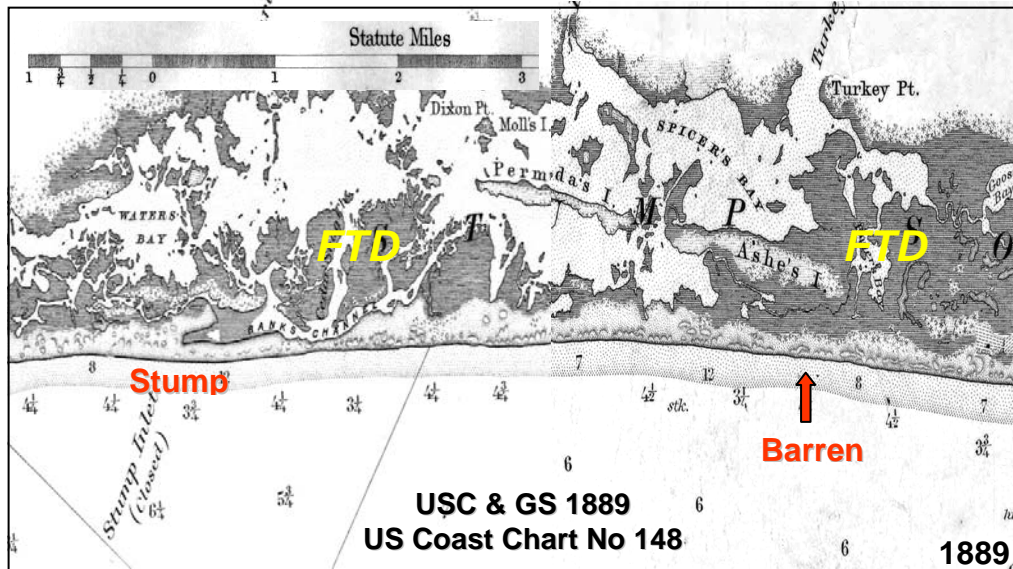


Historic and Future Inlets Along Topsail Island



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Pilkey and Neal (2009) provide some background information on the history of Topsail Island from the standpoint of historic inlets and the likelihood of new inlets forming during future hurricanes. They contend that *seven swash channels are present within the community, and these tend to open during storm-surge flood events and the associated back flow*. No documentation was provided, but it is assumed they are referring to the bridged areas along the northern portion of the North Topsail Beach. No permanent “swash “channels exist or have existed along the barrier. The following review focuses on several of Pilkey and Neal’s (2009) assertions and comments,

It is uncertain why Pilkey and Neal (2009) mentioned that Topsail Island was comprised of three Islands (Fig. 1) prior to the 1870s, perhaps it was intended provide a background for further comments pertaining to potential storm-related inlet openings and their relationship to historic Stump and Barren Inlets (Figs. 1-2). In the 17th and 18th centuries there were more inlets along the North Carolina coast than there is presently in 2014. Twenty years ago there were four more inlets than there are as of the writing of this report.

Stump Inlet was a pre-1730 storm-related inlet that closed in the 1870s, while Barren Inlet, also likely a storm-related inlet, opened in 1794 and closed prior to 1840. Both historic inlets built relatively large flood-tidal deltas in Stump Sound (Fig. 2). Stump Inlet remained open for a longer period of time due to the fact that its tidal basin was larger than Barren Inlet’s basin (Fig. 3). The latter inlet opened along a shoreline reach where two Pleistocene Barriers lie close to the modern barrier. The historic migration patterns of the historic Barren and Stump Inlets are not documented. However, their zone of migration can be ascertained to a reasonable degree by morphologic evidence identified on historic charts (Figure 4) and aerial photographs, and by the presence of peat deposits on the foreshore (Figs. 4-11). If old peat cops out along the foreshore/backshore, then historic inlets could not have existed.

The fact that Topsail Island was comprised of two to three islands during the past two centuries is not a unique situation, but rather it is commonplace for the transgressive modern barriers in southeastern North Carolina to be comprised of several barrier units. All the modern barrier islands that occur in New Hanover and Pender Counties have at one time or another been composed of a least two islands (Figs. 12-15). All of these barriers, in fact, are underlain by inlet fill that is less than 200 years old. This fact indicates that historic migrating inlets have eroded the former island.

Wrightsville Beach, for example, is comprised of two barriers (Fig. 12) that were separated by Moore's Inlet that was closed artificially in 1965. Masonboro Inlet, a long-lived inlet, migrated along the entire length of the southern portion of Wrightsville Beach, while Moore's Inlet and its predecessors, migrated along the entire two miles of the northern portion of Wrightsville Beach (Shell Island). In March 2001, Mason Inlet, that forms the northern boundary of the Shell Island, was relocated northward 3,100ft from its 1998 position at the margin of the Shell Island Resort (Figure 12 B). Relocation of the inlet was viewed by nearby residents and local and State agencies to be the most viable management option.

Mason Inlet opened in the late 19th C along Figure Eight Island (Fig. 13) immediately south of the Causeway on Figure Eight Island. In the 19th C. Figure Eight Island was much shorter in length, and through time has increased in length as Mason Inlet migrated southward and Nixon Inlet (Figure 13A), at the northern end of Figure Eight Island, closed (1895). Elmore's Island, an undeveloped barrier, located northeast of Figure Eight Island is a prime example of a barrier island that is comprised of multiple oceanfront segments of different ages (Fig. 14). Old Topsail Inlet, that had existed prior to 1730, finally closed in 1998 and thereby joined Elmore's and Lea Islands as a single barrier. Currently the northern portion of Lea Island is steadily eroding due to the southward migration of New Topsail Inlet (Figs. 14-16).

New Topsail Inlet, that borders Topsail Beach, opened prior to 1730 in a location off Sloop Point and has migrated southward more than six miles. Consequently, this segment

of Topsail Island (Topsail Beach) is the best example of a barrier in southeastern North Carolina that has continually lengthened during the past three centuries. New Topsail Inlet is an older migrating inlet than Oregon Inlet (1847) and has migrated a greater distance. Figure 17 depicts the migration of the inlet (ebb channel) during the period from 1938 to 2009. Channel migration rates have varied throughout the past eight decades (Fig. 17 insert). Since 1962 rates have decreased from a 160 ft/yr to the current rate of 46 ft/yr. Figure 16 shows the historic shapes of the southern portion of the Topsail Beach as a consequence of the inlet's migration. Note the erosion of Lea Island as Topsail Island lengthened.

In contrast to the migratory nature of New Topsail Inlet, New River Inlet (Fig.18) has been confined to a relatively narrow migration pathway during past several thousand years. Between 1856 and 1934 the ebb channel has migrated southward a net distance of 4,180ft. During the above mentioned time period, the inlet was unmodified despite the dredging of the AIWW (late 1920s). The hydrodynamics of the inlet system were altered substantially in the early 1940's by the construction of a 2.3 mile long navigation channel connecting the AIWW and the inlet throat. The new hydraulic connection is thought to have substantially increased the tidal prism and the retention capacity of the ebb delta. By the early 1960s the inlet had reached an "equilibrium condition". Between 1962 and 2009, the ebb channel migrated southward a net distance of 465 ft at an average rate of 9.9 ft/yr. This rate is relatively low compared to other inlets in the region.

The North Topsail Beach (NTB) shoulder changes (southwestern inlet margin) are related to the periodic growth and retreat of the updrift Onslow Beach spit. The progradation (elongation) of the spit into the inlet causes the ebb channel to shift southward, and as a consequence, erosion occurs along the NTB inlet shoreline. The greatest shoreline retreat has occurred inland ~ 3,000 ft from the inlet mouth along feeder channel's marsh shoreline. Since 1962, ~1,575 ft of erosion has occurred (Fig. 18).

Given the fact that no new inlet has opened during the past 140 years, despite numerous major storms, it seems unlikely that storm breaches or the sluices or "swash channels"

related to bridge sites will evolve into viable inlets. The historic inlets that opened in the 18th Century (Stump and Barren Inlets) opened at a time when individual “sounds” were not filled with tidal marsh nor were they connected; each bay had its own unique potential tidal prism. Furthermore, the aforementioned historic tidal inlets produced extensive flood-tidal deltas that eventually were colonized by marsh, thereby further reducing the potential tidal prism of the now connected bays (AIWW dredging). Over the past century and a half, the estuary has in-filled further due to tidal current related deposition of fine material and washover sediments that were deposited in the sound side channels adjacent to the island. A prime example of the impact of overwash-related deposition occurred during the hurricanes of the mid-late 1990s when shallow sluices (breaches) were formed at bridge sites (Fig. 7). Hurricane Bertha initiated the scour “channels”, and with repeated overwash and during the subsequent hurricanes (Fran, Bonnie and Floyd), the washover fans increased in size and further shoaled and elevated the backbarrier area. These features are washover fans (Figure 19) and not flood-tidal deltas as Drs. Pilkey and Neal assert. They were not produced by tidal currents. See the Section entitled: Storm Breaches and Inlet Development Potential for further discussion.

The northern portion of Topsail Island is a unique barrier island setting in this area of North Carolina due to the presence of a 10.6 mile long Pleistocene Barrier complex within the estuary that trends at a different orientation than the modern barrier (Figs. 3 and 19-22). This 125 ka old barrier complex extends from its attachment area (spit) near the Surf City Bridge (Fig. 23) to ~.75 mile NE of Alligator Bay on the seaward side of the dredge material islands (Fig. 20). There are 10 barrier segments (remnants) including the barrier spit, and are of variable length. The longest of the island remnants is Permuda Island (Figs. 3 and 23), which is ~1.4 miles long, while the shortest remnant is ~420 ft in length. The old islands are vestiges of their former shapes and have been eroded through time during low stands of sea level. The northern portion of the Pleistocene barrier trend has merged with the modern barrier near the south ramp of the Highway #210 high rise bridge.

