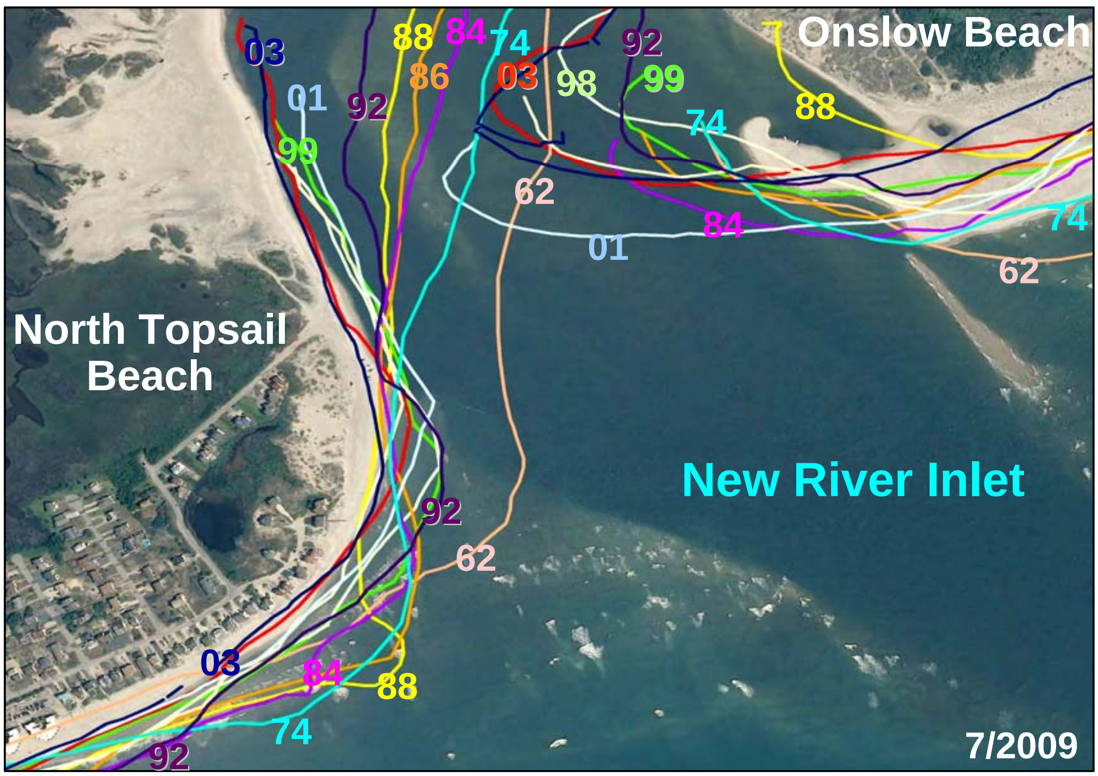
Migration of New River Inlet, NC



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New River Inlet Migration

It was stated by Pilkey and Neal (2009) that *the continued migration of New River Inlet and the potential for new inlet formation prompted the state to propose increasing the size of the designated inlet hazard zone.* This statement is totally misleading for a number of reasons. Firstly, potential inlet formation is not considered in the designation of an IHA. The IHA refers to those segments of the adjacent barriers that are influenced by inlet-related processes.

As a founding member of the NC Science Panel (1996), the Panel began working toward updating the Inlet Hazard Areas (IHAs) as early as 1997. The rationale was that the basis for the delineation of the IHA was outdated and was based simply upon historic migration trends. Most inlets are not long-lived migratory systems that migrate along lengthy pathways, but rather they are confined to relatively narrow zones. Rich, Lockwood's Folly and Shallotte Inlets are examples of the latter inlet category. The aforementioned inlets, while relatively stable (location-wise), are morphologically very unstable. The instability in terms of the inlets configuration is related to the fact they the ebb channel is generally aligned (skewed) along one margin or the other and not centered in a mid-inlet, shore-normal fashion. In time, the ebb channel's position and alignment changes through deflection or an ebb-tidal breaching event that repositions and often reorients the ebb channel.

This event causes the outer bar to be reconfigured, and in doing so, alters the wave-sheltering effect of the ebb-tidal delta along one oceanfront reach adjacent to the inlet. The oceanfront margin that is no longer afforded protection by the breakwater effect of the ebb-tidal then begins to erode. The shoreline retreat along the affected barrier can extend along 1.5 miles of the unprotected oceanfront. The erosion can be long-term and can occur while the throat segment of the ebb channel migrates very little and often away from the eroding shoreline. It is for this reason that the NC Science Panel sought to update how the Division of Coastal Management delineates an IHA; and the panel attempted to determine the length of the oceanfront influenced by inlet- processes not simply migration. The following overview of the history of New River Inlet provides data and information that pertain to the migration and rates of movement of the inlet (ebb channel).

New River Inlet is located in the northeastern portion of Onslow County and separates Onslow Beach to the northeast, a USMC controlled barrier, from developed North Topsail Beach to the southwest (Fig. 1). The inlet drains New River, the second largest coastal plain estuary in the region and the adjacent bar built estuaries. Geological and geophysical data indicated that the inlet is an old and permanent feature. The ultimate origin of the inlet is related to the incision of the ancestral channel of New River into the underlying Oligocene limestone during low stands of sea-level. The contemporary inlet's ebb channel currently lies along the southwestern margin of the incised paleo-valley.

