EFFECTS OF CULVERTS ON MISSISSIPPI'S RENOURISHED BEACHES

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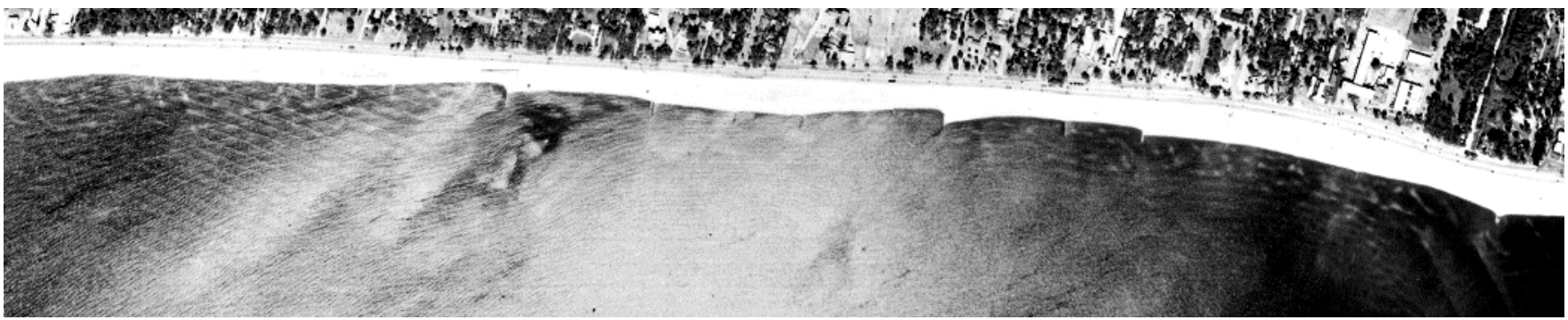
Why Study Culverts?

- Second thing noticed when visiting
- Tell us about the physical process acting on the beach
- Sensitivity to hardened shorelines
- As development increases so do number of culverts
- Some effectively act like groins, others appear to have little effect on beach morphology
- Do they influence regional erosion and potential for storm damage

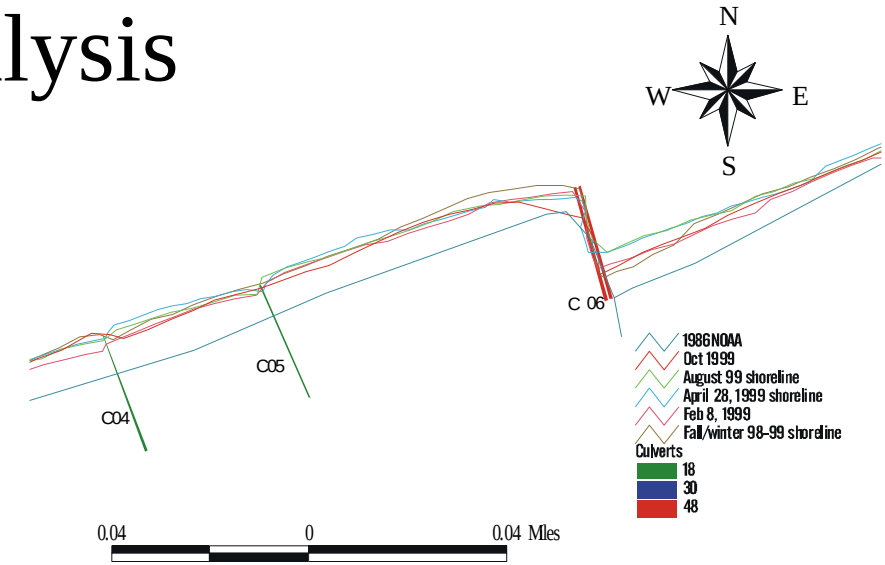


Field Methods

- GPS kinematic surveys of high tide shoreline over a one year time span
- GPS position and length of culverts
- Measurement of culvert diameter
- Photo for culvert specifics (smooth, rough, etc.)
- Two ‘culvert fields’ mapped

Analysis

- Data added to GIS/database
- Offsets measured from up-drift to down-drift sides
- Two dates chosen, after Hurricane Georges and during summer, 1999
- Eastern ‘culvert field’ was discarded due to high modification
- Western ‘culvert field’ was protected by shore bird habitat
- Lidar data for larger scale analysis