The Pleistocene barriers have had a significant impact on inlet breaching and flood-tidal delta development where they are present. Stump Inlet opened in an area where the old barrier spit and Permuda Island were separated by ~3.0 miles of open shallow water. Barren Inlet opened 4.7 miles to the northeast along an area of where Ashe Island was separated from an unnamed old barrier remnant by 1,950 ft of once open water. The barriers in this area are very close to the modern barrier island and the northern remnant barrier segment has merged with North Topsail Beach (Figs 3A and 21). The Pleistocene barriers will continue to play a role in whether a storm breach will evolve into a viable inlet and remain open for an extended period of time. Additional information is presented in the Section entitled Storm Breaches and Potential Inlet Evolution.

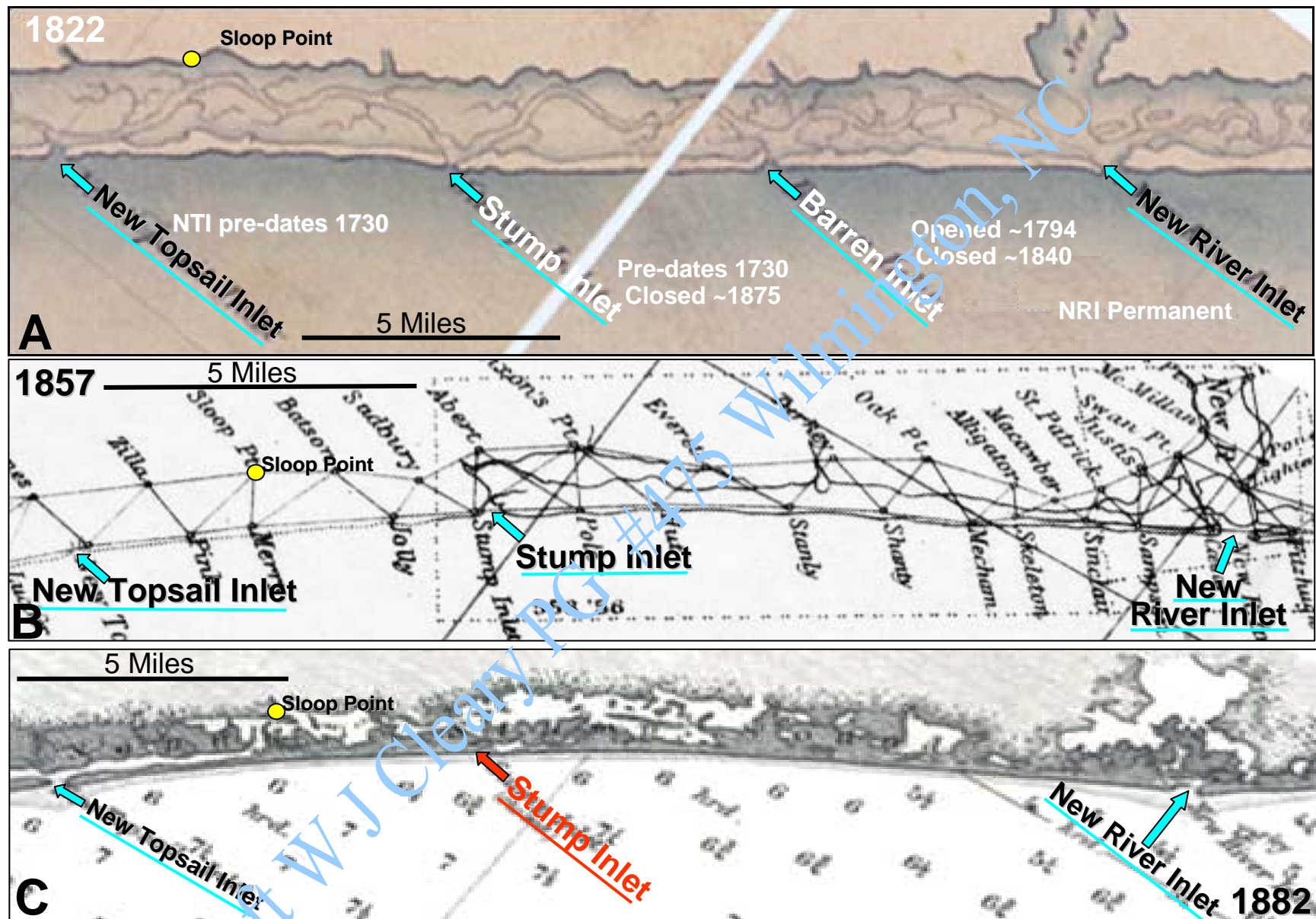


Figure 1. Historic maps of Topsail Island depicting historic inlet locations. Scales are approximate. A. Map segment from A Chart of the Coast of North Carolina comprising three Capes, Hatteras, Lookout and Fear, 1821, Elliot, J.D., Bernard, J., and Totten, G.J., Young, E.D. Surveyor, Engineer Dept., US Office of Topography, B. Map segment from US Coast Survey Sketch Map D showing progress of survey in Section IV from 1845-1856., 1856, Bache, A.D. C. Map segment from USC & GS 1889 Chart No. 148 Bogue Inlet to Old Topsail Inlet, NC.

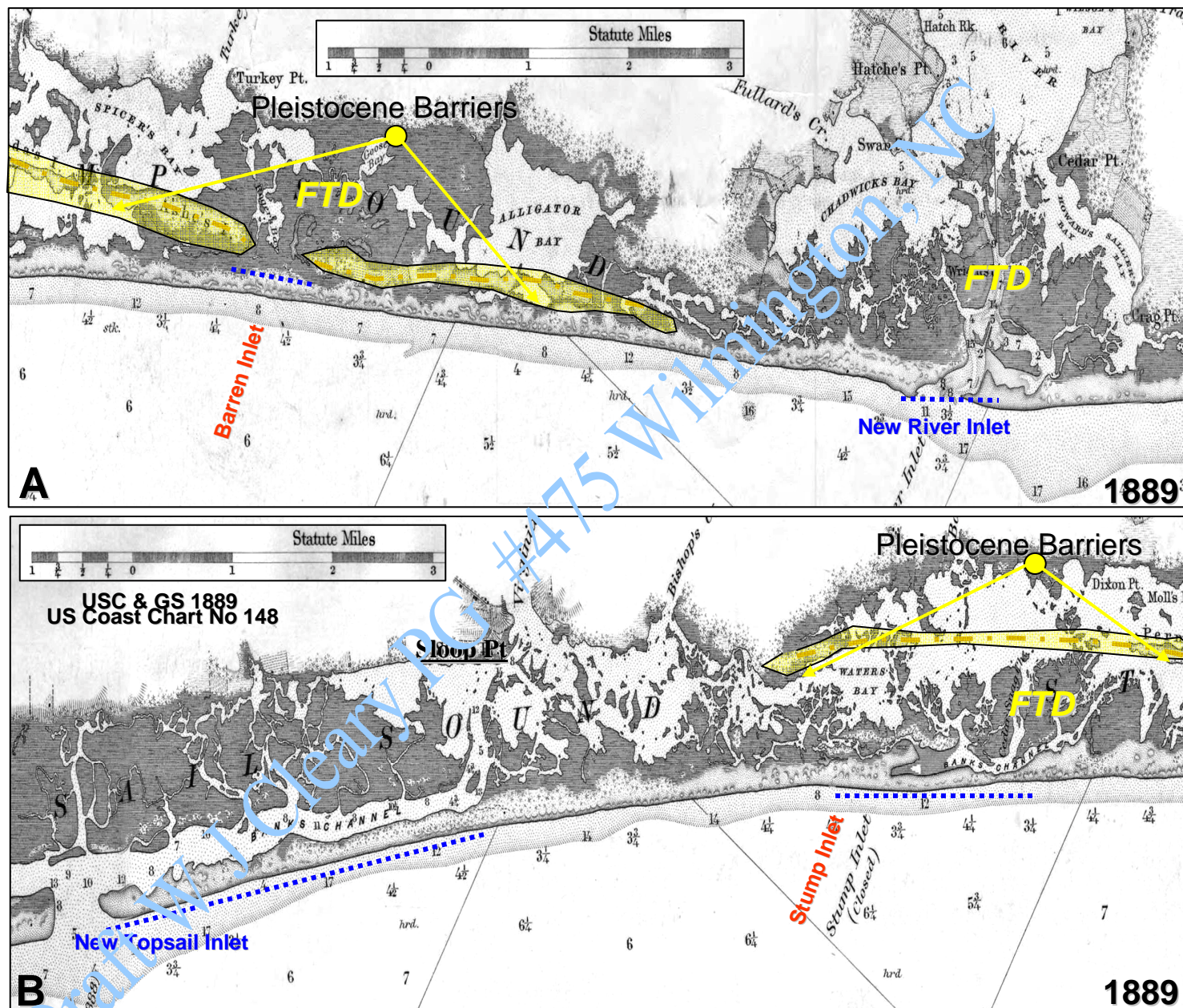


Figure 2. U. S. C. & G. S. Map segments depicting Topsail Island in 1889. A. Map portion depicting the northern segment of Topsail Island and the location of Barren Inlet that closed prior to 1845. B. Map portion depicting the southern segment of Topsail Island and the location of Stump Inlet that closed in the mid-1860s. The blue-dotted lines represent the inlet migration pathways. Note the lack of Pleistocene Barrier (Yellow polygons) south of Surf City within Topsail Sound.