During the latter part of the 19th Century navigating the winding, shallow channels of New River Inlet's flood-tidal delta (FTD) to the offshore fishing grounds was a difficult task at best (Figs. 2A and 3A). In 1880, the seaward portion of the New River within the tidal marsh (FTD) was navigable under ideal conditions via the Western Channel (old river channel) and through a tortuous series of sand shoals and oyster reefs to the shallow bar channel characterized by varying depths from 3-6ft at MLW (Fig. 3A). In 1885, as a means of improving navigation, cuts (4-5ft deep) were dredged through Wrights Island (Figs. 2A and 3A) and Cedar Bush Marsh. By 1894, the difficulty in maintaining the desired depths within the marsh cut required a new approach. As a consequence, an experimental project was completed in 1895 that consisted of a pile-training wall that extended across the Cedar Bush Marsh (Figs. 3A) from the apex of the flood-tidal delta to the channel leading to the Wrights Island cut (US House Document No. 239, 1903).

The Cedar Bush Marsh timber dike had deteriorated to such an extent that only remnants remained by 1903. Destruction of the dike occurred due the activity of shipworms (worm-like marine bivalves) rendering the cut un-navigable, while the Wrights Island cut remained in good condition. In order to restore the navigability of the marsh cut, oyster shells were utilized to rebuild the dike. The Cedar Bush Marsh cut remained usable for a period of time, but by the mid 1930s it had shoaled to 2.5ft at MLW (US House Document No. 239, 1903).

Within a short period of time subsequent to the completion of the AIWW (ca 1930), local interests requested that a suitable channel be provided that extended from the AIWW through New River to the ocean (Fig. 4). Their request was based on the assumption that the dredging of the AIWW had caused shoaling of the once-navigable channels to the ocean and had reduced the flow of ocean water to the shell fish beds (clams, oysters, and crabs). A variety of investigations were made by the USACE, and ultimately a project was recommended that provided an entrance channel 6 ft deep and 90 ft wide at New River Inlet that extended through the old Cedar Bush Marsh cut (Fig. 4) to the mouth of New River at the confluence of the AIWW (US House Document No. 691, 1938).

In June 1940, under the authority of the 1938 River and Harbor Act, a 6 ft deep x 90 ft wide channel was excavated that extended 2.3 miles from the AIWW to the inlet gorge. Concurrently, the inlet was relocated ~ 1,700 ft to the northeast of its 1938 position (Fig. 1). The new hydraulic connections were thought to have substantially increased the tidal prism and the retention capacity of the ebb-tidal delta.

Since 1963 the access channel that connects the inlet to the Atlantic Intra-Coastal Waterway (AIWW) and the New River Basin (Fig. 1) has been periodically maintained. Additionally, side-cast dredging of the bar channel began in the early 1964 and continues to date. In 1989, the existing navigation project was modified when the entrance channel across the outer bar was dredged to a depth of 8 ft x 150 ft wide. Maintenance dredging has been a source for beach fill that has been periodically placed along the northern end of the North Topsail Beach oceanfront.

The inlet was a relatively unstable feature during the period between 1856 and 1938 when it was a relatively unmodified inlet system. Figures 3 and 4 depict the inlet’s historic configurations and the location of the former dominant feeder channel (Western Channel) on the WNW margin of the flood-tidal delta in vicinity of Swan Point. Figure 1 depicts the locations of the historic feeder channel (now closed) and the modern primary feeder channel at the apex of the flood-tidal delta.

It is important to understand the history of modification of the inlet system when considering the instability of the inlet and the migration of the ebb channel. Figure 1 depicts the 1856 and 1934 historic shorelines of New River Inlet. The map illustrates that in 1856 the inlet was of average width (~2,500 ft) with a large middle ground shoal (1,470 ft) that occupied most of the inlet's entrance. The configuration of the above mentioned shoal is depicted on a map dating from 1852 (Fig. 2). The origin of the shoal may be related to a former storm breach or more likely the clogging of the inlet due to its very shallow entrance (Fig. 2). Judging by the size of the ebb-tidal delta and the shallow depths along most of the northeastern ebb channel, the tidal prism was likely very small. By 1888, the northern ebb channel had closed thereby lengthening the updrift barrier (Fig. 3A). Concurrently the southern channel assumed dominance, and in the process, the inlet appeared to shift southward several thousand feet. In addition, the former middle ground shoal became attached to Wright Island (Fig. 3A) by an extensive tidal flat that effectively closed the back barrier channel that once fed the northern ebb channel that existed in 1852 (Figs. 2 and 3).

Based upon information derived from the historic maps (Figs. 2 and 3) and the positions of the 1856 and 1934 historic shorelines (Fig. 1), it is estimated the inlet migrated southward 3,960 ft between 1856 and 1888 at an average rate of ~124 ft/yr. Utilizing the same methodology, it was also determined that the ebb channel migrated northward 1,320 ft between 1888 and 1934 at a much reduced migration rate of ~30ft/yr. Inspection of Figure 3 shows that a spit that developed on the North Topsail Beach shoulder prograded northward causing the ebb channel to shift in the same direction. The pond near the current inlet is a vestige of the channel the once existed behind the spit imaged on the 1932 map (Fig. 3B).

Maps and unpublished surveys from the 1930s (Figs. 3B and 4-5) illustrate the highly unstable nature of the inlet that migrated along a narrow shoreline reach. Information derived from the surveys indicated that between 1933 and 1936 the inlet migrated to the southwest ~700 ft (House Document No. 691, 1938) and continued to migrate westward an additional 1,000ft between 1936 and 1938 (Fig. 5). The migration rates during this five-year time period averaged ~345 ft/yr. Figure 4B depicts the configuration and location of the inlet in 1932 and the cat-eye pond behind the Topsail Island spit that likely marks the southwesterly limit of the ebb channel's excursion.

