline (5-18 ppt)		Euryhaline - Tolerant of wide range of salinities but common in transition zones between fresh and estuarine waters in south Florida						Polyhaline to Euhaline	
			Hydrobiid-like	Physidae, Lymnaeidae, *Planorbella, Elimia*-like	*Polymesoda* and/or *Cyrenoida*	*Melampus*	*Tagelus*	Ostreids	*Teredo*	*Anomalocardia*	*Lucina pectinata*	Tellinidae	*Acteocina*	*Bittiolum, Bulla*	Columbellids, *Carditimera*	*Parastarte*
South Harney River near mouth (GLW705-																
	0-26		P (rare)				P			P		P (abundant)	P	P	P	P
	26-54									P	P	P (abundant)	P	P		P
	54-64		P (few)		P					P		P	P	P		P
	64-68	Fragments														
	68-78						P			P		P	P	P		P
	78-114											P	P (rare)	P (rare)		
	114-165.5				P (abundant)		P	P		P	P	P	P	P	P	
Harney River near water monitoring station (GLW705-HR2A) *																
	0-20									P (rare)		P (rare)	P (rare)	P (rare)		
	20-86	No visible mollusk material or rare fragments														
	86-98.7		P (common)									P (rare)				
Shark River near entrance to Ponce de Leon Bay (GLW705-																
	0-5					P	P	P		P		P (abundant)	P		P	P
	5-20		P			P	P	P		P		P (abundant)	P (abundant)	P	P	P
	20-34							P		P		P	P	P		P
	34-36		P									P	P			P
	36-58							P		P		P	P	P	P	P
	58-74		P					P		P	P	P (abundant)	P	P		P
	74-90									P		P	P	P		P
	90-98	Fragments or no visible mollusk material														
	98-113.5						P	P		P		P	P	P		P
Shark River north of main channel (GLW705-SR2A)																
	0-10		P			P						P	P			
	10-64		P		P	P				P	P	P	P	P		P
	64-102		P	P							P	P	P	P		
	102-144		P	P												

* The mollusk list was prepared from examination of the unprocessed sediment samples for the three cores indicated, and may be biased toward the larger specimens in these cores. Mollusk list for othe three cores was prepared from processed samples with sediments removed.

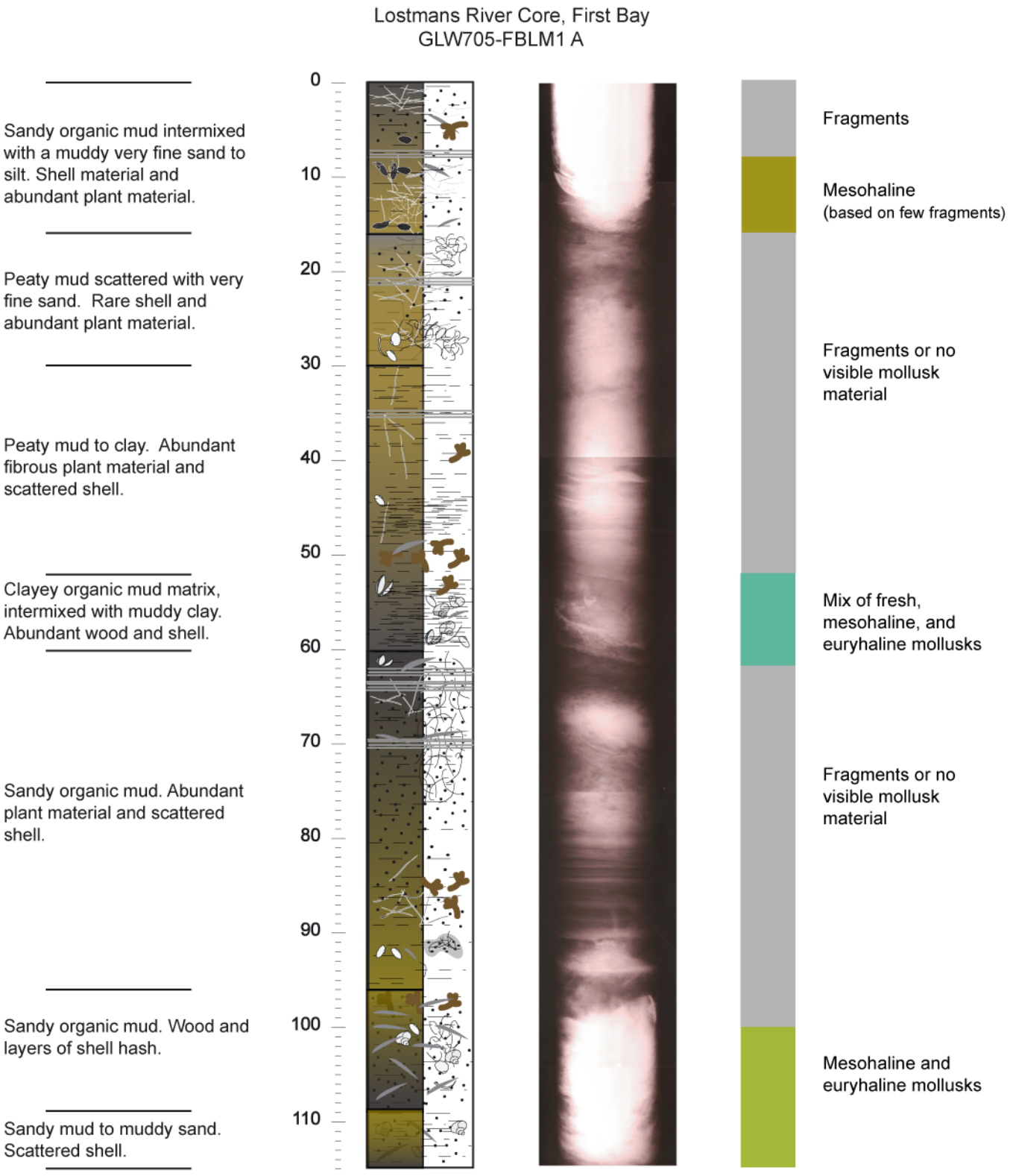


Figure 5. X-radiograph of the Lostmans River Core, First Bay (GLW705-FBLM1A), with a schematic diagram and brief sediment description on the left, and a preliminary summary of the environments indicated from an examination of molluscan fauna on the right. Note: Evaluation of molluscan fauna was made from unprocessed samples and therefore is biased towards larger specimens. Location of depth in x-radiograph is only approximate due to shrinkage that occurred after collection and prior to cutting. Legend shown on following page.