Data

Groin	Diameter (in)	Updrift dist.east (m)	Updrift dist.west (m)	double v. single	length (m)	shoreorient (deg)	att(1) v. detach(0)	rib(1) v. smooth(0)
C01	30	173	306	1	19	73	1	0
C02	30	138	172	1	31.5	73	1	1
C03	30	130	139	1	25	73	0	1
C04	18	53	128	1	40.5	73	1	1
C05	18	104	53	1	34.8	73	0	1
C06	48	249	108	2	38.4	73	1	1
C07	30	160	251	1	32	73	1	1
C08	48	172	161	2	33.9	83	1	0
C09	48	273	173	1	20.7	83	1	0
C10	18	304	275	1	3.3	83	0	0
C11	48	500	307	2	10.3	83	1	0

Culvert	Hurr Geog	Aug-99	Change
C01	7.8	1.6	-6.2
C02	1	0.1	-0.9
C03	5	-1	-6
C04	3.3	-1.7	-5
C05	0.5	-4.3	-4.8
C06	32	21	-11
C07	7.2	0	-7.2
C08	20.9	14.3	-6.6
C09	25	9.9	-15.1
C10	5.7	-4	-9.7
C11	27	12	-15

- Positive offsets = buildup on eastern side of culvert
- Negative offsets = buildup on western side of culvert
- All culverts had a buildup on east side following HG (*sediment moved east to west*)
- Buildup on east side was reduced during summer (*sediment moved west to east*)
- Evolution (chronology) important for analysis

Primary Factor(s)

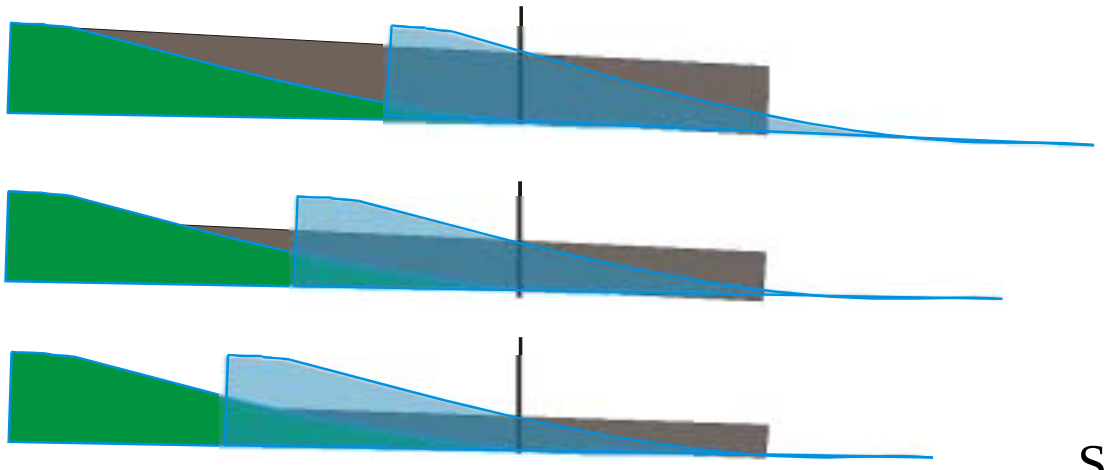
- Correlation coefficient to highlight major factors
- > +/- 0.60 at alpha of 0.05, +/- 0.52 at alpha of 0.1
- Some interdependency problems
- Goal to analyze culvert differences; not model sand movement around culverts

	Diameter (in)	*Updrift dist.east (m)*	*Updrift dist.west (m)*	*double v. single*	*length (m)*	*shoreorient (deg)*	*att(1) v. detach(0)*	*rib(1) v. smooth(0)*	*Hurr Geog*	*Aug-99*	*Change*
Diameter (in)	1										
Updrift dist.east (m)	0.550145777	1									
Updrift dist.west (m)	0.114262209	0.586967157	1								
double v. single	0.745412801	0.532743974	0.026937813	1							
length (m)	-0.02053334	-0.712254832	-0.74902166	0.06624	1						
shoreorient (deg)	0.451558792	0.691512414	0.380275137	0.38576	-0.618445	1					
att(1) v. detach(0)	0.570562885	0.134651317	0.249117213	0.375	0.2854646	0.0385758	1				
rib(1) v. smooth(0)	-0.38686076	-0.618048182	-0.63364931	-0.2609	0.7153857	-0.8280787	-0.149071	1			
Hurr Geog	0.909414619	0.661026947	0.102103612	0.79759	-0.0908462	0.5045739	0.47751	-0.412609	1		
Aug-99	0.922176395	0.477241598	-0.0331384	0.86388	0.1353938	0.3453178	0.564296	-0.271442	0.95007	1	
Change	0.610282479	0.818629953	0.33401781	0.42822	-0.5029254	0.6617243	0.164872	-0.562365	0.79533	0.566461	1