Since 1940, the inlet the ebb channel migration rates have varied considerably as the inlet evolved in accordance with the new hydraulic connections, maintenance dredging and natural changes in the feeder channel. Using the available data gleaned from historic photographs it was determined that the history of the inlet could be subdivided into five phases each characterized by distinct morphologic changes and/or events. The initial phase covered the period between 1934 and 1945 when the hydraulic connections of the system were altered. During this interval of time the ebb-tidal delta, interior channels and the North Topsail Beach and Onslow Beach shorelines were adjusting to the newly established conditions. Immediately following the relocation of the inlet in early 1940 the ebb channel migrated to the southwest and was strongly skewed toward North Topsail Beach. During this period of instability the ebb channel migrated a net distance of 636ft to the northeast at an average rate of 58 ft/yr. The distance, migration direction and rate are misleading and are not useful in comparing migration rates for different periods due to the fact that the ebb channel was artificially relocated 1,700 ft to the NE in 1940.

The second phase of inlet evolution covered the period between 1945 and ~1962. The inlet presumably attained the current morphologic configuration by the mid 1950s. Aerial photographs clearly show that by the mid 1950s the ebb-tidal delta had enlarged substantially while the ebb channel was positioned along the North Topsail Beach shoulder. During this portion of the inlet's history the ebb channel migrated to the southwest ~490 ft at an average rate of 29 ft/yr.

The third phase of inlet evolution covered the period between 1962 and 1990. Inspection of historic aerial photographs from the mid 1950s to the early 1970s show the development of an asymmetrically shaped ebb-tidal delta whose apex was offset to the SW along North Topsail Beach. Figure 4 depicts the positions of the ebb channel between 1962 and 2009. It is noteworthy to mention that since 1974 the position of the ebb channel has remained within a very narrow zone while the landward channel segment displays greater movement. Inspection of Figure 6 shows that the outer bar channel segment by contrast has been positioned across a relatively wide area. During the third period of inlet evolution the ebb channel migrated to the southwest a net distance of ~ 650 ft at variable rates. Migration rates are skewed toward faster migration rates due to the ebb channel's migration between 1962 and 1974 when the inlet shifted to the southwest a net distance of 534 ft at an average rate of ~41 ft/yr. The migration rate between 1974 and 1990 was ~7 ft/yr compared to the ~17 ft/yr for the period 1962-1990.

The second to last phase of inlet change occurred between 1990 and 2013 when the inlet migrated a net distance of 112ft in a southwest direction (Fig.7). Migration rates during the most recent phase of inlet change averaged ~ 9 ft/yr. The ebb channel reversed its direction of movement numerous times since 1990. During the early portion of this period the ebb channel was deflected toward Onslow Beach when its alignment (azimuth) changed from 149^o on 1 Jan 91 to 111^o on 10 Mar 03. Since 2003, the ebb channel has been generally shifting southward, and as of mid June 2012 the alignment of the outer bar channel was 140^o.

The most recent phase of the inlet covers the period from January 2013 to present (September 2014). This period of the inlet differs from all others due to the artificial realignment of the outer bar channel in mid January 2013 (Fig. 7). As part of a long-term beach and inlet management plan, the seaward most segment of the ebb channel was relocated to a near shore-normal alignment of 155^o. The intent of the project was to re-position the ebb channel in such a fashion that would reconfigure the ebb-tidal delta and restore the break-water effect it once afforded North Topsail Beach in the 1980s. Since the dredging of the new ebb channel in January 2013, there have been significant changes in the configuration of the ebb-tidal delta, and the position and alignment of various segments of the outer bar channel (Fig. 7). The reconfiguration of the ebb shoals has led to the progradation of a 400 ft long spit into the inlet throat that has led to a northeasterly shift of the ebb channel near the mouth of the inlet (Fig. 7). The extension of the North Topsail Beach spit into the inlet throat has resulted in ~440 ft of movement of the ebb channel in a northeasterly direction (Fig. 8). The above channel shift is likely to be relatively short-lived as the ebb-tidal delta continues to reconfigure in accordance with the location and alignment of the outer bar channel.

Figure 1. Photograph (3/2012) depicting the 1856 and 1934 historic shoreline positions and the locations of New River Inlet. Note the locations of the primary feeder channels in the 19th and early 20th centuries.