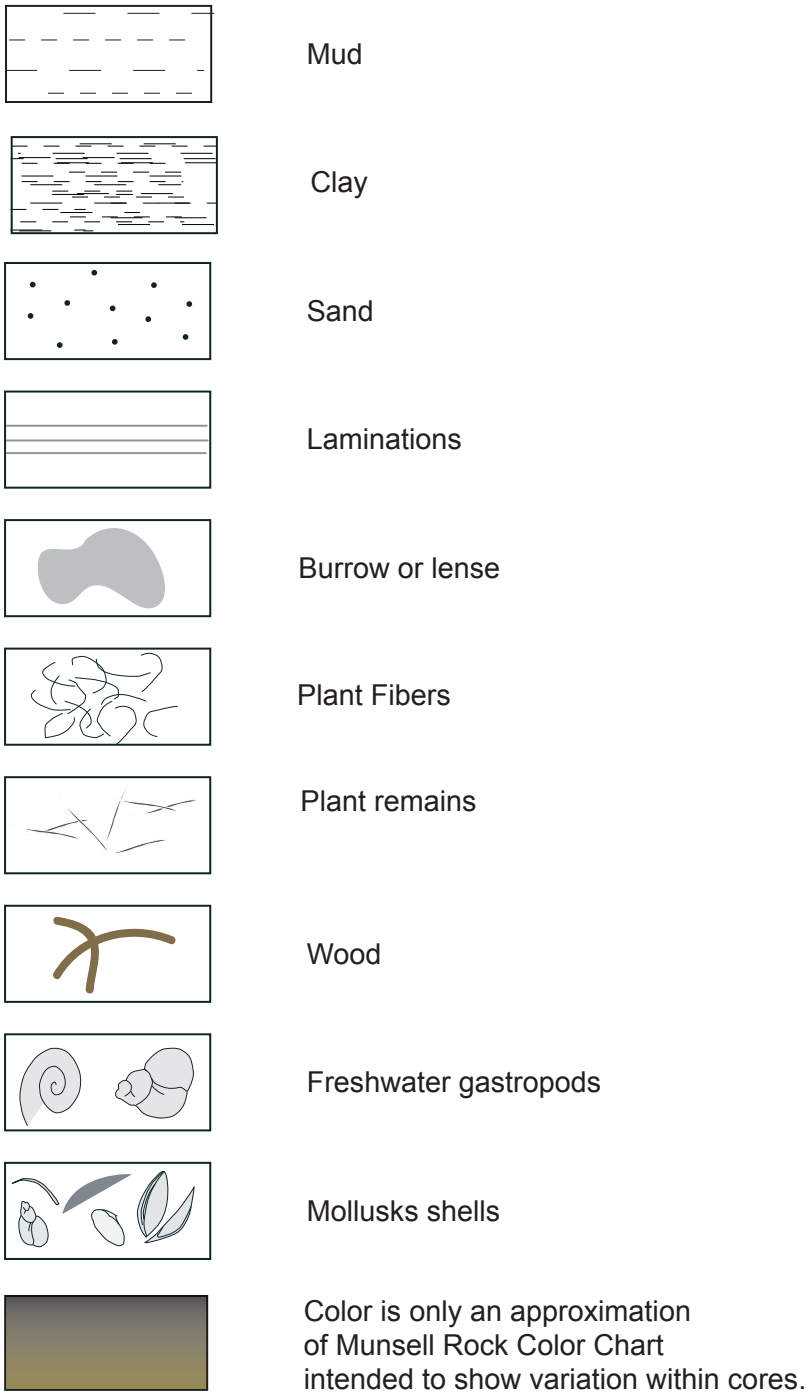


Figure 5. (Continued) Legend for core schematics.

16-30	Peaty mud with scattered very fine quartz sand within mud and interspersed laminae of very fine sand. Abundant plant fibers and microscopic pieces of wood. Rare shell fragments visible. Spongy texture and high water content. (Pale yellowish brown – 10YR 6/2 to dark yellowish brown – 10YR 4/2 to dusky yellowish brown – 10YR 2/2)
30-52	Peaty mud to clay, cohesive, with very fine laminae (<1 mm thick) present in parts of segment. Sandy and poorly sorted in middle portion (42-44 cm). Clay and peaty mud intermixed giving a mottled appearance in lower portion of segment. Abundant fibrous plant material and pieces of decayed wood, some relatively large. Wood comprises bulk of sample from 50-52 cm.. Scattered shell fragments. (Olive gray - 5Y 4/1 clay and dusky yellowish brown – 10YR 2/2 peaty mud)
52-60	Clayey organic mud matrix with high water content, intermixed with a muddy clay. Abundant pieces of wood and shell material. Distinct pockets of shell debris in some portions of zone. (Olive gray 5Y 4/1 to olive black 5Y 2/1)
60-96	Sandy organic mud, with silt to very fine quartz sand decreasing in lower portion of segment. Fibrous plant material abundant. Scattered shell fragments, pieces of wood and/or bark. Laminae present in some sections; layering of plant debris parallel to bedding plane contributes to laminar appearance. Lowest portion of segment (90-92 cm) is transitional to underlying sediment; mixing of two lithologies gives a mottled appearance. (Olive black - 5Y 2/1 grading to olive gray – 5Y 4/1 below 84 cm)
96-109	Sandy organic mud. Relatively large pieces of wood, fibrous plant material. Shells and shell fragments scattered throughout, but occurring in distinct layers of coarse material forming a shell hash in some portions of segment. (Olive black - 5Y 2/1)
109-114.5	Sandy mud to muddy sand, poorly sorted with high clay content in part. Scattered shell debris. (Light olive gray - 5Y 6/1)

Lostmans River Second Bay Core (GLW705-SBLM2A) (Figure 6)

Depth (cm)	**Description**
0-20	Organic mud to a muddy quartz sand, poorly sorted, with a high water content decreasing downward. Very fine sand to silt sized grains increase downward. Whole shells and coarse fragments and plant material including twigs, leaves, bark and fibrous matter throughout, but concentrated in lower portion of segment (14-20 cm). (Olive gray - 5Y 4/1 grading down to olive black – 5Y 2/1)