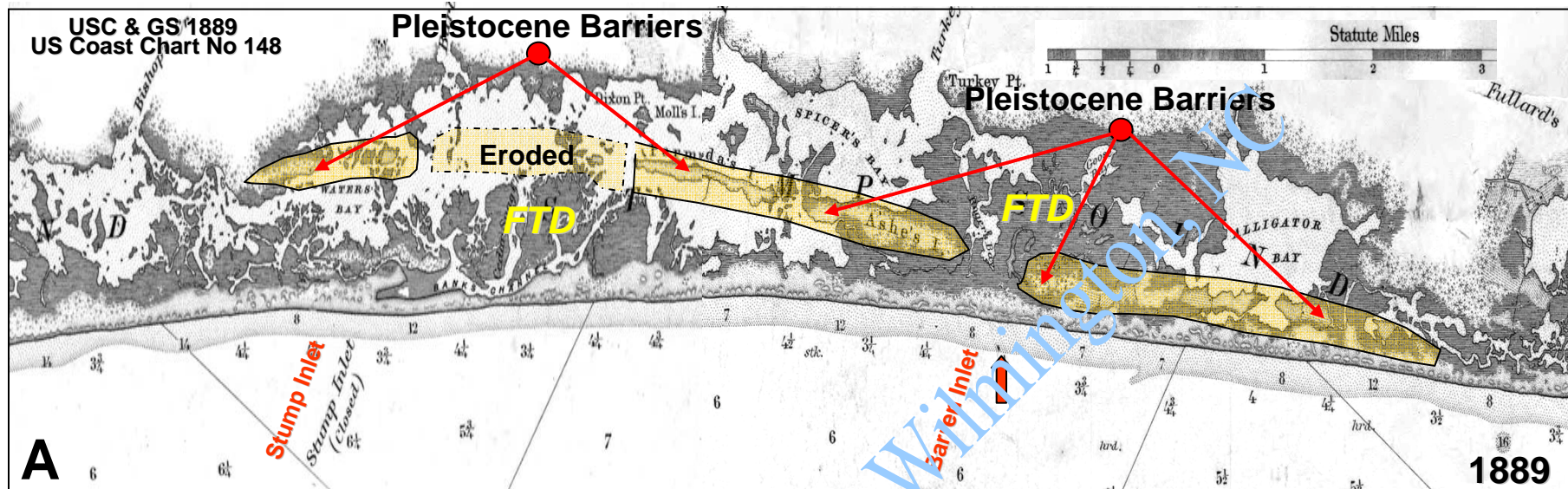


Figure 3. A US C & G S Map (1889) segment depicting a portion of Surf City and North Topsail Beach and aerial photograph of Stump Sound and Permuda Island (Pleistocene Barrier). A. Map show the location of Pleistocene Barriers (beige polygons) within the estuary. Note the different trends of the modern and Pleistocene barriers. Barren Inlet located closed prior to 1840 while Stump Inlet closed in the early to mid 1870s. B. Permuda Is. is the longest of the barriers. Note the lack of an appreciable amount of marsh between the modern barrier and Permuda Island.

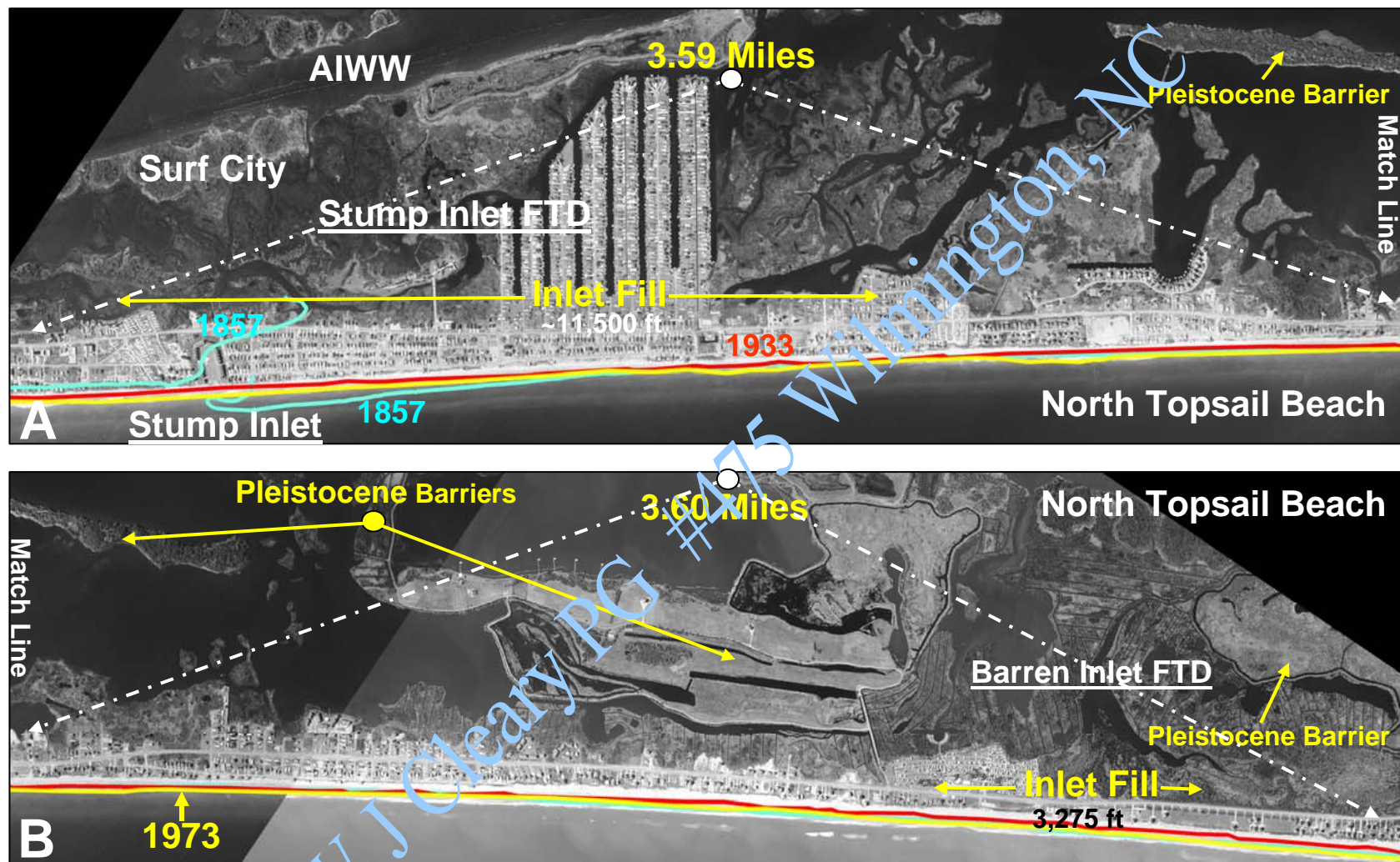


Figure 4. Map of a portion of Surf City and portions of North Topsail Beach on Topsail Island depicting a photograph (9/20/03) with selected historic shoreline positions. A. Map of the Surf City depicting the location of Stump Inlet in 1857. The inlet closed in the 1860s. Its zone of influence is delineated. B. Map of a portion of North Topsail Beach depicting the location of Barren Inlet a late 18th C inlet that remained open until ~1840. Consequently that length of the Topsail Island has changed depending upon the position and number of inlets. Extensive exposures of peat and stumps are often observed after storms during low tide conditions along much of the remaining portion of NTB. The presence of the aforementioned exposures testifies to the lack of historic inlet activity.



Figure 5. Ground views of peat exposures along North Topsail Beach (NTB). A. View (9/15/06) of high marsh peat exposure along NTB with shrub and cedar stumps. B. View (9/15/06) of road bed resting atop the peat bed. C. View (10/12/96) of beach during low tide condition with extensive high marsh exposure. D. View (4/9/93) of the beach along the southern portion of NTB (Topsail Drive). The extensive peat exposures along this shoreline reach indicates no inlets have been active in this area in the recent past.



Figure 6. Photographs depicting NTB and New River Inlet. A. Photograph (2008) depicting New River Inlet and adjacent NTB. Note yellow dotted outline refers to Figure 7. B. Oblique view (8/28/98) of peat units in surf zone. Location is referenced in "A" by white rectangle outline.



Figure 7. Photographs of NTB depicting distribution of peat exposures A. Photograph (2008) depicting the regional distribution of peat along the oceanfront and the northern breach zone location. Rectangular refers to location of "B" and "C". B. Northward view (9/7/96) of breach sites showing extensive peat outcrops. C. Photograph depicting shallow breach (#3) and washover fan and peat exposures.

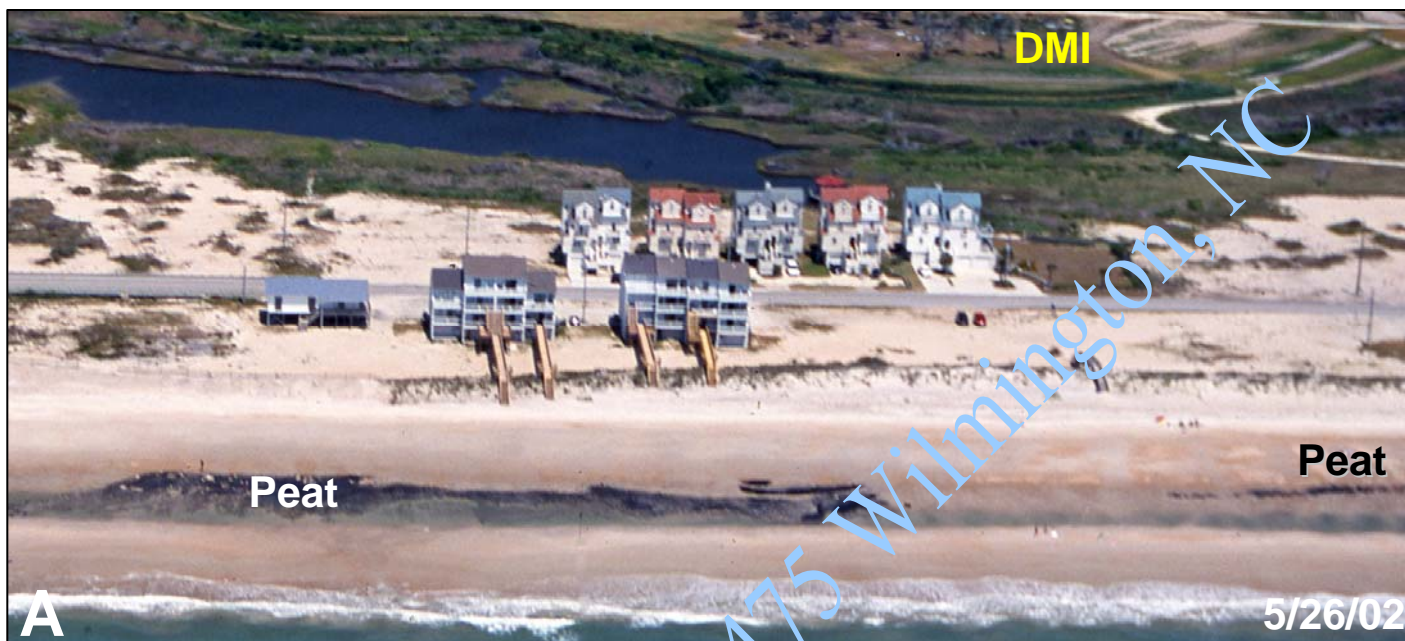


Figure 8. Oblique aerial photographs of the of peat exposures along North Topsail Beach (NTB). A. View (5/26/02) of peat exposure on lower foreshore fronting developed dredge material island (DMI). B. View (10/12/96) beach in vicinity of a NTB pier and peat that is exposed along much of this shoreline reach. C. View (10/12/96) of beach during low tide condition and high marsh peat exposure in vicinity of Baptist Church.

