

are s.d.(~) and this implies  $B_{11}^{-1}A_{11}$  is

B such that  $r(B) > r(A + B)$  and A, sample, let

and  $B = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{pmatrix}$ .

LITERATURE CITED

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OSTEOLOGICAL SPECIMENS OF MARINE MAMMALS  
(CETACEA AND SIRENIA) FROM THE WESTERN  
GULF OF MEXICO

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**Abstract.**—This report documents the holdings of marine mammal specimens from the western Gulf of Mexico currently deposited in the Texas Cooperative Wildlife Collection at Texas A&M University. These include 124 catalogued specimens of 17 species of cetaceans (nine whales and eight dolphins) and one species of sirenian (manatee). Collection data and relevant information are provided for specimens of each species.

There has been comparatively little research on the marine mammals of the western Gulf of Mexico until recently. This body of water is known to contain at least 31 species of marine mammals, including 28 cetaceans, two species of pinnipeds and one species of sirenian (Schmidly & Melcher 1974a; 1974b; Schmidly 1981; Jefferson et al. 1992; Davis & Schmidly 1994). Of these taxa, many are considered to be protected, threatened or endangered by the Convention on International Trade in Endangered Species of Wild Flora and Fauna and the Texas Parks and Wildlife Department. Most of the literature on the marine mammals of this area (exclusive of the extensive information on the coastal bottlenose dolphin, *Tursiops truncatus*) has been in the form of short notes reporting occasional strandings or opportunistic sightings of offshore oceanic species. Schmidly (1981) compiled and summarized records of cetaceans and pinnipeds from the Gulf of Mexico. Jefferson et al. (1992) updated the taxonomy and distribution maps of Schmidly (1981) and Blaylock et al. (1995) reported stock assessments and population characteristics for cetaceans from this area.

Much of the information comprising these summary publications was obtained from reports of stranded animals or from records for specimens in natural history collections and museums. Yates et al. (1987) listed the Texas Cooperative Wildlife Collection (TCWC) as the 14th largest collection of mammals in North America. The TCWC currently has over 53,000 cataloged specimens obtained from the early 1930's to present. This collection contains over 150 marine mammal specimens. One hundred twenty-four of these specimens are from the western Gulf

of Mexico, mostly from Texas waters. The TCWC is the second largest collection of cataloged osteological material of marine mammals from the Gulf of Mexico in the world after the Florida Museum of Natural History, University of Florida, Gainesville, Florida, and is the largest such collection for the western Gulf. It is slightly more extensive and diverse than the collection maintained by the Texas Marine Mammal Stranding Network (TMMSN) in Galveston. Much of the material in the TCWC has been collected during the last decade through efforts of the TMMSN (Tarpley & Marwitz 1986; Tarpley 1987); however, there are a number of animals obtained by workers, supervised by David J. Schmidly during the 1970's. This facility also houses some of the earliest reported specimens in the literature for the Gulf of Mexico (Gunter 1941a; 1941b; 1946).

The following is a listing of the marine mammal specimens from the western Gulf of Mexico maintained by the TCWC, with a brief summary of their pertinent data. Available data for each specimen are given as to collection locality, date of collection, sex, catalog number, type of material (skull = cranium & lower jaw, skeleton = post-cranial material). Measurements, when available, are total length in cm = TL (obtained from stranding reports or literature) and condylobasal length in mm = CBL (obtained by the senior author, following Perrin 1975 or from the literature). In a few instances there are supplemental remarks regarding specific animals or taxa. Additional details for many localities are available from the TCWC. For most specimens obtained after 1980, additional information regarding circumstances of their recovery and necropsy can be obtained from the TMMSN, 4700 Avenue U, Building 303, Galveston, Texas 77551.

*Balaenoptera acutorostrata* Lacepede  
Minke whale

*Material examined.*—TEXAS: MATAGORDA COUNTY, Matagorda Peninsula (4 mi SW of jetty), 30 March 1988, one ♀ specimen (TCWC 52892; skull & skeleton; TL 579 cm).

*Balaenoptera edeni* Anderson  
Bryde's whale

*Material examined.*—LOUISIANA: PLAQUEMINES PARISH, Venice (offshore), 15 January 1975, one ♂ specimen (TCWC 39643; baleen plates; TL 841 cm).

*Remarks.*—The occurrence of this species of whale from the coast of Louisiana was reported by Shane & Schmidly (1976).