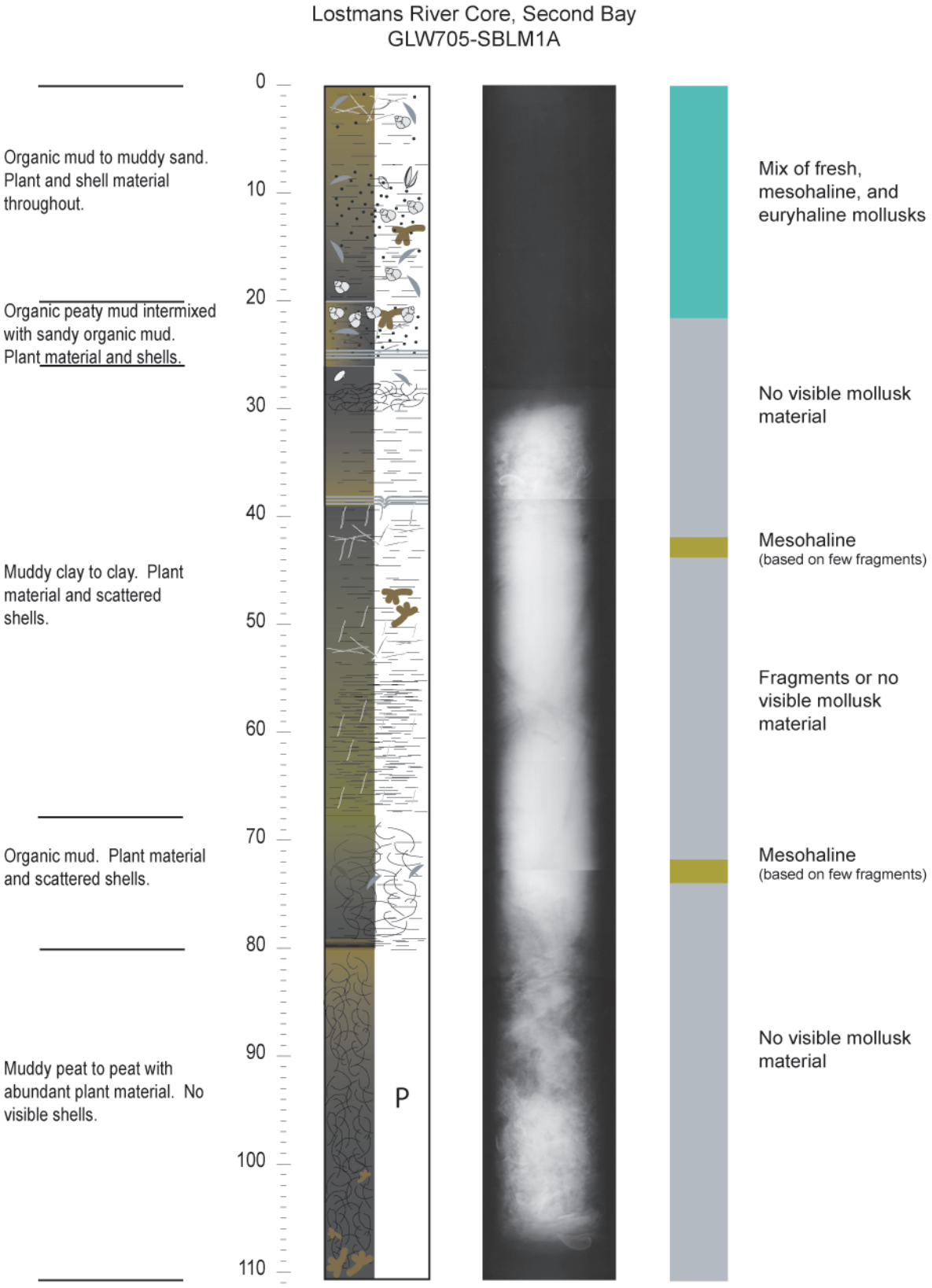


Figure 6. X-radiograph of the Lostmans River core, Second Bay (GLW705-SBLM1A), with schematic diagram and brief sediment description on the left, and a preliminary summary of the environments indicated from an examination of molluscan fauna on the right. Note: Evaluation of molluscan fauna was made from unprocessed samples and therefore is biased towards larger specimens. Location of depth in x-radiograph is only approximate due to shrinkage that occurred after collection and prior to cutting. Legend shown on Figure 5.

20-26	Highly organic mud, almost ranging to a peat, mottled with a sandy organic mud. Large coarse pieces of wood and bark in upper portion with abundant freshwater gastropods and other shell fragments. Transitions downward to laminated, cohesive organic mud with abundant fibrous plant material; rare shell fragments. (Brownish black – 5YR 2/1)
26-68 cm	Muddy clay to clay. Remains of decayed wood and root material, some *in situ*, compressing and cross cutting laminae; fibrous plant material present. Scattered shell fragments. (Light olive gray – 5Y 6/1 to olive gray – 5Y 4/1)
68-80 cm	Organic mud, with fibrous plant material throughout. Scattered shell fragments and occasional whole shells increasing in abundance downward from 68-76 cm. Lowest portion of segment transitioning to underlying lithology, becoming slightly blocky in texture and with fewer shells than above. (Olive black – 5Y 2/1 transitioning to brownish black - 5YR 2/1 at 78 cm)
80-110.5	Muddy peat to peat, with abundant plant material. Spongy to crumbly texture. No visible shell debris. Upper portion of segment does not have any wood pieces, just fibrous plant material, but small fragments of wood are present from 100 cm downward, and large pieces of wood from 108 to the bottom of the core. (Brownish black – 5YR 2/1)

South Harney River Core near mouth (GLW705-SHR1A) (Figure 7)

Depth (cm)	**Description**
0-14	Sandy mud, with high water content decreasing downward. Very fine white quartz sand to silt grains mixed with coarser dark organic clasts and calcareous material. Segment from 10-14 cm with increasing clay content. Scattered pieces of wood and whole shells. Fibrous plant material. (Dark yellowish brown – 10YR 4/2)
14-19	Very fine quartz sand to silt, very well sorted with almost no mud or clay present in upper-most part of zone, transitioning downward to a poorly sorted muddy clay with scattered silt, and calcareous and organic material. Rare plant material and shells. (Pale yellowish brown – 10YR 6/2 grading down to dark yellowish brown – 10YR 4/2)
19-60	Clayey mud to muddy clay with scattered very fine quartz sand to silt size grains. Sand/silt content decreases downward through segment. Large flakes of organic material, fibrous plant material and visible shells (abundant in some sections) and ostracodes. Minor laminations visible in lower portion of segment (50-60 cm) (Brownish gray – 5YR 4/1)