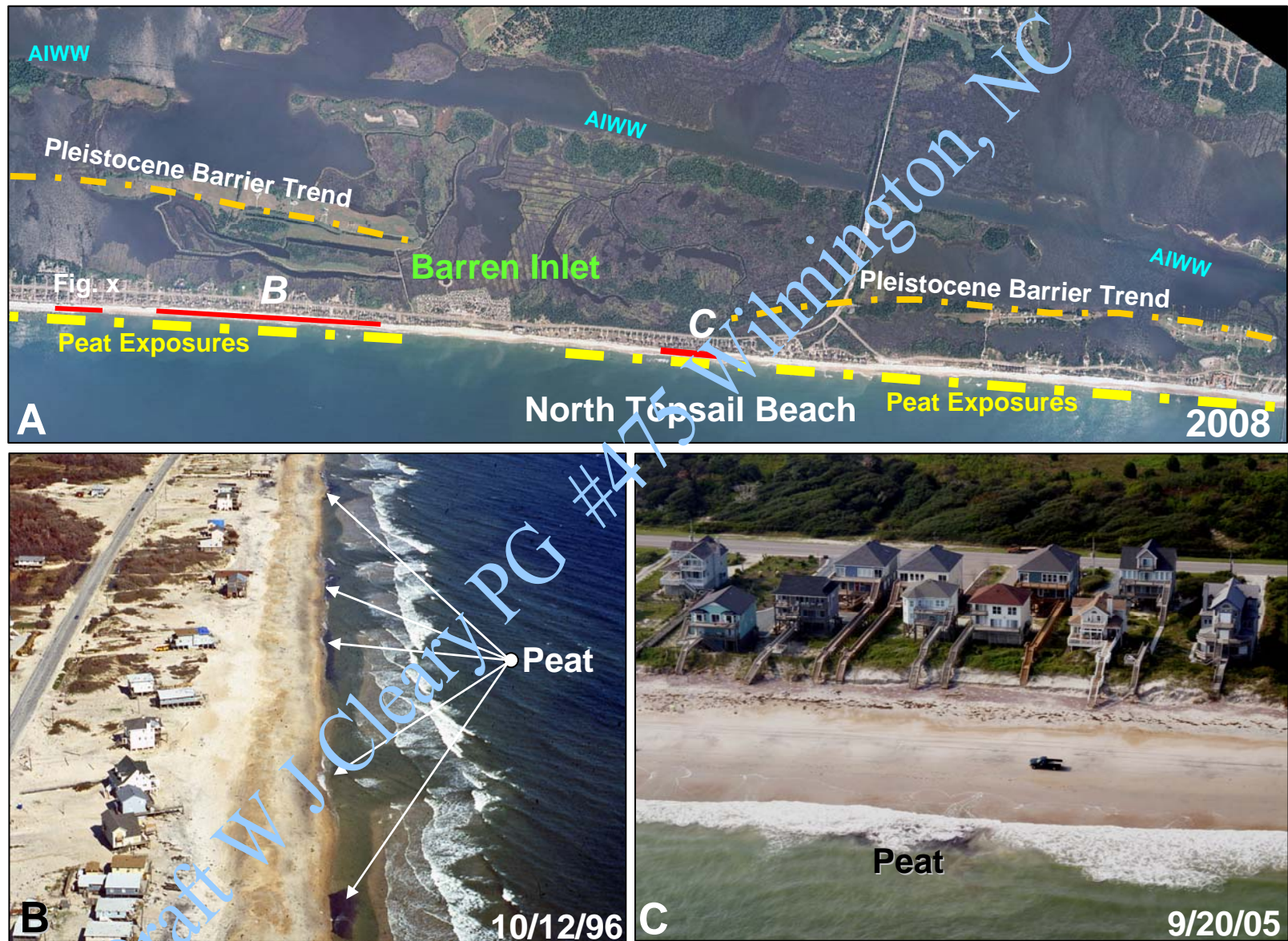


Figure 9 Aerial photographs of the of peat exposures along the southern portion North Topsail Beach (NTB). A. Photograph (2008) depicting distribution of peat exposures and the Pleistocene barriers trends. Red lines reference images in “B” and “C” and the subsequent figure. B. View (10/12/96) of high marsh peat landward of submerged longshore bars that are migrating onto the beach. Locale is south of the NTB bridge. C. View (9/20/05) of peat exposure in surf zone.

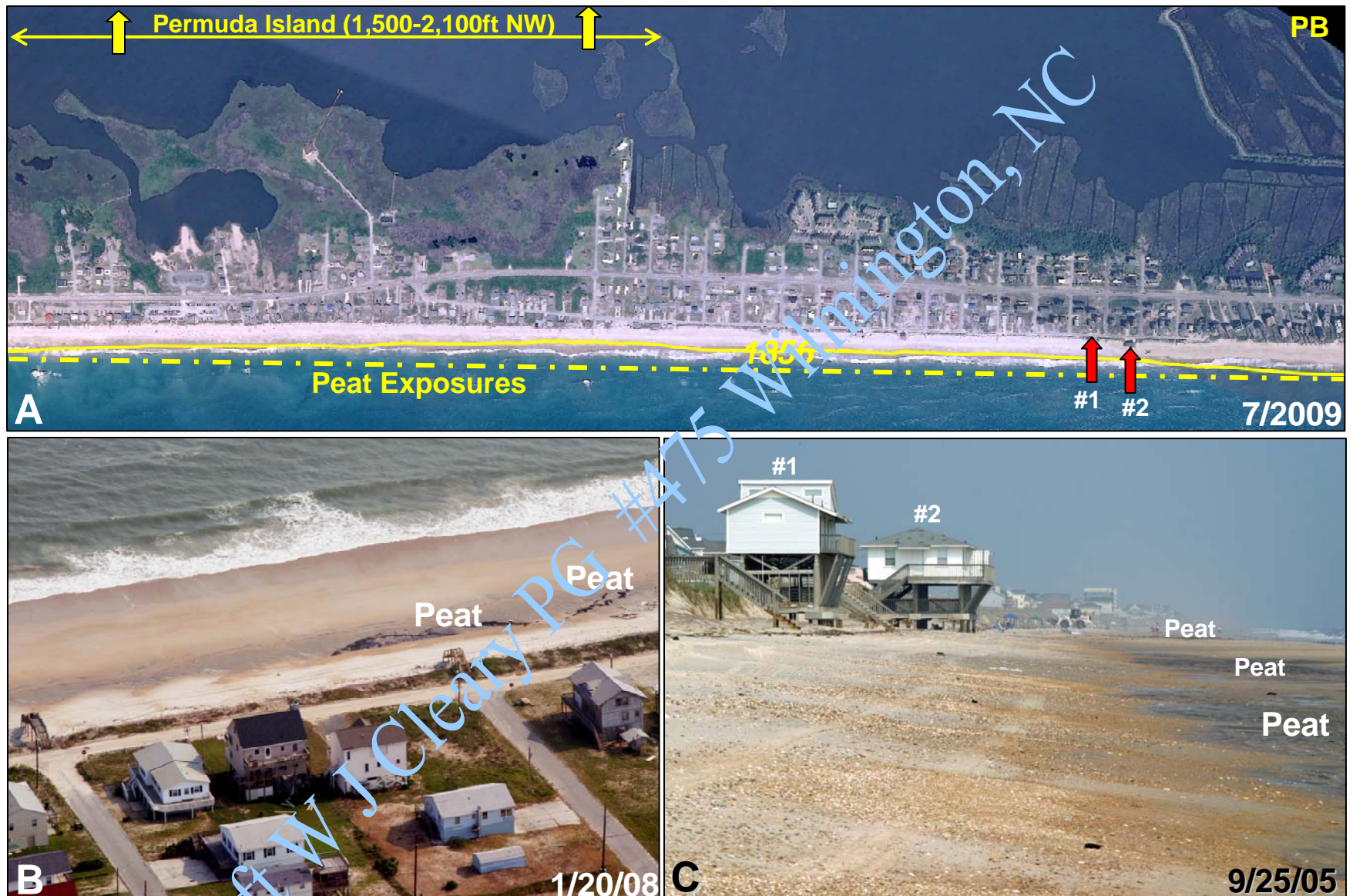


Figure 10. Aerial photograph and oblique aerial photographs of the of peat exposures along the southern portion North Topsail Beach (NTB). See regional location of “A” in Figure Z. A. Photograph (7/09) with 1856 shoreline position. Stump Inlet was located southwest of view. Red arrows denote locations of houses (#s 1 & 2) imaged in “C” where extensive exposures are frequently observed. B. View (1/20/08) of upper foreshore high marsh peat. C. View (9/25/05) of beach south of “B” near 3rd and Topsail Dr. Peat is exposed along much of this oceanfront fronting the Pleistocene barriers (PB).