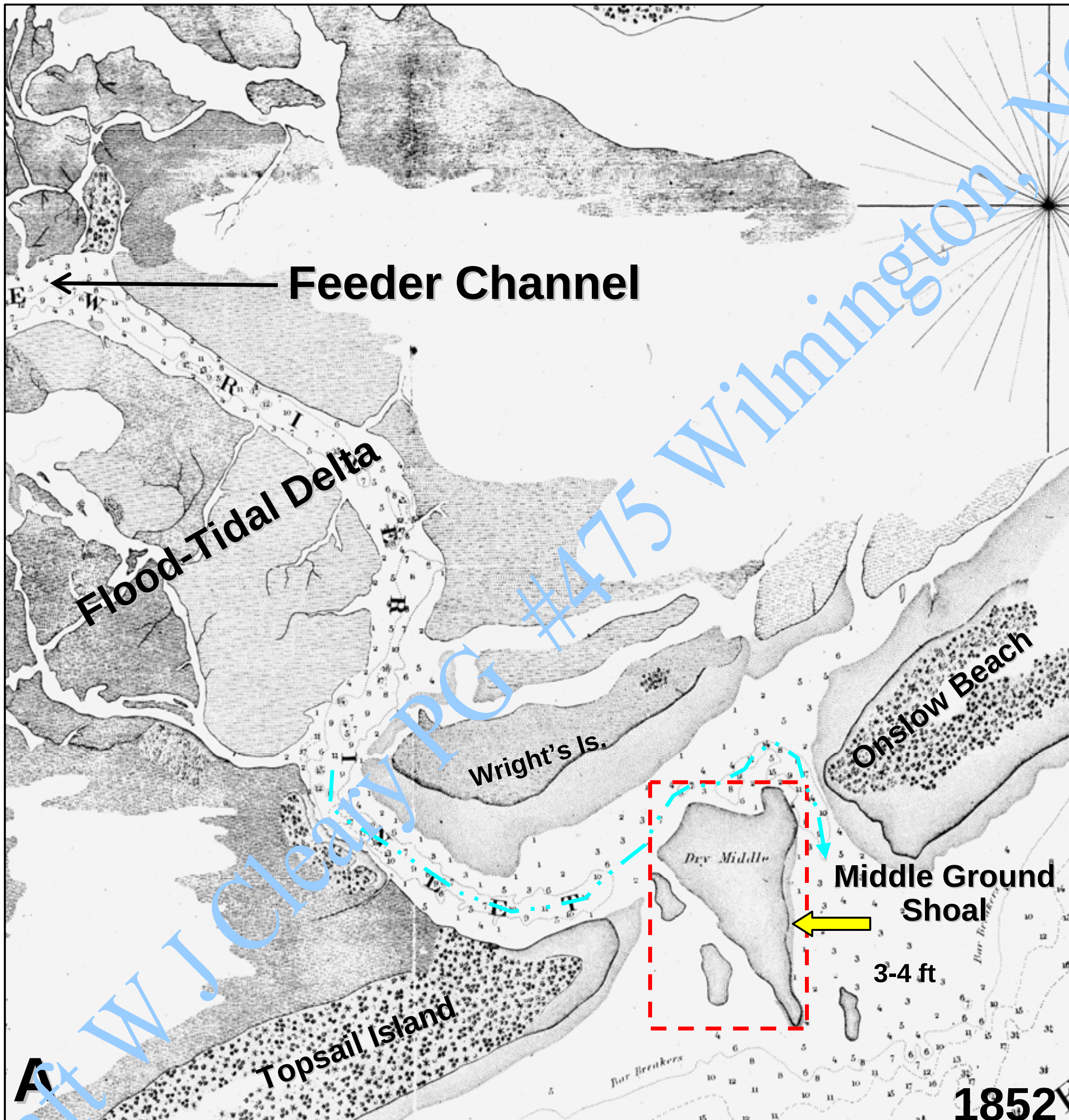

Figure 2. Historic map (1852) of New River Inlet depicting the inlet with a very large middle ground shoal, a shoaled bar channel and a spit extending northeastward from Topsail Island.