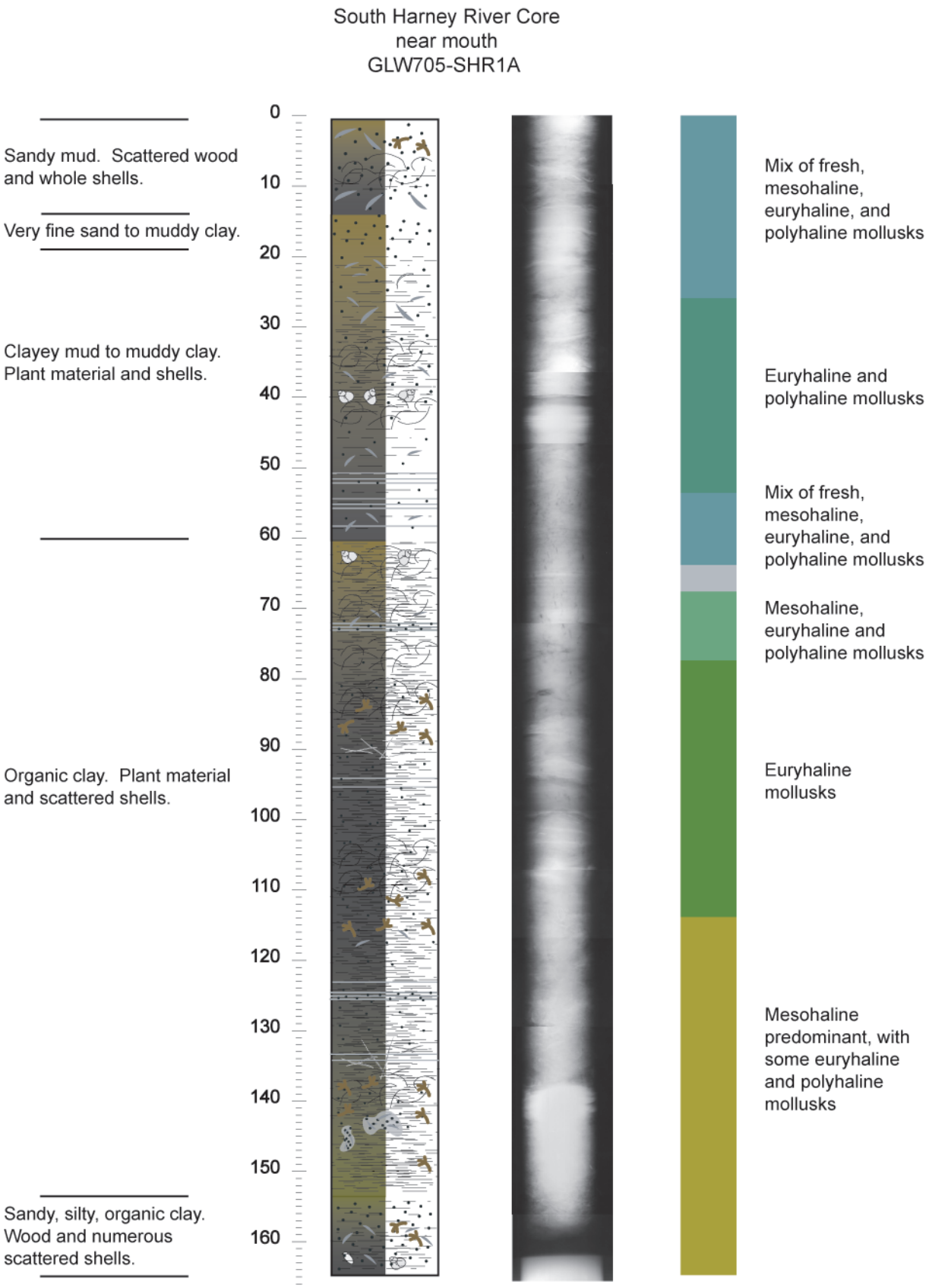


Figure 7. X-radiograph of the South Harney River core near the mouth (GLW705-SHR1A), with schematic diagram and brief sediment description on the left, and a preliminary summary of the environments indicated from an examination of molluscan fauna on the right. Location of depth in x-radiograph is only approximate due to shrinkage that occurred after collection and prior to cutting. Legend shown on Figure 5.

60-153	Organic clay with fibrous plant material. Scattered shells, but fewer than in overlying sediment. Laminae present through much of segment and scattered lenses of lighter colored very fine quartz sand to silt. Lower portion of segment (144-148 cm) appears burrowed; large lenses of very fine sand, shell debris and organic material in clay matrix. Scattered wood and areas of leaves and/or bark that parallel bedding plane. Occasional shell material. (Olive gray – 5Y 4/1 to olive black – 5Y 2/1)
153-165.5	Sandy, silty organic mud; blocky texture. Numerous scattered shells and some wood. (Olive black – 5Y 2/1)

Harney River Core near water monitoring station (GLW705-HR2A) (Figure 8)

Depth (cm)	**Description**
0-86	Organic mud to clay, with silt to very fine quartz sand. Disseminated organic flakes, scattered shells, ostracodes, foraminifers and plant material present. Very high water content decreasing slightly downward; fibrous plant material and cohesiveness of sediment increases downward. Some zones with thin laminations of very fine sand and/or silt. (Olive black –5Y 2/1)
86-98.7	Gradational with overlying segment. Cohesive organic mud to clay, with silt to very fine quartz sand grading downward to a crumbly, coarser-grained clayey very fine sand to silt. Shell and wood content relatively high through this section, with abundant foraminifers, ostracodes, and freshwater gastropods. Some zones with thin laminations of very fine sand and/or silt. (Olive black – 5Y 2/1 to brownish black – 5YR 2/1)

Shark River Core near entrance to Ponce de Leon Bay (GLW705-SR1A) (Figure 9)