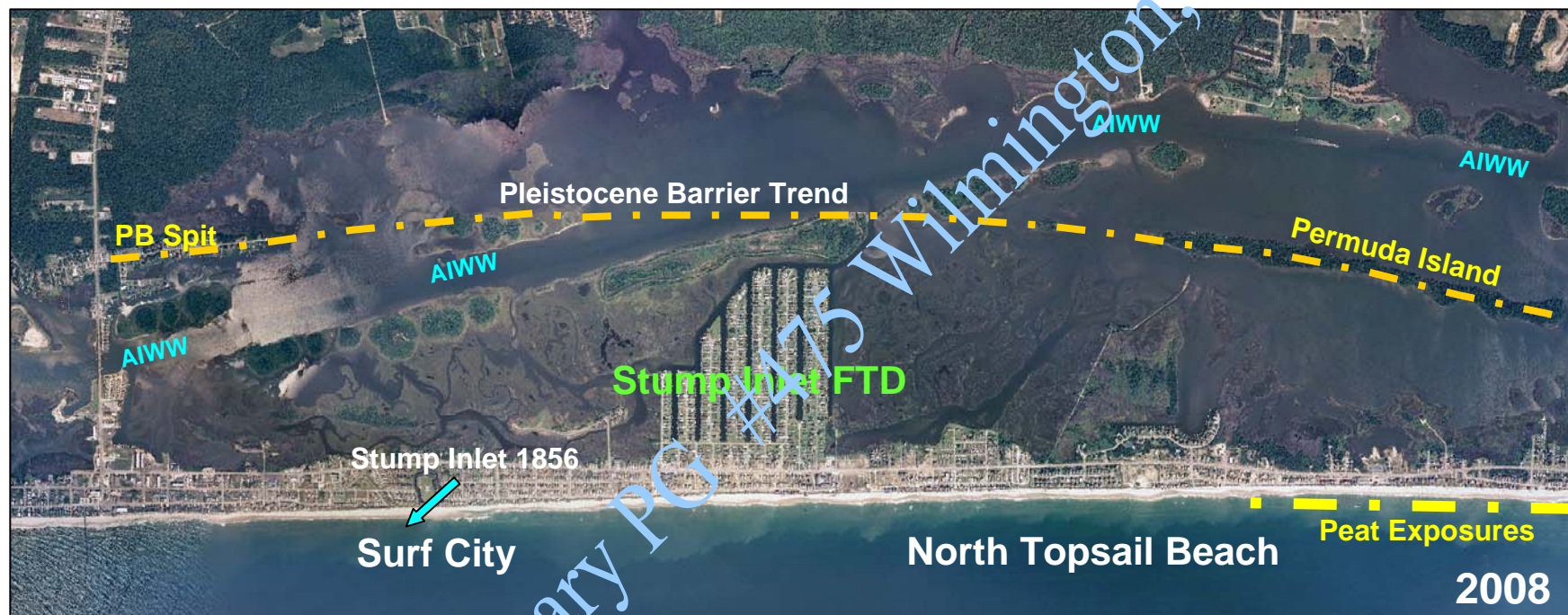


Figure 11. Aerial photograph (2008) depicting the southern portion of North Topsail Beach and the northern portion of Surf City. Note peat exposures are not found along Stump Inlet's migration pathway. Also note location of Stump Inlet in 1856. The finger canals were dredged across the widest portion of the inlet's flood-tidal delta (FTD).

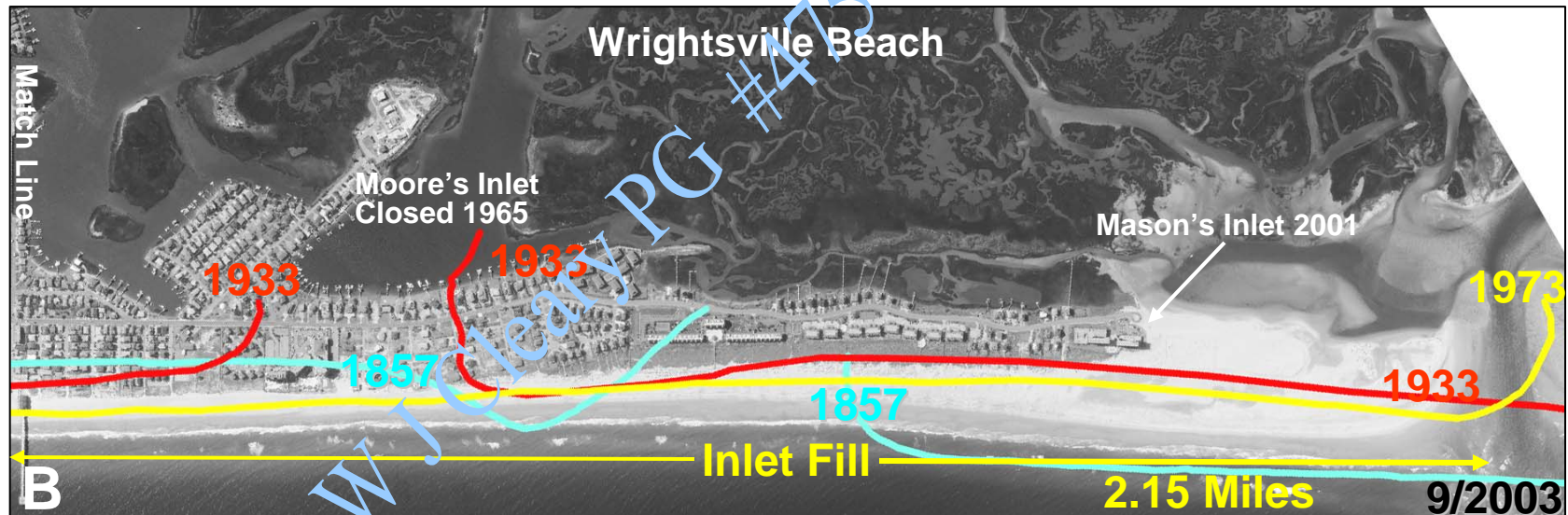
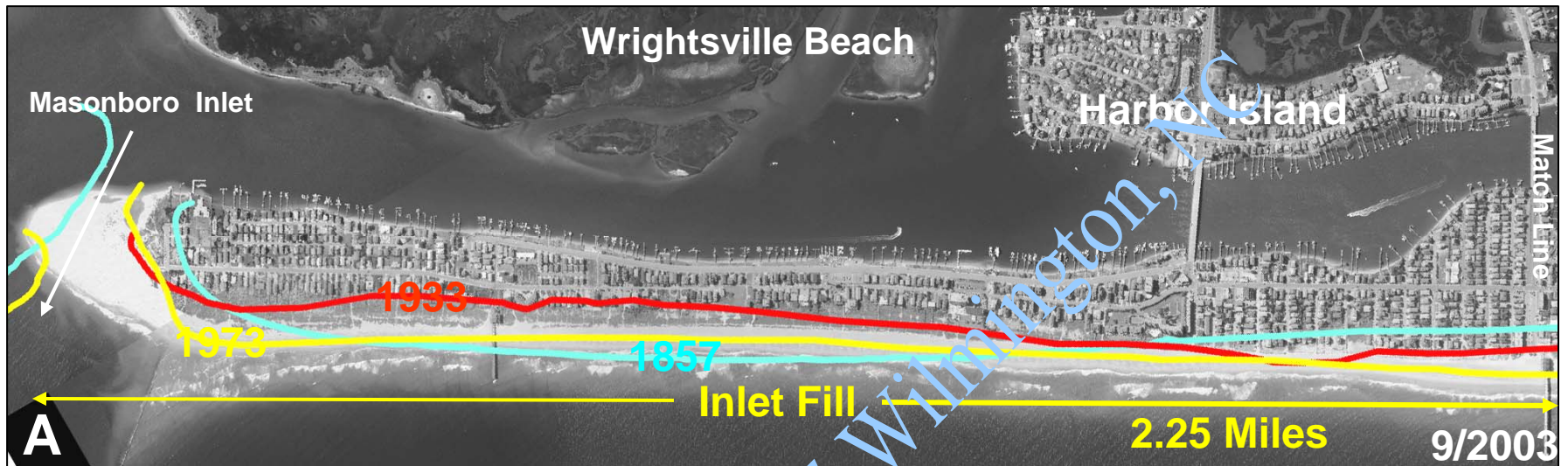


Figure 12. Map of Wrightsville Beach depicting a photograph (9/20/2003) with selected historic shoreline positions. A. Map of the southern portion of Wrightsville Beach depicting the extent of inlet fill. Masonboro Inlet has migrated along the barrier from Harbor Island to its present location. B. Map of the northern portion of the barrier (Shell Island). Moore's Inlet (Wrightsville Inlet) have migrated along the length of Shell Island. Mason Inlet in 2001 was located at the base of the Shell Island resort. All of Wrightsville Beach is underlain by inlet fill and as recently as 1965 was comprised of two Islands.