	Offset		
Increaese	Hur Geo (east - west)	Aug (west - east)	Inter-correlations
Diameter	increase	increase	Effect of double culvert
Double v single	increase w double	not important	Effect of Lg diam
Updrift spacing (E)	increase	increase?	(-)length, shoreoerient, R vs sm
Shoreorient	not important	increase	Rib vs smooth
Rib vs smooth	not important	smth=increase	

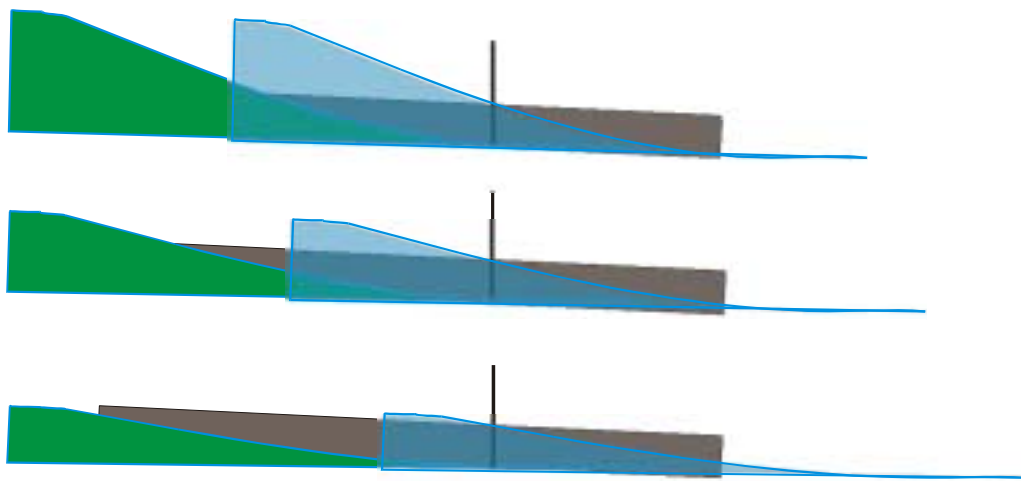
Diameter & Slope Relationship

Diameter



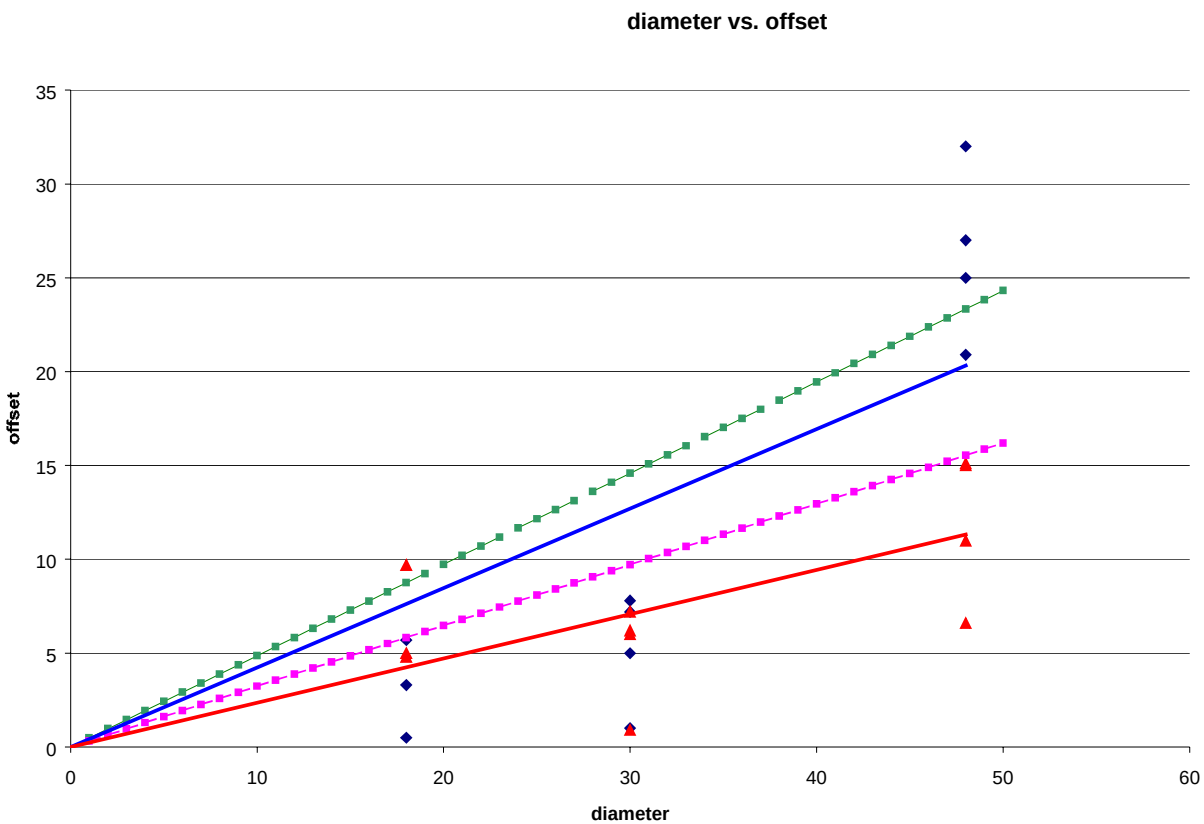
- Simplified linear relationship
- Beach slope and diameter - measurable