Depth (cm)	**Description**
0-66	Organic mud, with relatively high water content, decreasing downward. Scattered very fine quartz sand to silt-sized grains scattered throughout, most sub-rounded to well-rounded, increasing downward through section. Becomes clayey mud in some segments. Fibrous plant particles and small fragments of bark and/or wood disseminated in mud. Some shell material, foraminifers and larger pieces of wood. (Olive gray – 5Y 4/1 to olive black -5Y 2/1)
66-70	Muddy clay, with laminations of slightly lighter and darker material. Rare fibrous plant material present and scattered shells. (Olive gray – 5Y 4/1 and 5Y 3/2)

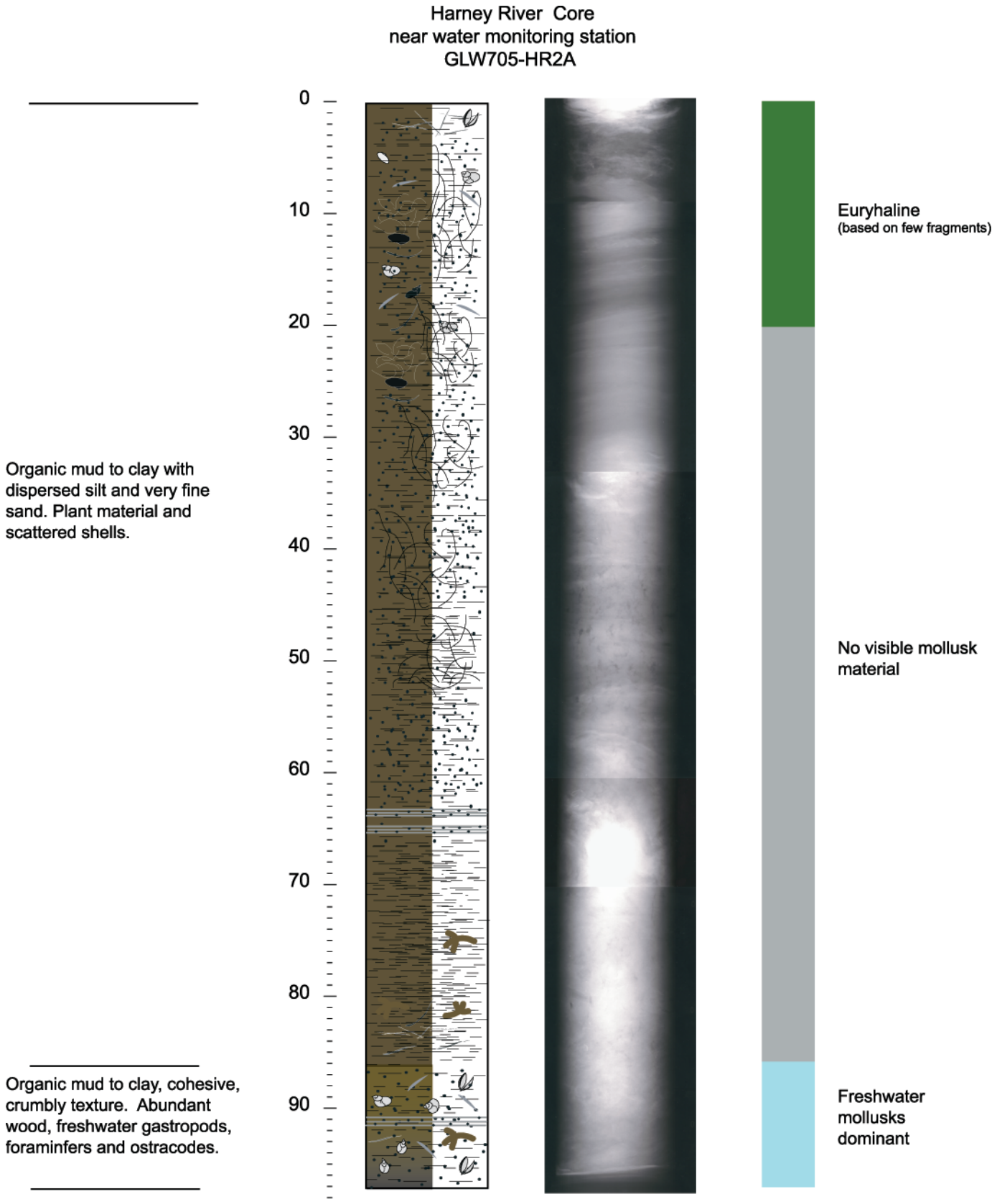


Figure 8. X-radiograph of the Harney River core, near the water monitoring station (GLW705-HR2A), with schematic diagram and brief sediment description on the left, and a preliminary summary of the environments indicated from an examination of molluscan fauna on the right. Note: Evaluation of molluscan fauna was made from unprocessed samples and therefore is biased towards larger specimens. Location of depth in x-radiograph is only approximate due to shrinkage that occurred after collection and prior to cutting. Legend shown on Figure 5.