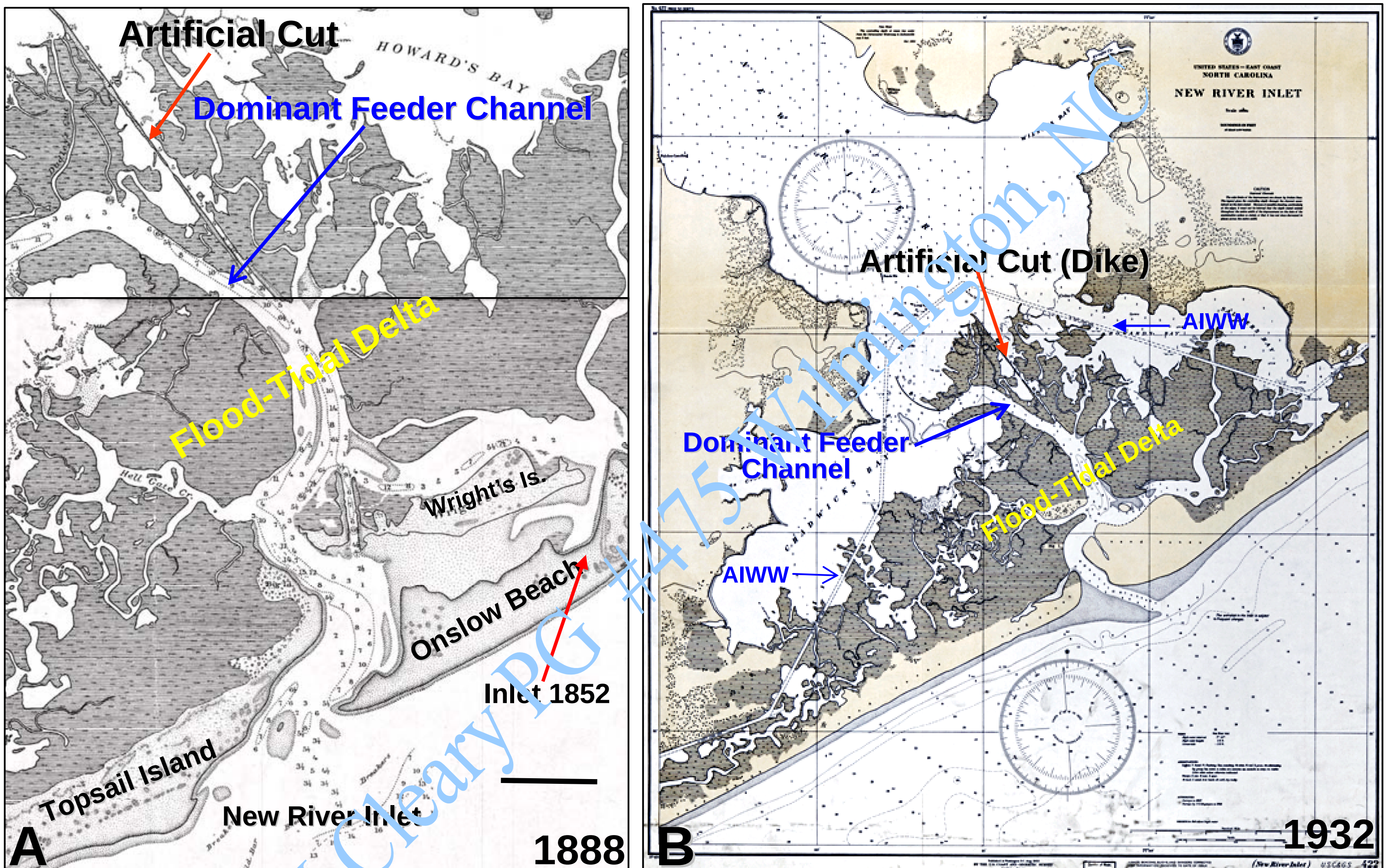

Figure 3. Historic maps of New River Inlet. A. Map (1888) showing the New River Inlet flood tidal delta and the primary feeder channel. Note the erosion of the Topsail Island inlet and oceanfront shorelines due to the southwestward elongation of the Onslow Beach spit that led to then deflection of the ebb channel to the SW. The progradation of OB was presumably due to the incorporation of the middle ground shoal. B. Map (1932) depicting the inlet several years after construction of the AIWW and before additional major channel dredging across the flood-tidal delta. Note the location of the historic primary feeder channel and the artificial cut in “A” and “B”. Chart no. 422. USC & GS 1932. National Archives Washington, DC.

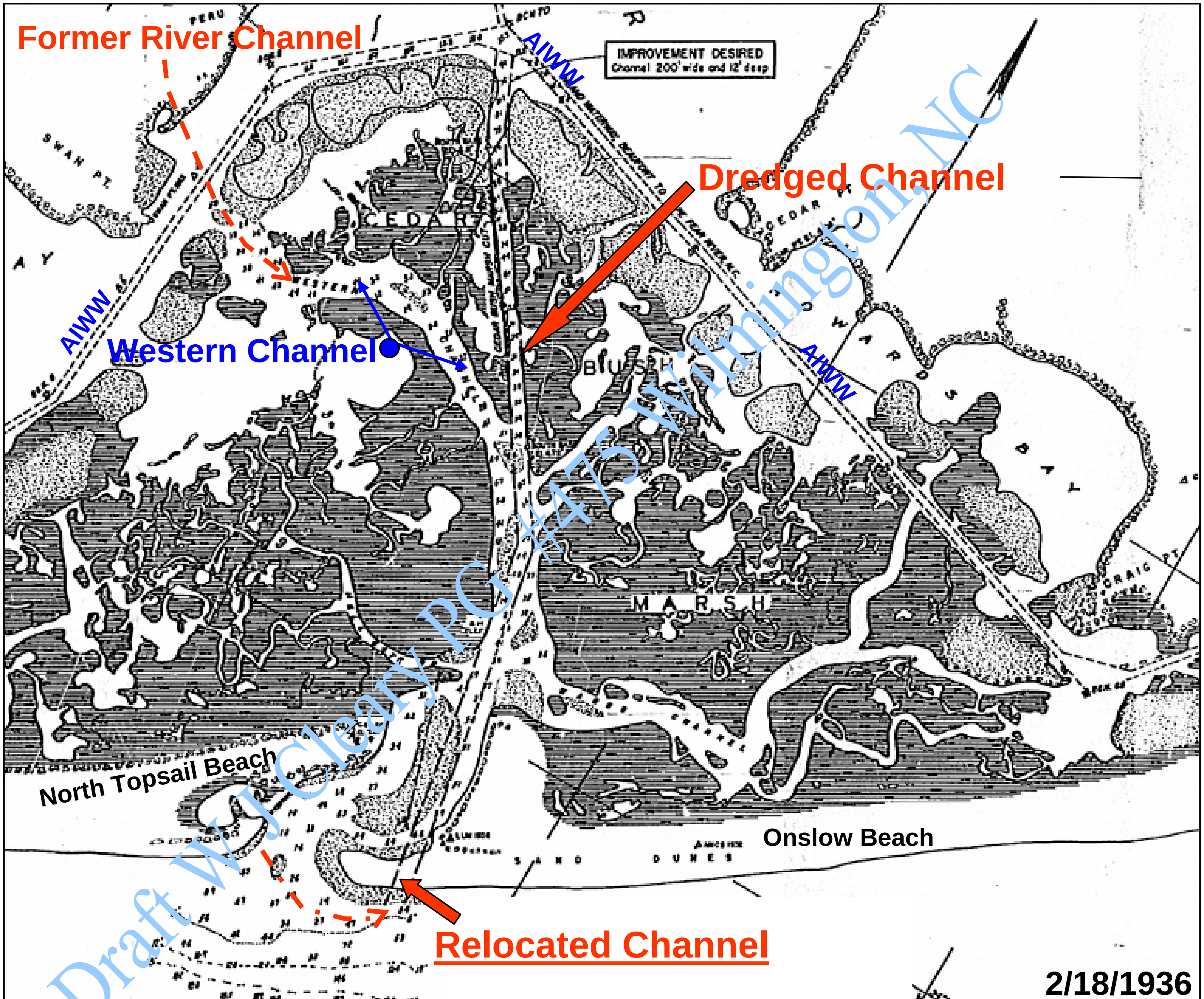

Figure 4. Partial map of 1938 Recommended project for navigation improvement of New River from landward portion of Cedar Bush Marsh (AIWW confluence) to New River Inlet. Modified after House Document No. 239, 1938)