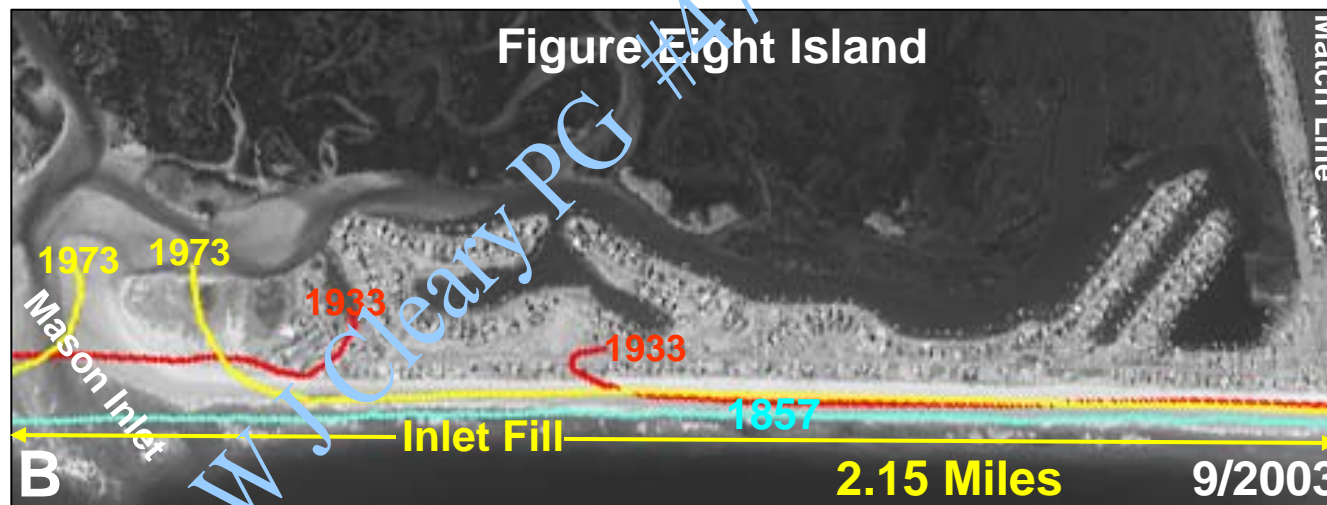
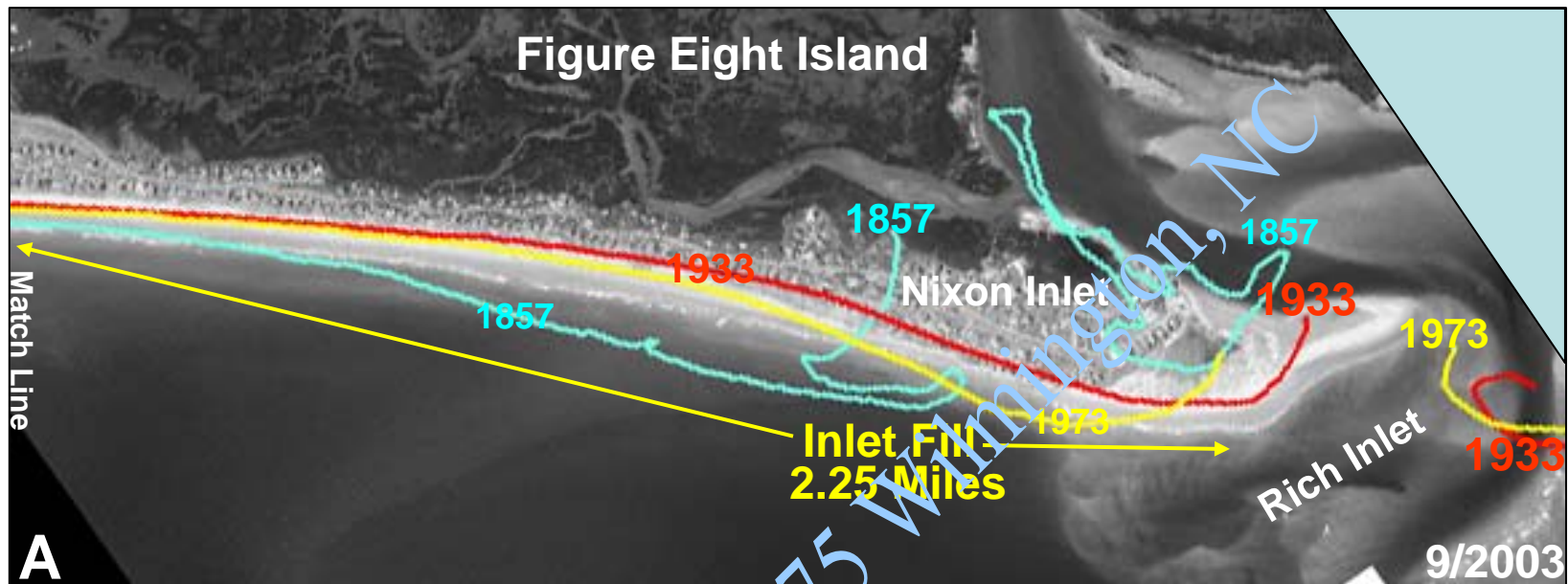


Figure 13. Map of Figure Eight Island depicting a photograph (9/20/2003) with selected historic shoreline positions. A. Map of the northern portion of Figure Eight Island depicting the extent of inlet fill. Nixon Inlet a mid-19th C inlet remained open until 1895. Previous inlets that pre-date the colonial era have migrated along the northern segment of the barrier. B. Map of the southern portion of F8I. Mason Inlet has migrated along the length of the southern barrier segment. Mason Inlet in 2001 was located at the base of the Shell Island Resort before it was relocated northward. Consequently the length of the island has changed depending upon the position and number of inlets.

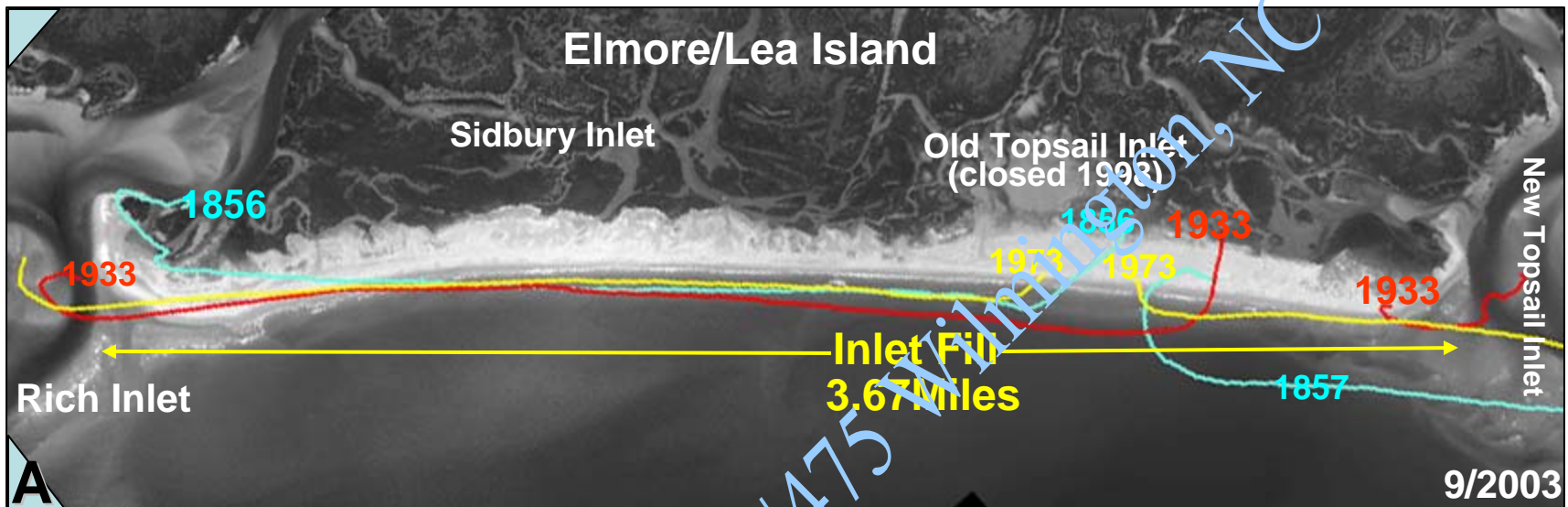


Figure 14. Map of Elmore's Island depicting a photograph (9/20/2003) with selected historic shoreline positions. The barrier shown consisted of two island as recently as 1998 when Old Topsail Inlet closed after a long history of migration. Sidbury Inlet has opened and closed several times during its history. Consequently the length of the islands has changed depending upon the position and number of inlets.



Figure 15. Northward view (1/20/08) of New Topsail Inlet (NTI) and Topsail Sound. NTI opened prior to 1730 and has migrated more than six miles. Note the increasing width of the barrier as it migrates southward. Lea Island (bottom) continues to erode as the inlet shifts in southerly direction. Insert depicts the location of Sloop Point on the mainland and general location where the inlet opened prior to 1730.

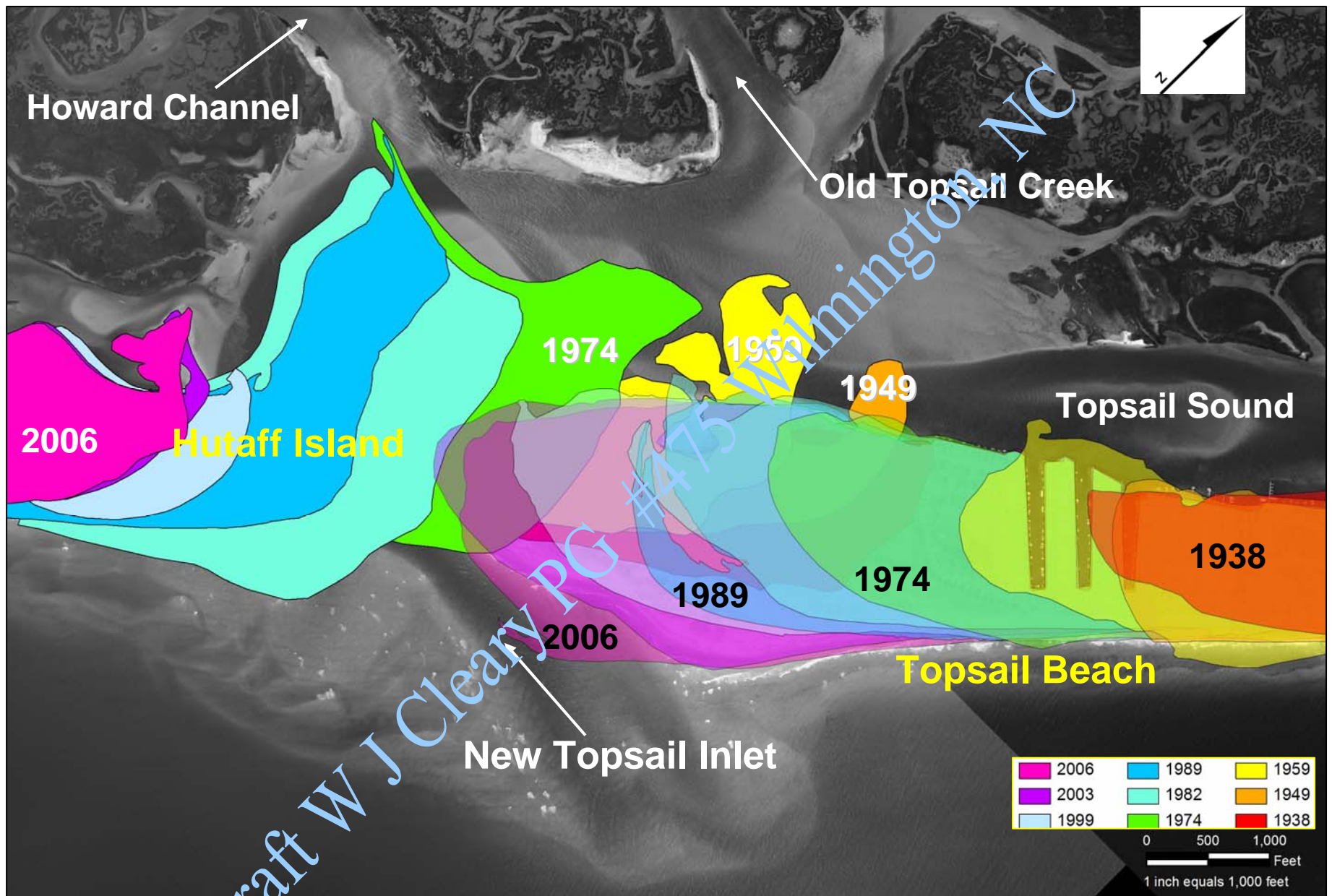


Figure 16 . Map with 7/2003 photograph of Topsail Inlet with historic shapes of the southern end of Topsail Beach and the northern portion of Hutaff Island. Note the increasing width of Topsail Beach as the inlet migrates southward. Modified after McLean (2009).