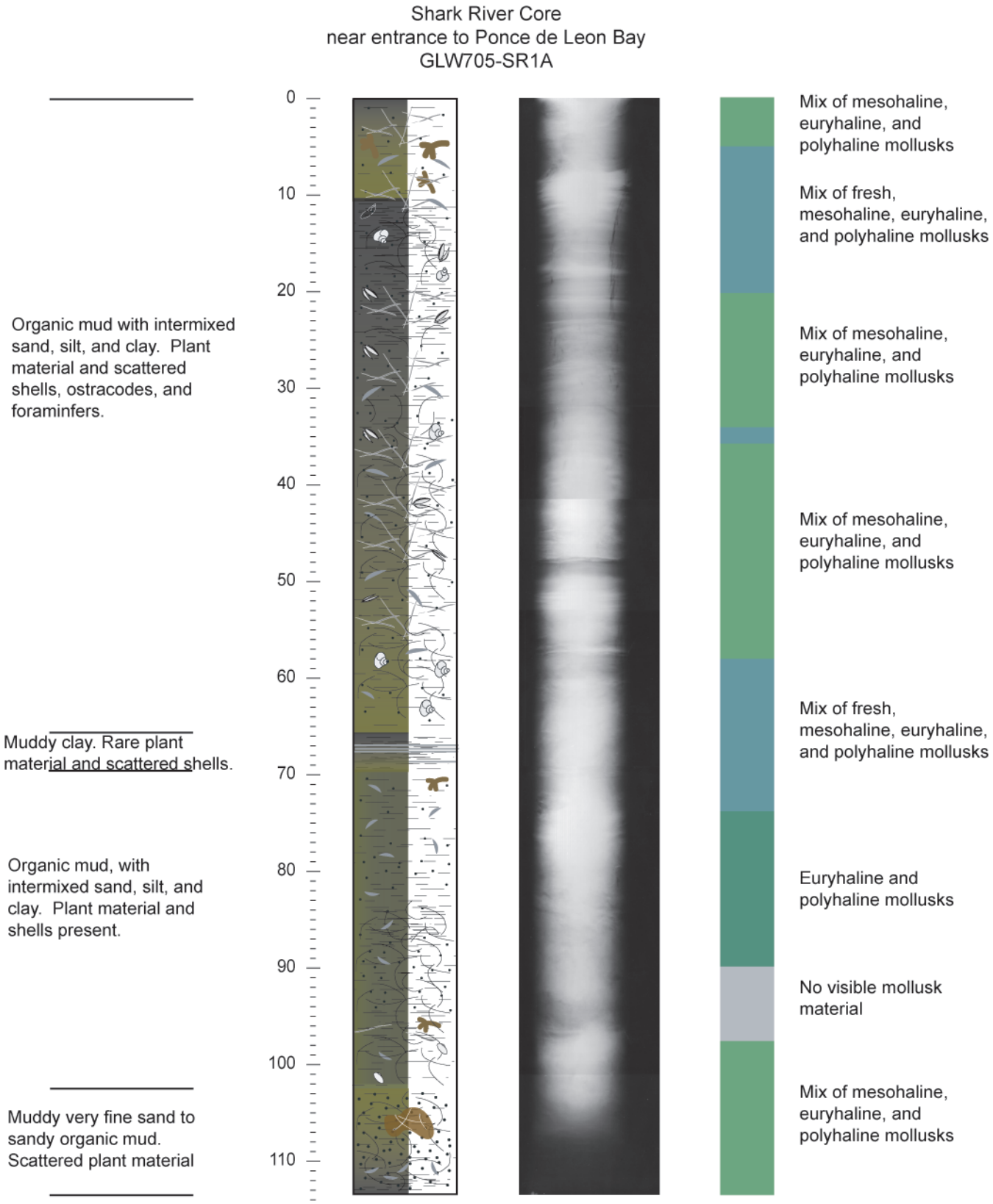


Figure 9. X-radiograph of the Shark River core near the entrance to Ponce de Leon Bay (GLW705-SR1A), with schematic diagram and brief sediment description on the left, and a preliminary summary of the environments indicated from an examination of molluscan fauna on the right. Location of depth in x-radiograph is only approximate due to shrinkage that occurred after collection and prior to cutting. Legend shown on Figure 5.

70-103	Organic mud, with relatively high clay content and very fine quartz sand to silt size grains. Proportions of clayey mud to silt fluctuate throughout segment. Fibrous plant material, shells, and wood present. (Olive gray – 5Y 4/1)
103-113.5	Muddy very fine quartz sand to sandy organic mud; sand grains are sub-rounded to rounded. Scattered fibrous plant material and organic clasts throughout, and scattered large clasts of peat in sand matrix. No visible shell material. (Light olive gray – 5Y 6/1 to olive gray -5Y 4/1)

Shark River Core north of main channel (GLW705-SR2A) (Figure 10)

Depth (cm)	**Description**
0-96	Sandy organic mud, with relatively high water content, decreasing downward, becomes relatively cohesive at 28 cm. Very fine quartz sand to silt-sized grains intermixed in mud matrix. Fibrous plant material and scattered wood, shells, ostracodes and foraminifers, abundant in some segments. (Brownish black – 5YR 2/1)
96-106	Peaty organic mud, gradational with overlying segment. Texture is spongy, with no visible sand or silt grains. Shells and plant material are abundant. Freshwater gastropods visible in section from 102-106 cm. (Olive black – 5Y 2/1)
106-114	Transitional, peaty organic mud from above mottled with muddy clay from below. Freshwater gastropods abundant throughout. Content of peaty mud decreases downward as muddy clay increases, transitioning to underlying section. (Olive black and brownish gray – 5Y 2/1 and 5YR 4/1)
114-132	Muddy clay, with scattered silt grains. Clay content increases downward as mud content decreases. Abundant freshwater gastropods, decreasing slightly in abundance downward. Bundles of fibrous plant material and root casts are perpendicular to bedding plane and appear to be in situ. (Brownish gray - 5YR 4/1)
132-144	Clay, firm with fibrous plant material oriented perpendicular to bedding plane and probably in situ. Scattered shell material. (Olive gray - 5Y 4/1)