*Feresa attenuata* Gray  
Pygmy killer whale

*Material examined.*—TEXAS: MATAGORDA COUNTY, West Matagorda Peninsula, 30 March 1989, one specimen (TCWC 52893; skull & skeleton). NUECES COUNTY, Aransas Pass, 19 November 1983, one ♂ specimen (TCWC 45105; skeleton); one ♀ specimen (TCWC 48380; skeleton).

*Globicephala macrorhynchus* Gray  
Short-finned pilot whale

*Material examined.*—TEXAS: ARANSAS COUNTY, St. Joseph Island, 5 September 1945, one specimen (TCWC 3668; skull; TL 391 cm). Locality unspecified (probably Texas coast), one specimen (TCWC 50848; skull).

*Grampus griseus* (G. Cuvier)  
Risso's dolphin

*Material examined.*—TEXAS: ARANSAS COUNTY, San Jose Island, 12 February 1988, one ♂ specimen (TCWC 50948; skull & skeleton; TL 283 cm). MATAGORDA COUNTY, On beach 7.3 mi E of mouth of Colorado River, 17 December 1988, one ♀ specimen (TCWC 52894; skull & skeleton; TL 297 cm).

*Stenella attenuata* (Gray)  
Pantropical spotted dolphin

*Material examined.*—TEXAS: GALVESTON COUNTY, Bermuda Beach, Galveston Island, 2 July 1988, one ♀ specimen (TCWC 52897; skull & partial skeleton; TL 198 cm). KENEDY COUNTY, Padre Island National Seashore, 3 April 1988, one ♀ specimen (TCWC 52896; skull & skeleton; TL 121 cm). NUECES COUNTY, Locality unspecified, 7 April 1988, one ♀ specimen (TCWC 50941; skull and skeleton; TL 199 cm; CBL 414 mm). Locality unspecified (probably Texas coast), one specimen (TCWC 50851; skull).

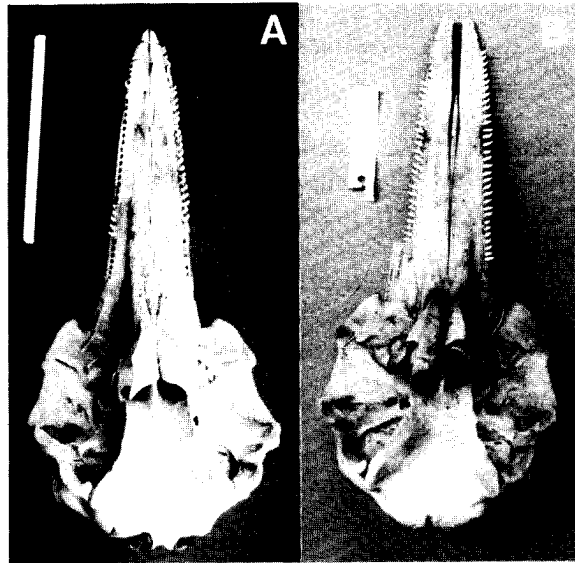


Figure 1. Crania of two specimens of *Stenella clymene*, both at various times given the number TCWC 25575. A. "Hildebran's specimen" (currently TCWC 52870). B. LSUMZ 18519. From ventral view, the skulls can easily be distinguished from the broken left pterygoid of LSUMZ 18519.

*Stenella clymene* (Gray)  
Clymene dolphin

**Material examined.**—TEXAS: BRAZORIA COUNTY, Bryan Beach, 5 February 1986, one ♂ specimen (TCWC 50934; skull & skeleton; TL 168 cm; CBL 375 mm). GALVESTON COUNTY, Galveston, 14 September 1987, one ♀ specimen (TCWC 50947; skull & skeleton; TL 176 cm). KLEBERG COUNTY, Padre Island National Seashore, 11 March 1985, one ♀ specimen (TCWC 50936; skull & partial skeleton; TL 186; CBL 378 mm); 9 September 1986; one ♂ specimen (TCWC 50937; skull & skeleton; TL 186 cm; CBL 364 mm). NUECES COUNTY, Yarbrough Pass, Padre Island, 19 September 1971, one ♂ specimen (TCWC 25576; skull; TL ca. 175 cm; CBL 372 mm); one specimen (TCWC 52870; skull; TL ca. 175 cm; CBL 390 mm). 6.9 mi S. Access Rd., 26 April 1984, one ♂ specimen (TCWC 50938; skull; TL 178 cm; CBL 365 mm). Port Aransas, 27 October 1984, one ♂ specimen

(TCWC 50939; partial skeleton; TL 176 cm); one ♀ specimen (TCWC 50940; skeleton; TL 171 cm). Locality unspecified (probably Texas coast), one specimen (TCWC 50847; skull).