Slope

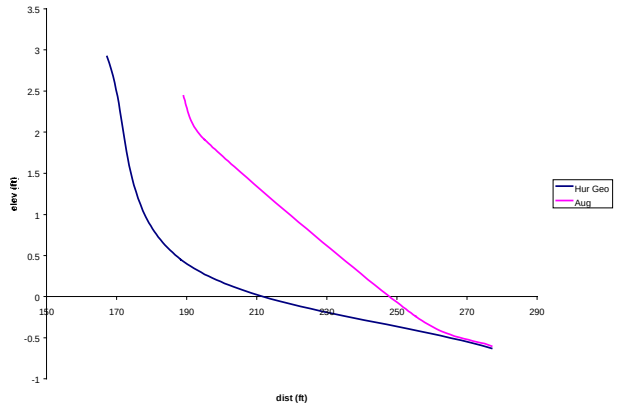


$$Offset \approx \frac{diameter}{\tan(beachslope - lowtideslope)}$$

Theory v. Observed

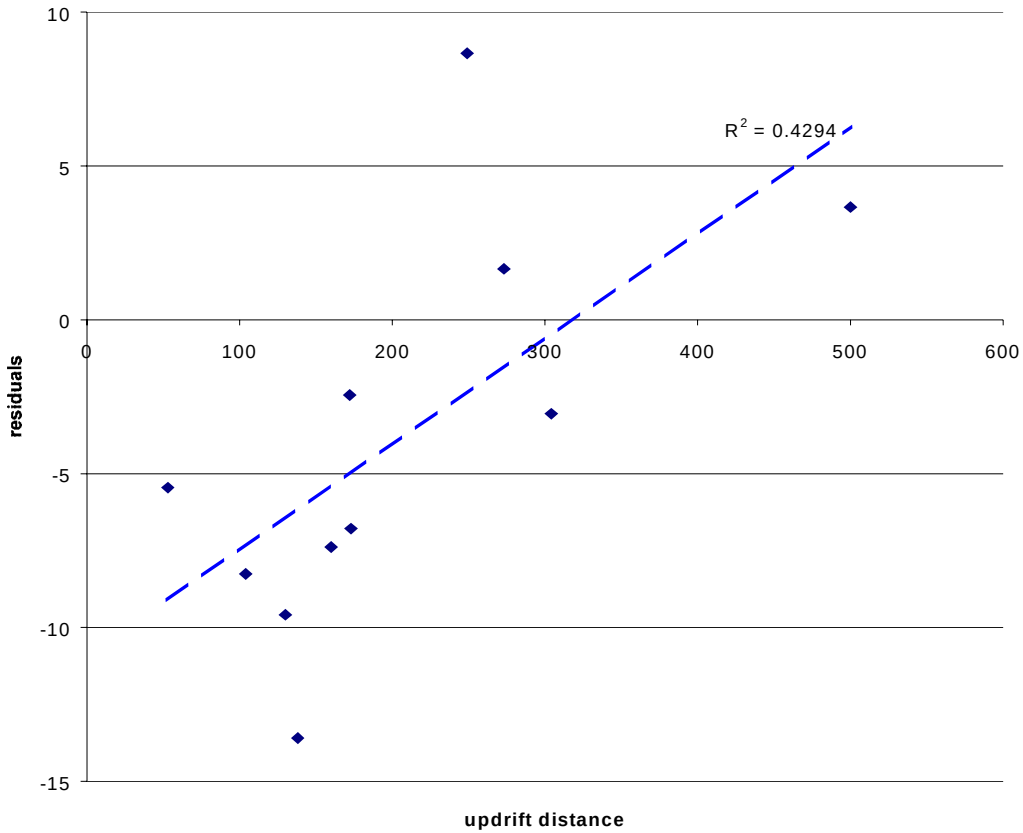


Profiles



Role of spacing

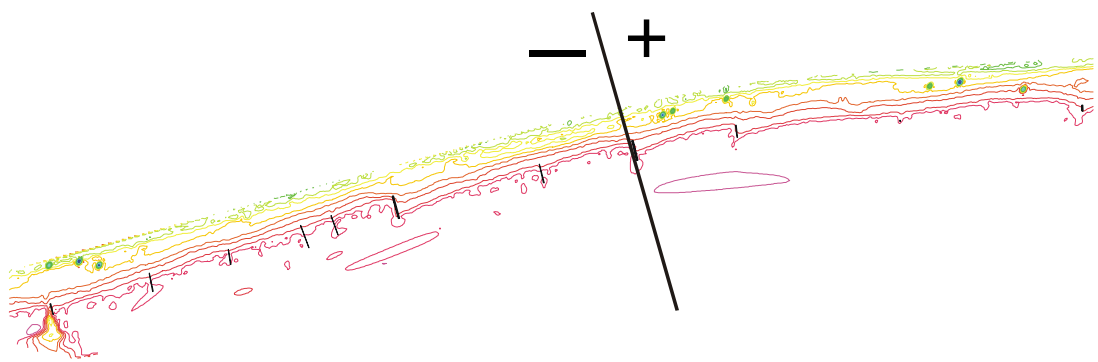
	Offset		
Increaese	Hur Geo (east - west)	Aug (west - east)	Inter-correlations