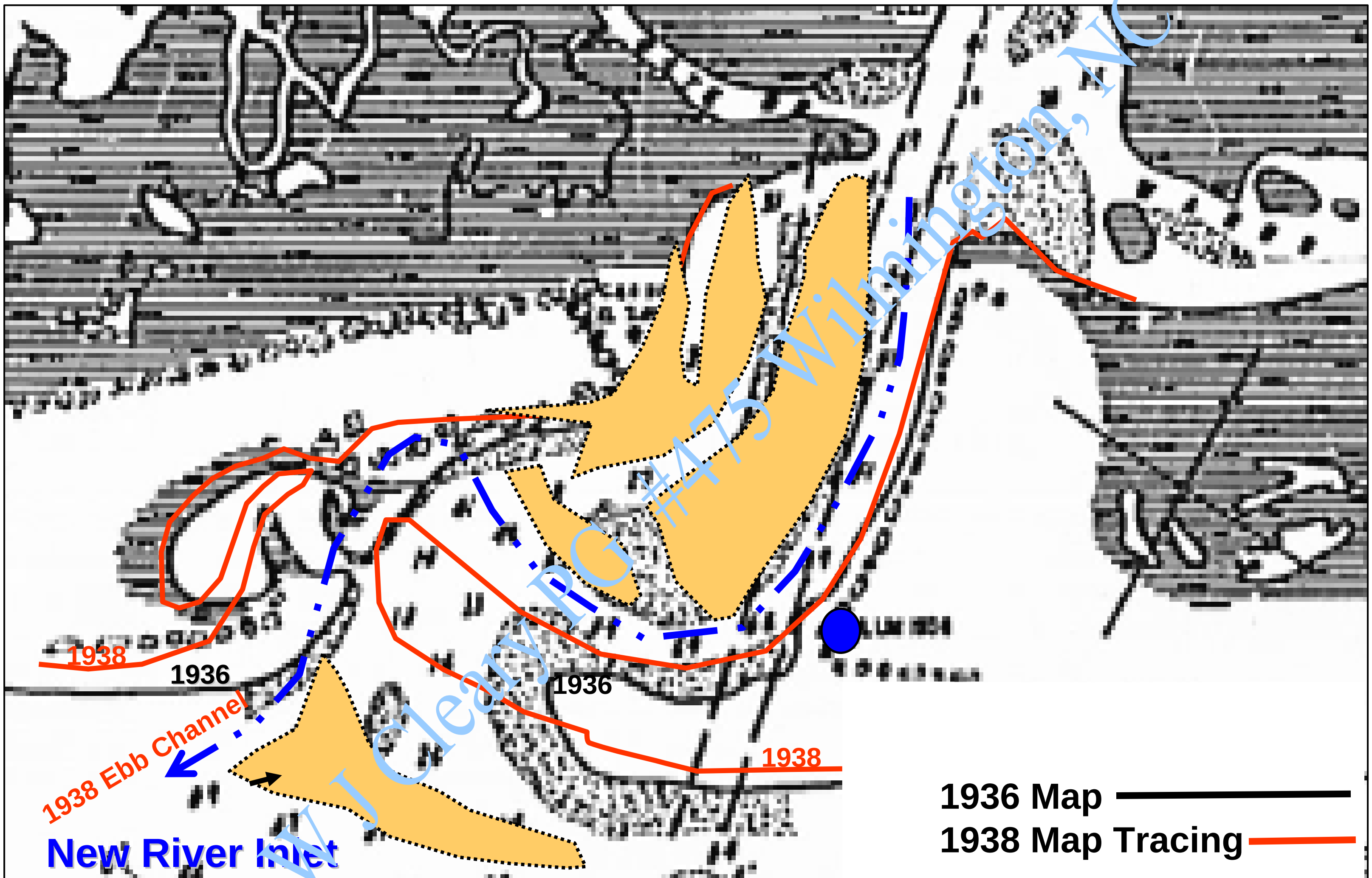

Figure 5 .A comparison of a 1936 survey of New River Inlet and a survey from 1938. The red line tracing (1938) shows the inlet migrated to the southwest 1,000ft. Modified after US House Document No.691, 1938, 75th Congress, 3rd Session.