**Remarks.**—In the past there has been confusion regarding the catalog number of TCWC 52870 and a second specimen (Figure 1). Three dolphins stranded at Yarbrough Pass, Texas in September of 1971 were originally identified as *Stenella frontalis* (cf. Schmidly et al. 1972; Schmidly & Shane 1978). Skulls from two of these dolphins were deposited in the TCWC and were assigned the catalog numbers 25575 and 25576. In 1974, TCWC 25575 was transferred to Louisiana State University Museum of Zoology, where it was renumbered LSUMZ 18519. The skull of the third animal of this stranding was retained for some time at the University of Corpus Christi (now Texas A&M University at Corpus Christi) and was referred to by Schmidly et al. (1972) and Perrin et al. (1981) as "Hildebran's specimen." This skull appears to have been subsequently deposited in the TCWC. This conclusion is based on information written on a specimen in the TCWC and agreement between measurements of this skull and ones given by Schmidly et al. (1972) for the Hildebran specimen. Upon its deposition in the TCWC, it appears that the Hildebran specimen was mistakenly assigned the TCWC catalog number 25575. Following the realization that this specimen had been given an occupied number, it was reassigned as TCWC 52870. Perrin et al. (1981) reidentified all three of these animals (TCWC 25576, 52870, LSUMZ 18519) as *S. clymene*.

*Stenella coeruleoalba* (Meyen)  
Striped dolphin

**Material examined.**—TEXAS: GALVESTON COUNTY, Bolivar Peninsula, Crystal Beach, 14 April 1986, one specimen (TCWC 50942; skull & partial skeleton; TL 204 cm; CBL 414 mm). JEFFERSON COUNTY, 17 September 1986, one ♂ specimen (TCWC 50935; skull & skeleton; TL 166 cm; CBL 412 mm). NUECES COUNTY, Mustang Island, 20 April 1985, one ♂ specimen (TCWC 50943; skull & partial skeleton; TL 209 cm; CBL 407 mm).

*Stenella frontalis* (G. Cuvier)  
Atlantic spotted dolphin

**Material examined.**—TEXAS: GALVESTON COUNTY, 2 mi W of High Island, 25 February 1967, one specimen (TCWC 21358; skull; CBL 420 mm). NUECES COUNTY, Port Aransas, summer of 1940, one specimen

(TCWC 1543; skull). Padre Island (19 mi SE of Corpus Christi), 3 September 1965, one ♂ specimen (TCWC 25577; skull; CBL 449 mm). Locality unspecified (probably Texas coast), one specimen (TCWC 50850; cranium).

*Remarks.*—The only data directly associated with TCWC 1543 is that of its collector (G. Gunter); however, it is quite likely this animal is the same as that reported by Gunter (1941b) as *Stenella plagiodon*. This conclusion was made because both specimens (TCWC 1543 and that of Gunter, 1941b) have the same collector plus similar measurements and characteristics. The genus *Stenella* was recently revised by Perrin et al. (1987).

*Stenella longirostris* (Gray)  
Spinner dolphin

*Material examined.*—TEXAS: JEFFERSON COUNTY, Sabine Pass Beach, 16 May 1974, one specimen (TCWC 28286; skull, scapula & flippers; TL 156 cm; CBL 361 + mm). KLEBERG or NUECES COUNTY, Padre Island (4 mi S of Malaquite Beach), 3 March 1975, one specimen (TCWC 29035; skull; TL 188 cm; CBL 420 mm). NUECES COUNTY, Mustang Island, 1 June 1987, one ♂ specimen (TCWC 50946; skull and skeleton; TL 190 cm; CBL 418 mm).

*Steno bredanensis* (Lesson)  
Rough-toothed dolphin

*Material examined.*—TEXAS: GALVESTON COUNTY, West end of Galveston Island, June 1969, one ♀ specimen (TCWC 50914; skull & skeleton; TL 234 cm). Bolivar Peninsula, Crystal Beach, 6 September 1985, one ♂ specimen (TCWC 50915; skull & partial skeleton; TL 254 cm).