Updrift spacing (E)	increase	increase?	(-)length, shoreoerient, R vs sm



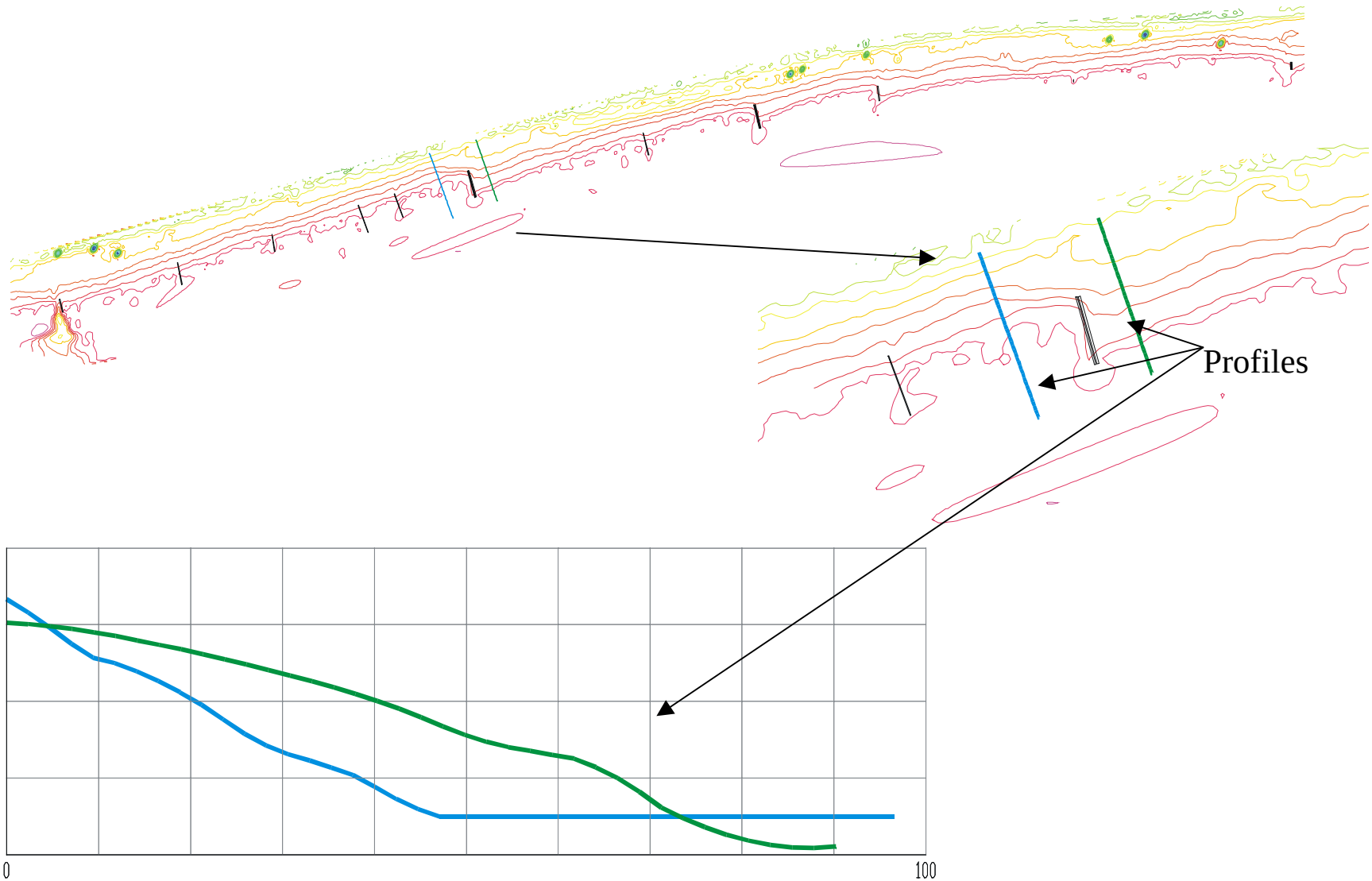
- East up-drift spacing correlates for both Hurricane Georges and, especially, August change; west up-drift spacing does not
- Makes fundamental sense for Hur. Georges, but not for August.
- Residuals from expected (using dia.) also correlate to up-drift spacing for HG.