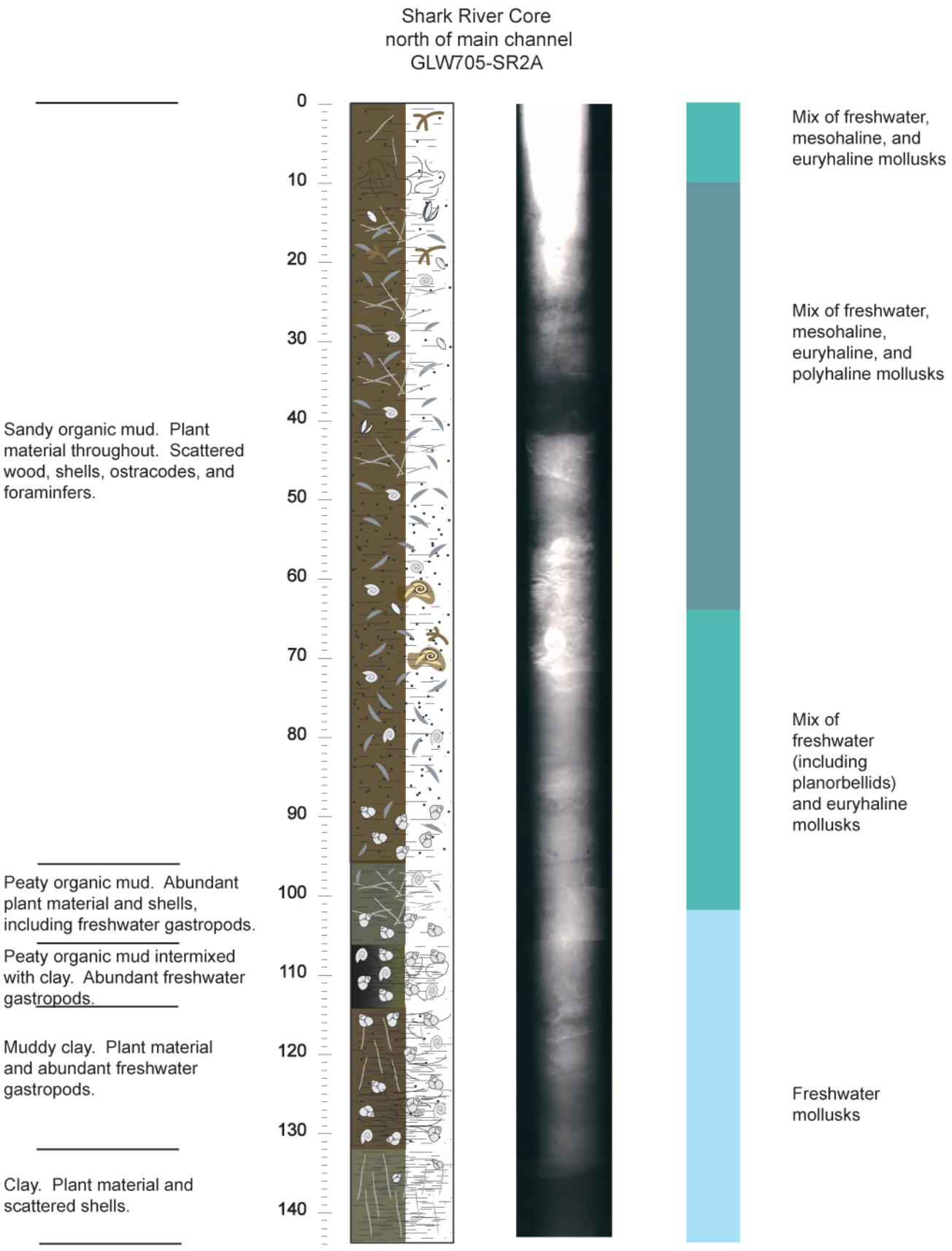


Figure 10. X-radiograph of the Shark River Core, north of the main channel, (GLW705-SR2A), with a schematic diagram and brief sediment description on the left, and a preliminary summary of the environments indicated from an examination of molluscan fauna on the right. Location of depth in x-radiograph is only approximate due to shrinkage that occurred after collection and prior to cutting. Legend shown on Figure 5.

DEPOSITIONAL ENVIRONMENTS

Although the environmental interpretations based on the molluscan fauna are preliminary, and are likely to be refined with quantitative analysis, the presence of key indicator species of mollusks (Table 3) provides an accurate first look at the broad-scale changes taking place at these sites during the time of deposition of the cores. In addition, comparison of depositional environments in the 2005 cores, with those from the 2004 cores (Wingard and others, 2005) provides additional insights into environmental changes in the significant southwest coastal area.

The inner bay cores collected in 2004 from Big Lostmans Bay, Broad River Bay, and Tarpon Bay were dominated by peat accumulation in the lower portion of the cores (Wingard and others, 2005). With the exception of the core from Lostmans River, Second Bay, none of the cores collected from the Lostmans, Harney or Shark River channels in 2005 contain true peats, although some sections contain peaty muds (Figures 5-10), nor do any of the six cores contain visible terrestrial gastropod remains. These findings indicate the sediment from Lostmans First Bay and the Harney and Shark River systems represent areas that have been submerged throughout the time of deposition; whereas the inner bays were partially emergent.

Comparing the mid-channel cores to the channel mouth cores, in general, salinity decreases up channel away from the open water of the Gulf of Mexico. Figure 11 illustrates spatial and temporal salinity patterns in the Harney River and Shark River systems. Both mid-channel cores (GLW705-HR2A and GLW705 SR2A) show a very distinctive transition to exclusively freshwater mollusks in the lower portions of the cores (at 86 cm depth in GLW705-HR2A and at 102 cm in GLW705-SR2A). While the transition from exclusively freshwater mollusks to a euryhaline assemblage is separated by a zone of "no visible mollusks" in the Harney River core (GLW705-HR2A)(possibly an artifact of examining unprocessed samples), this is not the case in the Shark River core. The lowermost zone of the Shark River core (GLW705-SR2A, 102-144 cm) contains the remains of freshwater gastropods (planorbellids and hyrdrobiids); these taxa also are found in the overlying transition zone (64-102 cm), which contains a mix of freshwater and euryhaline species. Hydrobiids have been found in portions of all cores collected from the southwest coastal area for this project. They are indicative of freshwater influx, but because hydrobiids are minute (full grown adults rarely exceed 5 mm) they can be rafted on freshwater currents into estuarine waters (see field data available at http://sofia.usgs.gov/exchange/flaecohist/). The much larger planorbellids have only been found where the water column is fresh throughout most of the year. The presence of planorbellids in the sediments up to 64 cm in core GLW705-SR2A suggests substantial freshwater flow through the Shark River system when the lower portion of the core was deposited. The change above 64 cm implies significant salinity changes, although the sediments do not change in this interval. We interpret this change as indicative of reduced freshwater influx, which excluded the planorbellids while maintaining enough flow to sustain or carry the hydrobiids into this section of the river system. The upper portion of the mid-channel Harney River core lacks visible freshwater species.