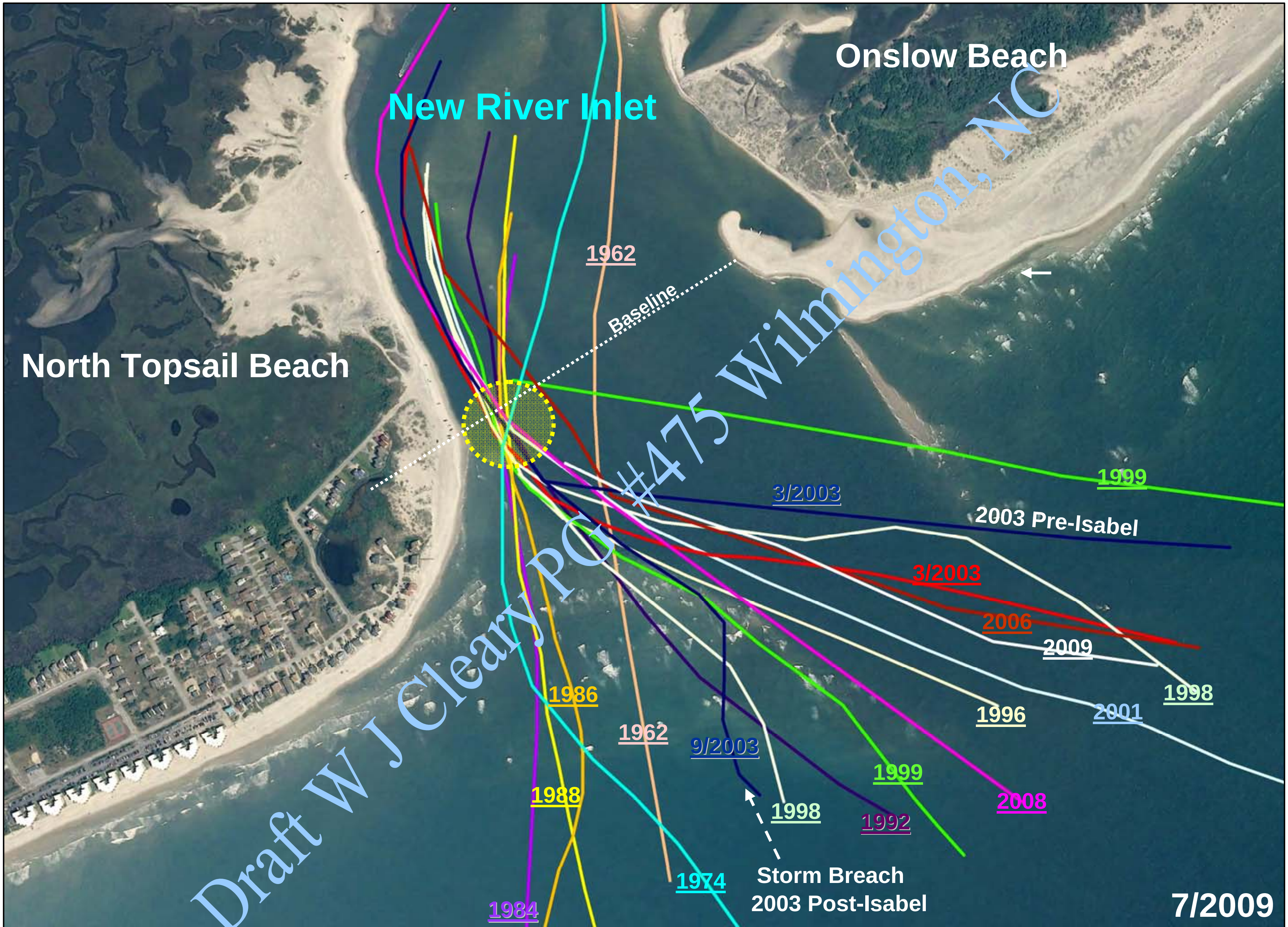

Figure 6. Photograph (2009) depicting historic ebb channel positions and outer bar channel orientation (azimuth). Two ebb channels existed during 1998 and 2003 that were related to storm-breaching episodes. Note the narrow zone (yellow dotted circle) within the inlet throat where the ebb channels were positioned.