Role of other Factors

- **Shore orientation-** closer to east/west tends to increase offset for August.
- **Smooth Vs Rough-** smooth groins have a higher offset for August.
- **Length-** longer length does not correlate to more offset. Length is negatively correlated, and is a result of beach ‘capture’ by other culverts.



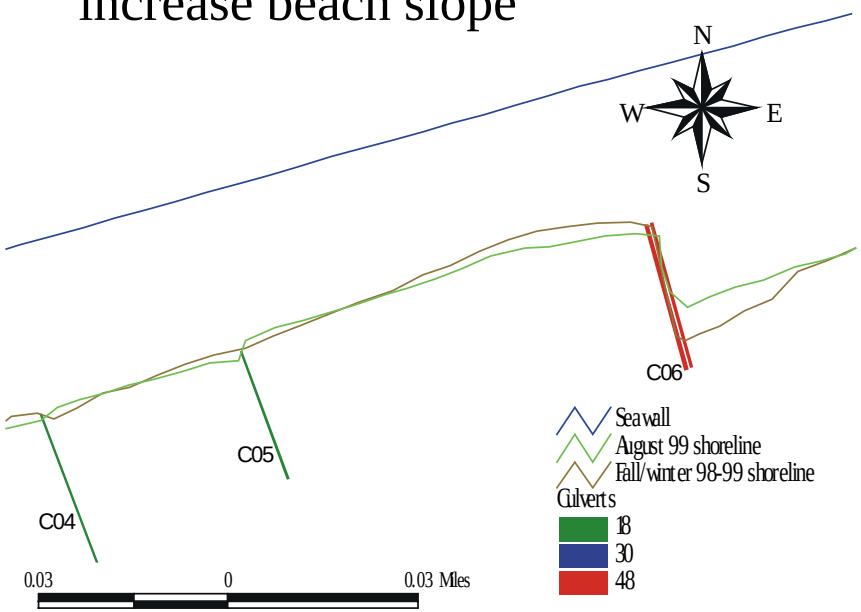
Lidar Profiles-Beach Morphology



What do culverts tell us about sediment movement?

Obvious observations

- Hurricane (storm conditions) move sand from east to west and dominate
- Summer conditions move sand from west to east and/or increase beach slope



Less obvious

- Sediment movement from larger (storm) waves mainly bypass the smaller diameter culverts
- Low tide terrace shows no obvious signs of transport, sediment transport only during higher water levels?

Conclusions

- Diameter of culvert is the driving factor in offset, or sediment blocking
- Up-drift spacing (East) is important in increasing or decreasing offset during storm conditions.
- Other factors such as orientation and geometry appear to play a minor role
- Overall sediment movement is towards the west
- Sediment movement takes place mostly on beach face (higher tide)
- Culverts create storm damage potential