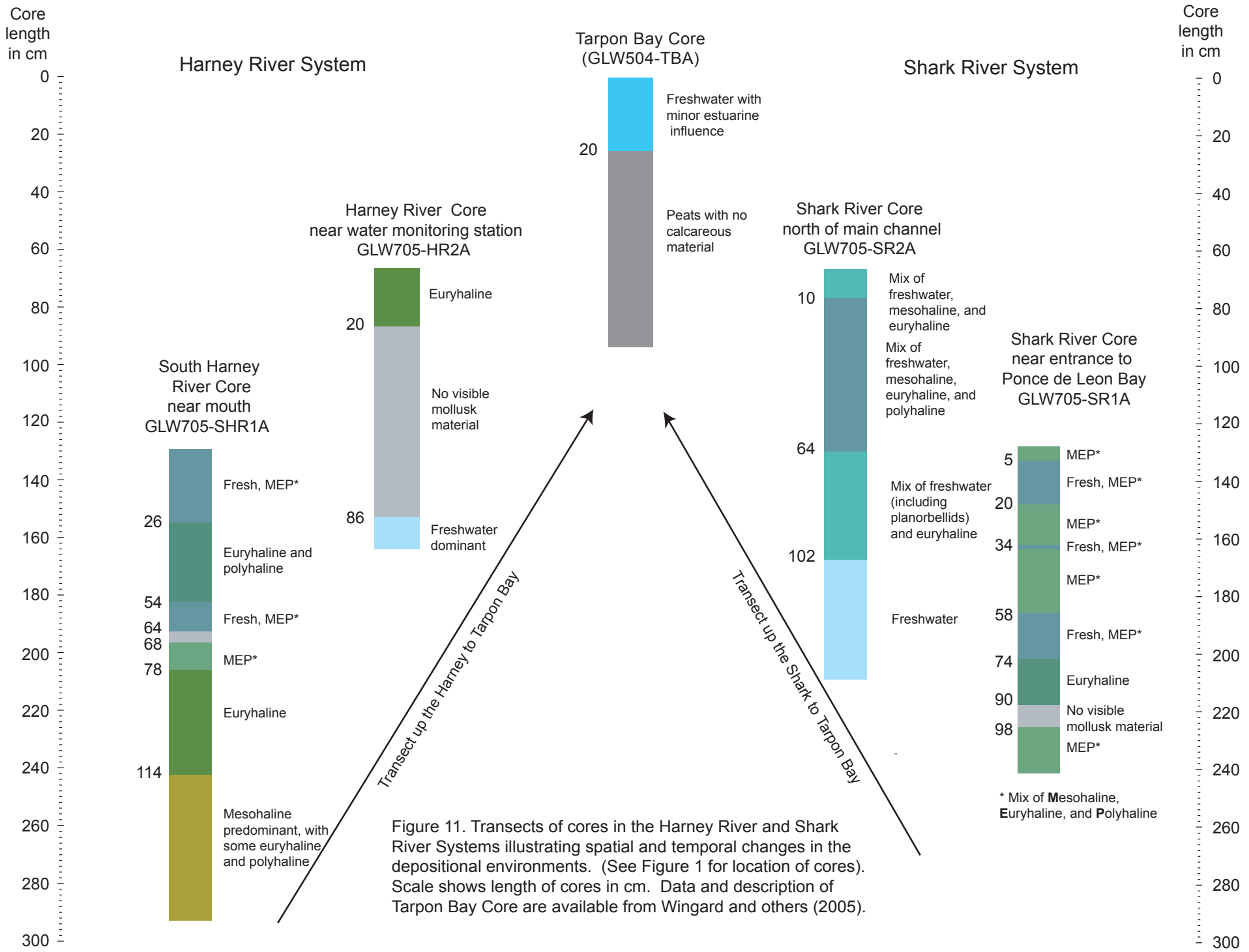


Figure 11. Transects of cores in the Harney River and Shark River Systems illustrating spatial and temporal changes in the depositional environments. (See Figure 1 for location of cores). Scale shows length of cores in cm. Data and description of Tarpon Bay Core are available from Wingard and others (2005).

Cores from the mouths of the Harney and Shark River systems (GLW705-SHR1A and GLW705-SR1A) illustrate temporal fluctuation of salinity (Figure 11) in the estuary. The internal variations within the sedimentary units also indicate a dynamic environment and fluctuating flow regime. Neither core shows any indication of deposition in a strictly freshwater or strictly marine setting. The presence of *Polymesoda* spp. below 114 cm in the South Harney River core (GLW705-SHR1A) indicates predominantly mesohaline conditions during the time of deposition. This species does not appear to be present in the core from the mouth of Shark River (GLW705-SR1A), but the Shark River core is shorter than the South Harney River core. Until an age model is in place for these cores direct comparisons cannot be made.

Based on a preliminary analysis of the mollusks in the river transects, we have developed a preliminary flow model. Lostmans River shows little visible evidence of freshwater influx throughout the time of deposition. In addition, Lostmans Second Bay contains peat at the bottom of the core and the 2004 core from Big Lostmans Bay was peat except for the upper 10 cm. These preliminary observations suggest that the Lostmans system was more emergent throughout the time of deposition than the systems to the south; however, the Lostmans core observations are based on unprocessed samples and therefore minute freshwater gastropods may have been missed in the examination. The Harney River system, flowing from Tarpon Bay, has been submerged throughout the time of deposition of the cores and has received freshwater fluxes that reached to the mouth of the system periodically over time. The Shark River channels, flowing south out of Tarpon Bay, have received a continuous supply of freshwater at least to the point of the middle core (GLW705-SR2A) throughout the time of deposition, but a significant decrease is indicated at 64 cm, as discussed above. The general pattern appears to be substantial flow in the south (from Tarpon Bay out through the Shark River channels), with diminished flows northward toward Lostmans. These findings are only preliminary, based on the presence of key indicator species of mollusks. Development of an age model and quantitative analyses of the mollusks, ostracodes and pollen within the cores will allow us to test the model suggested here.

SUMMARY

Examination of the sediments and an initial assessment of key indicator species of mollusks in six cores collected from the southwest coastal area of Everglades National Park in 2005 have provided a preliminary model of general patterns of freshwater flow over time for this area. Two cores collected in 2004 form transects with the 2005 cores and provide additional information (Wingard and others, 2005). During deposition of the sediments recovered by these cores, the greatest flow to the southwest coastal area was through the Shark River channels, diminishing to northward toward the Lostmans River system. The Lostmans system was less influenced by freshwater flow and more emergent than the two systems to the south. The mouths of the river channels have persistently been zones of mixed estuarine environments, with pulses of freshwater periodically reaching the mouth of the Harney and Shark River systems. The lower portions of the mid-system cores from the Harney and Shark Rivers were deposited in freshwater environments, but a change in the system caused a shift towards more estuarine conditions.

Age models will be developed for the 2004 and 2005 cores, and detailed quantitative analyses of the fauna, flora, and sediment geochemistry will be conducted to test the model of flow suggested by these preliminary examinations of the cores. The results of the quantitative analyses will provide restoration managers with essential information on the historical pre- and post-1900 changes to the southwest coastal system and will provide some insight into the natural versus anthropogenic components of change to the region.

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