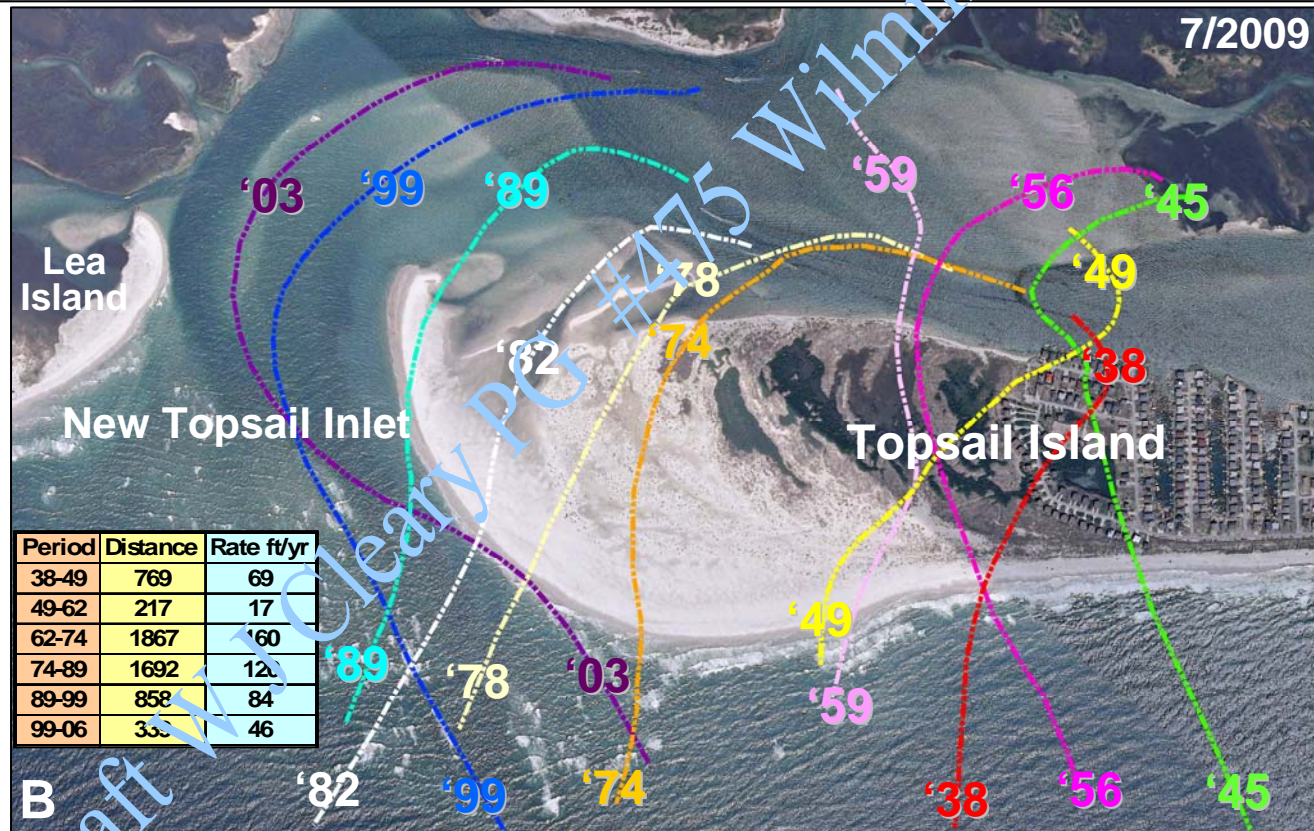
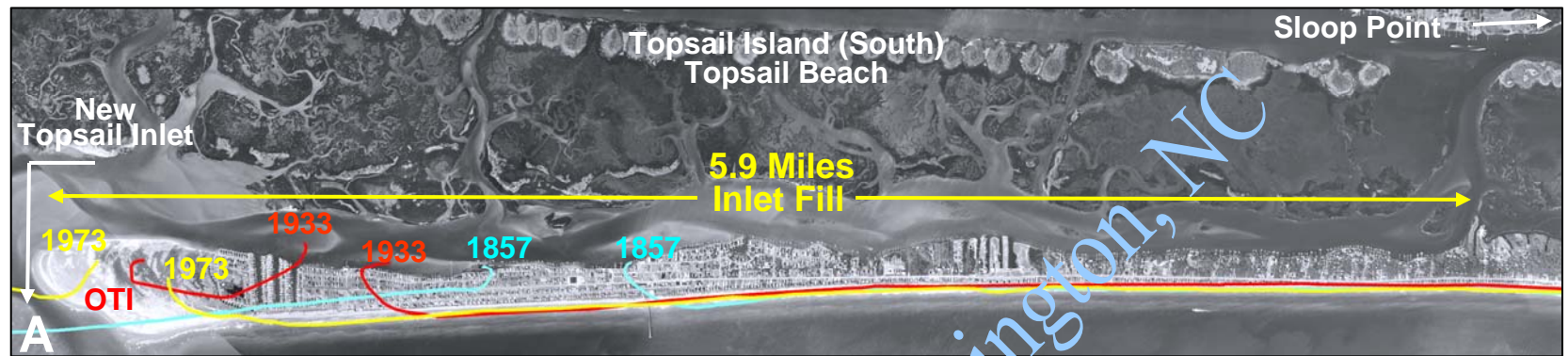


Figure 17. Maps of the southern portion of Topsail Island (Topsail Beach). A Map with photograph (9/20/03) with selected historic shoreline positions and the extent of inlet fill along Topsail Island. New Topsail Inlet is the longest-lived migrating inlet. Its migration pathway extends ~six miles along the barrier. The inlet likely opened in the early 1700s and continues to lengthen Topsail Island. Old Topsail Inlet (OTI) was located along the spit portion in 1933. Consequently the length of the island has changed depending upon the position of NTI. B Map with 2009 photograph and selected ebb channel positions since 1938. Insert lists period migration rates.

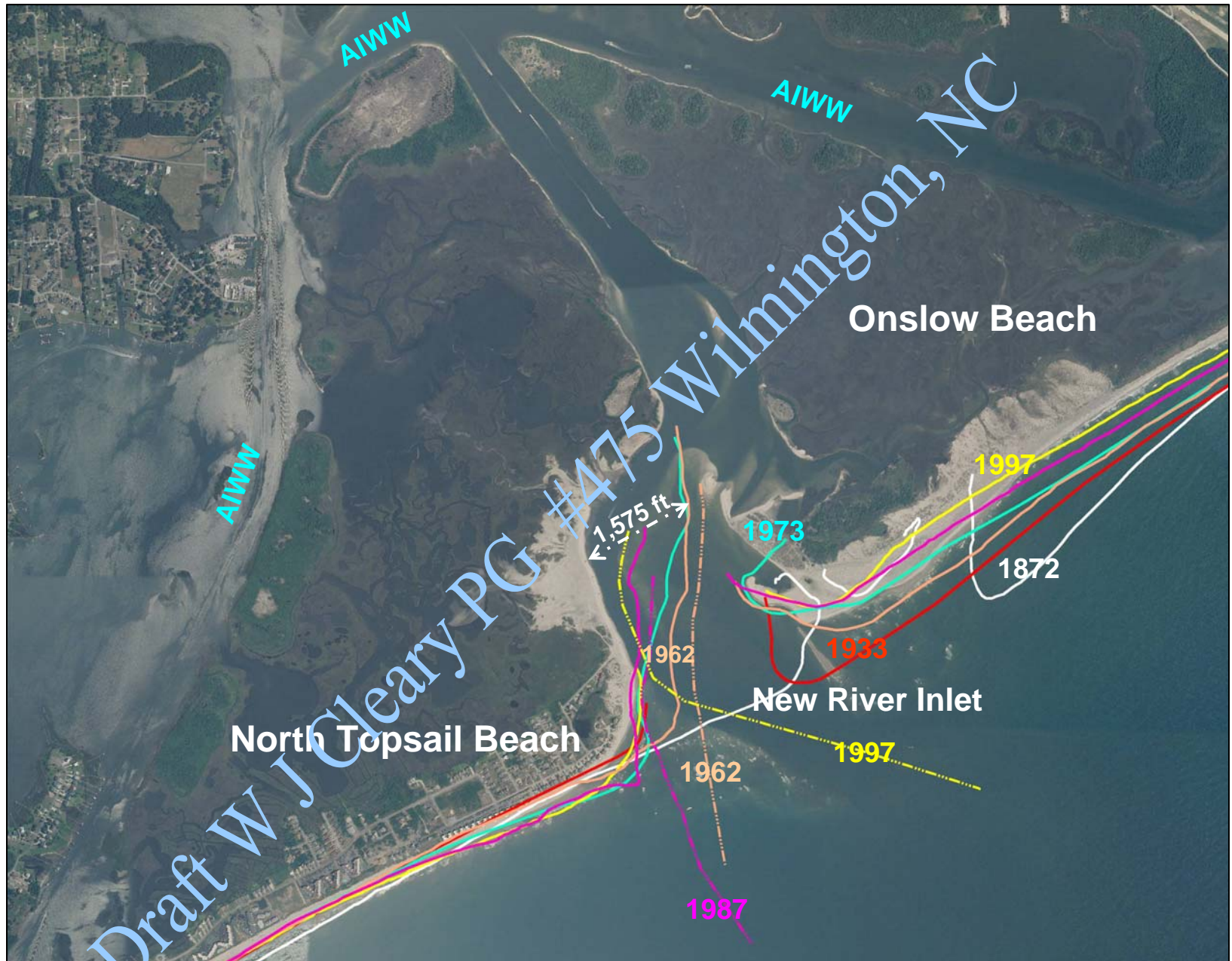


Figure 18. Map with 7/2009 photograph depicting selected historic shoreline and ebb channel positions.