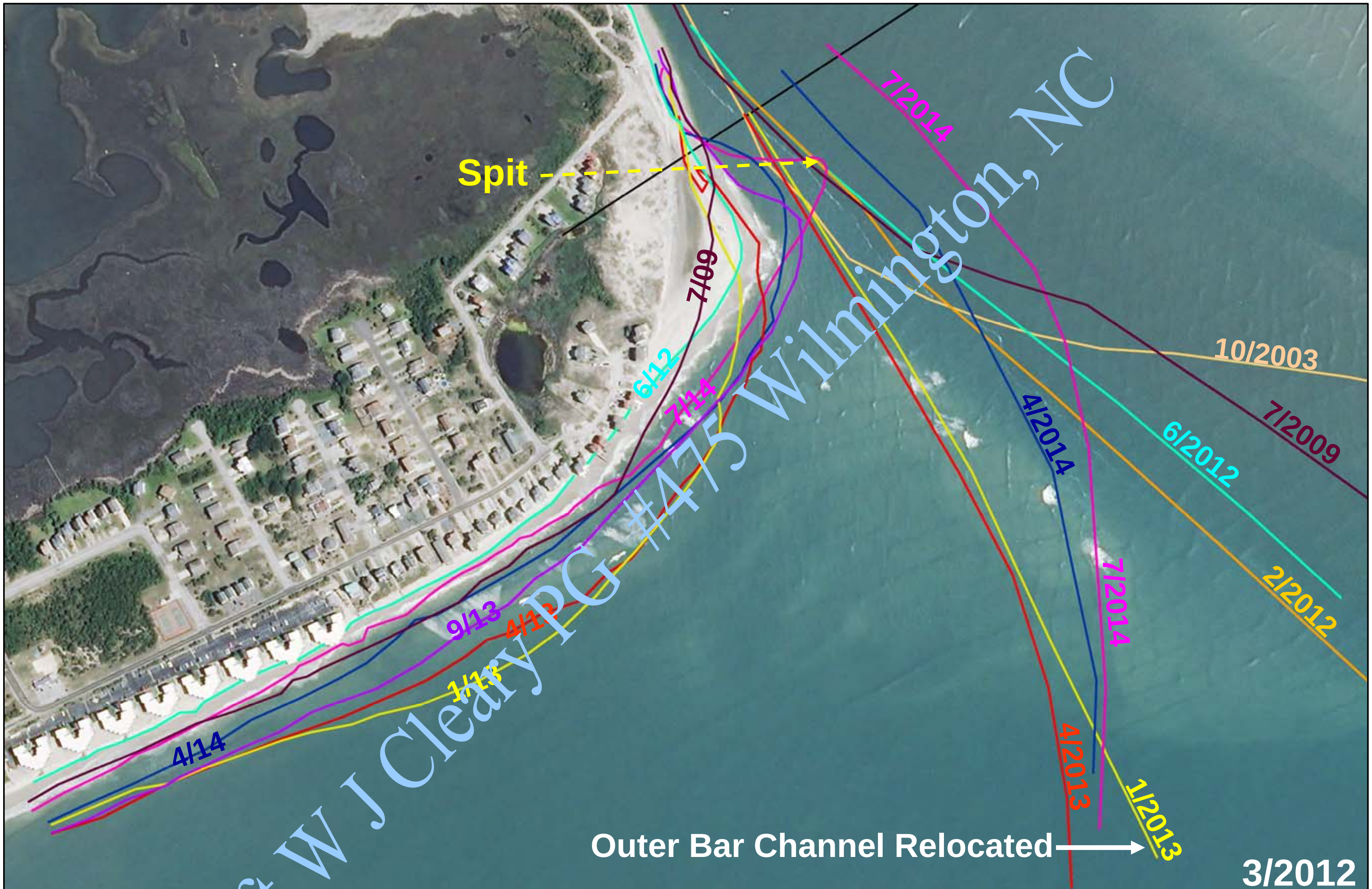

Figure 7. Photograph (2012) depicting recent (2003-2014) ebb channel positions and outer bar channel orientation. Select shoreline positions are also depicted. Note the progradation of the North Topsail Beach spit and the northeasterly shift of the ebb channel.

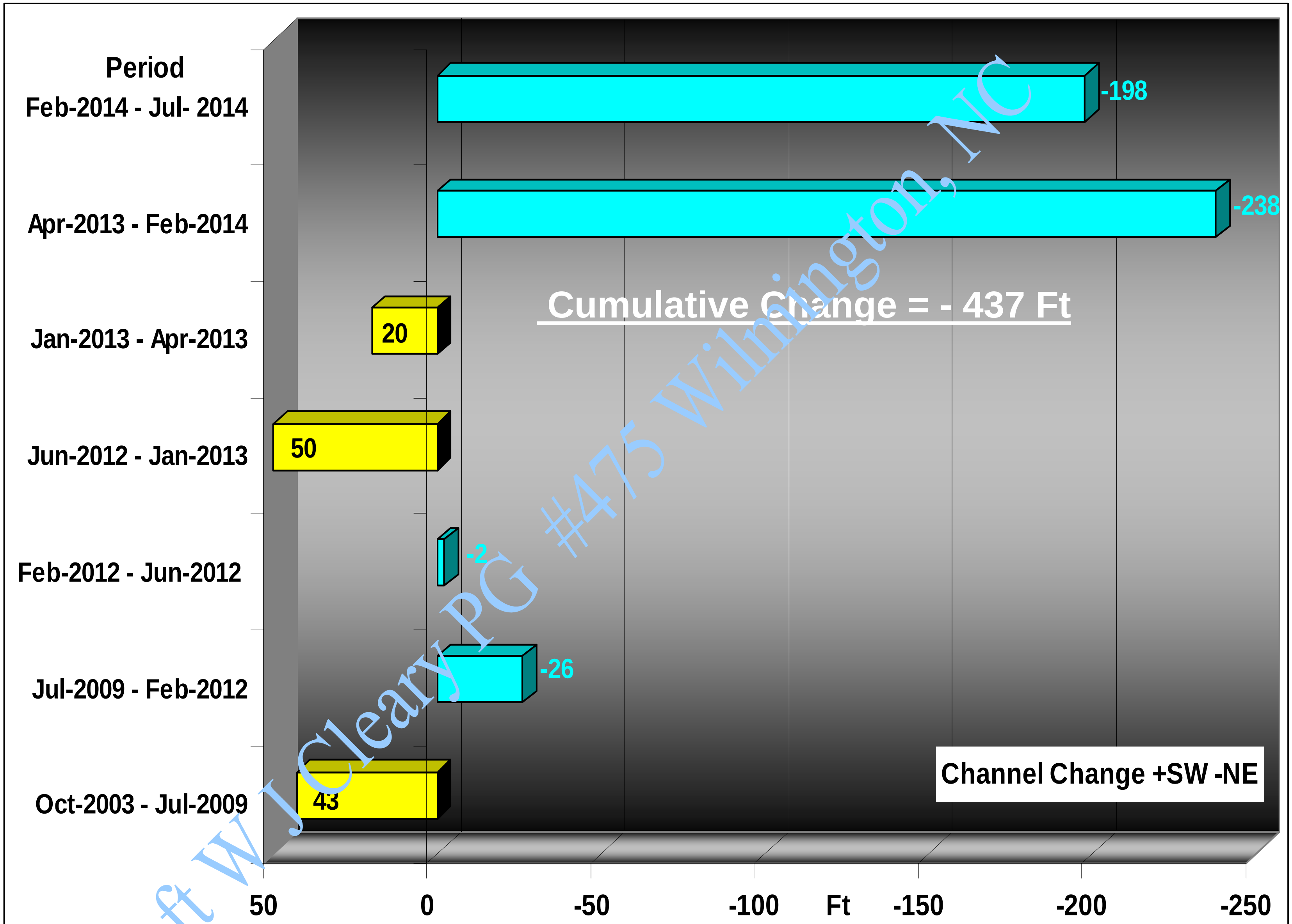

Figure 8. Bar graph depicting the movement of the ebb channel during the period from October 2003 to July 2014. Note the cumulative change is toward the northeast (measured along baseline)