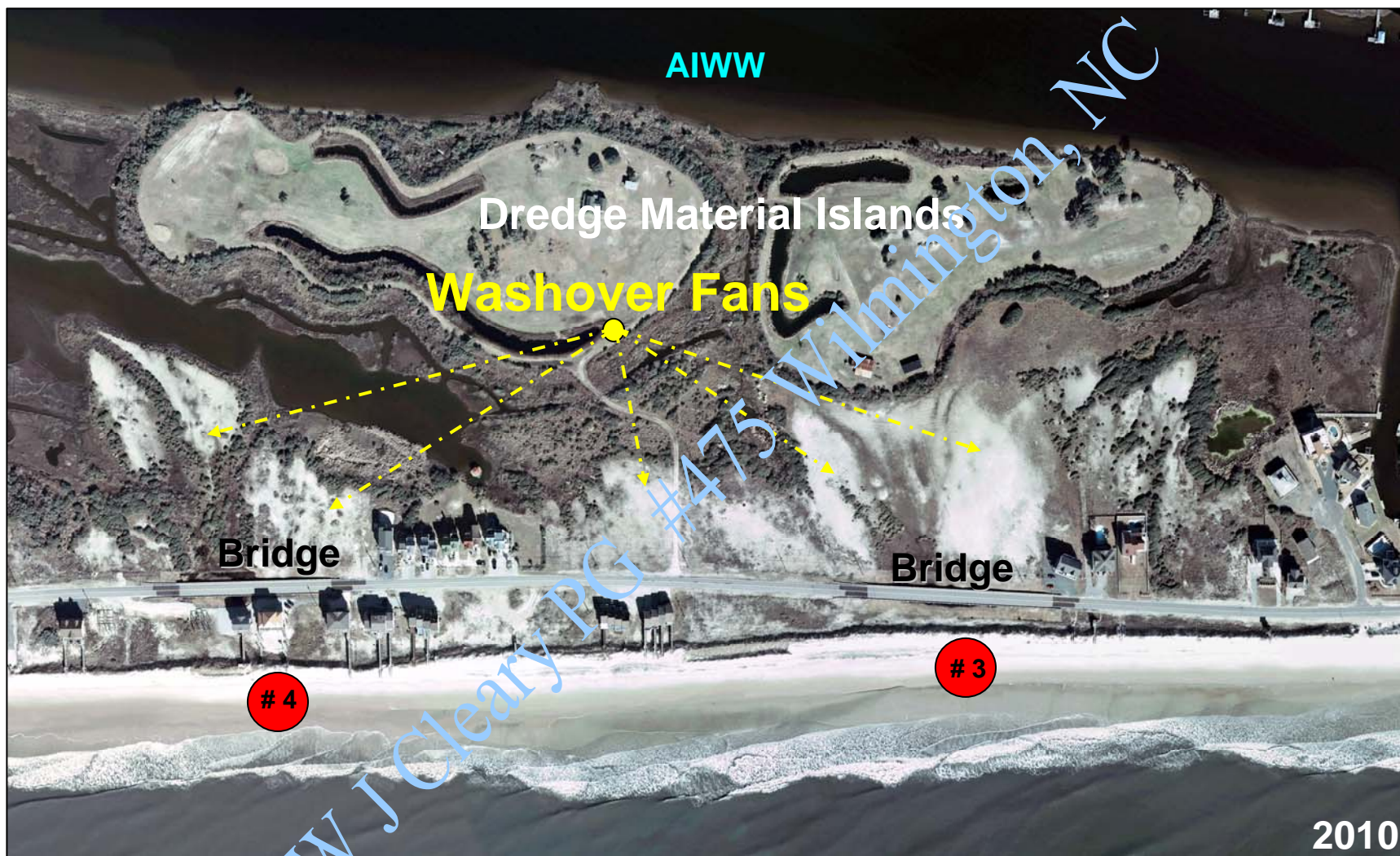


Figure 19. Aerial photograph (2010) showing the NTB breach zone with large washover fans developed near bridge sites. See Figure 7 for oblique views.



Figure 20. North view (1/20/08) of the northern segment of North Topsail Beach. Note an almost continual line of Dredge Material Islands (DMI) that separates the AIWW from the marsh filled NTB backbarrier. A small remnant of a Pleistocene Barrier is identified (PBR)



Figure 21. Landward views (1/20/08) of North Topsail Beach. A. View of development on the old barrier remnant (PB) Note the proximity of the landward margin of NTB. B. View depicting a Pleistocene Barrier (PB) in close proximity to the landward margin of NTB. The old barriers have portioned the estuary lands into distinct compartments.



Figure 22. Northward view (1/20/08) of North Topsail Beach immediately southward of Highway # 210 high rise bridge.. One of the Pleistocene Barriers has coalesced with the modern island (Yellow arrow). Note the peat on the lower foreshore. Old washover fans are delineated by the crenulated outline of shrubs. Historic Barren Inlet lies immediately to the south.

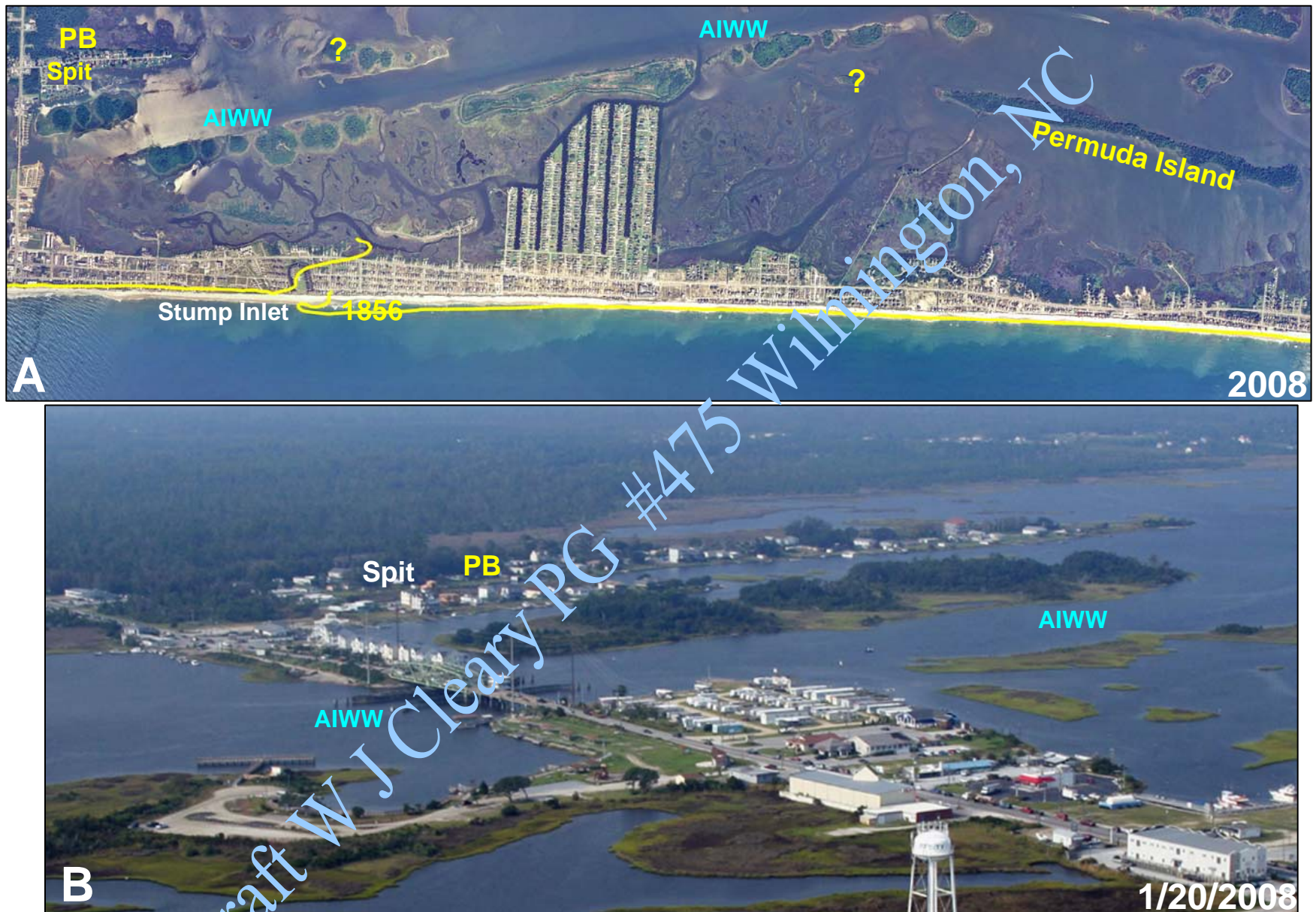


Figure 23. Views of Topsail Beach. A. View of Surf City and Stump Inlet's migration pathway. The Pleistocene barrier spit attachment point is near the bridge. It and the small forested islands (?) are remnants of a once continuous barrier chain. Permuda Island (top) represents. Notice the position of the 1856 shoreline, erosion rates in this area are low. B. Landward view of Surf City and the point of attachment for the Pleistocene barrier spit. Most of the old barriers have been eroded in this area with only a few very small remnants preserved.