*Remarks.*—The specimen TCWC 50914 is represented by an articulated skeleton that was formerly on display at a marine park (Sea Arama) in Galveston, Texas.

*Tursiops truncatus* (Montagu)  
Bottlenose dolphin

*Material examined.*—TEXAS: ARANSAS COUNTY, Atwell, Aransas Refuge, January 1940, one specimen (TCWC 1071; partial cranium). 2

mi NNE of Fulton, 1958, one specimen (TCWC 9470; skull & miscellaneous skeletal parts). Rockport (N side of Key Allegro Island), 25 March 1988, one ♀ specimen (TCWC 50916; lower jaws & skeleton; TL 225). E side of Aransas Bay, 3 October 1990, one ♀ specimen (TCWC 52903; skull & skeleton; TL 189 cm). BRAZORIA COUNTY, Surfside beach, 15 March 1985, one ♀ specimen (TCWC 50926; skull & skeleton; TL 166 cm). CAMERON COUNTY, South Padre Island, 17 January 1986, one ♀ specimen (TCWC 50917; partial skeleton; TL 221 cm). CHAMBERS COUNTY, 20 mi SW of Sabine Pass, 17 November 1985, one ♂ specimen (TCWC 50918; skull & skeleton; TL 219 cm). GALVESTON COUNTY, 7 mi W of Galveston, 17 March 1939, one ♂ specimen (TCWC 1089; skull). Pelican Island, Galveston Channel, 28 June 1977, one specimen (TCWC 44003; cranium). Galveston, 13 April 1984, one ♂ specimen (TCWC 49004; skull & skeleton; TL 114 cm); 15 December 1984, one ♂ specimen (TCWC 49006; skull & skeleton; TL 147 cm); 22 January 1986, one ♀ specimen (TCWC 50933; partial skeleton; TL 227 cm). Galveston Island, 3 December 1985, one ♂ specimen (TCWC 49010; skull & skeleton; TL 266 cm); 3 January 1985, one ♀ specimen (TCWC 50927; skull & skeleton; TL 247 cm); Beach Pocket Park, 19 April 1984, one ♂ specimen (TCWC 49005; skull & skeleton; TL 225 cm); Stewert Beach, 12 March 1985, one ♀ specimen (TCWC 49007; skull & skeleton; TL 204 cm); East Beach, 12 March 1985, one ♂ specimen (TCWC 49008; skull & skeleton); Big Reef Beach, 19 November 1984, one ♂ specimen (TCWC 50929; skull & skeleton). Bolivar Peninsula, 14 March 1986, one ♀ specimen (TCWC 49012; skull & skeleton; TL 245 cm); Crystal Beach, 12 March 1985, one ♀ specimen (TCWC 49009; skull & skeleton; TL 264 cm); 7 January 1989; one ♀ specimen (TCWC 50931; skeleton; TL 233 cm); High Island, December 1985, one ♀ specimen (TCWC 49011; skull & skeleton; TL 242 cm); 6.5 mi W of Bolivar Ferry Landing, 21 November 1987, one ♀ specimen (TCWC 50919; skeleton; TL 253 cm). Gilchrist, 19 April 1984, one ♂ specimen (TCWC 49014; skeleton; TL 274 cm); 13 March 1988, one ♂ specimen (TCWC 50928; skull & skeleton; TL 212 cm). Gilchrist area, 14 April 1986, one specimen (TCWC 50930; skull & skeleton). HARRIS COUNTY, San Jacinto River, 27 February 1987, one ♂ specimen (TCWC 50920; partial skull & partial skeleton; TL 237 cm). JEFFERSON COUNTY, 20 August 1986, one ♂ specimen (TCWC 49013; skull & skeleton; TL 262 cm). 21.8 mi E of Rollover Pass, 26 July 1987, one ♀ specimen (TCWC 52906; partial skeleton; TL 250 cm). 14.5 mi W of McFaddin National Wildlife Refuge, 22 February 1990, one ♀ specimen (TCWC 52907;

skull; TL 251 cm). **KLEBERG COUNTY**, Padre Island National Seashore, 1 March 1988, one ♂ specimen (TCWC 50932; skull; TL 179 cm). **MATAGORDA COUNTY**, East Matagorda Bay, 21 January 1990, six ♀ specimens (TCWC 52858; skull & skeleton; TL 240 cm); (TCWC 52862; skull & skeleton; TL 245 cm); (TCWC 52863; skull & skeleton; TL 216 cm); (TCWC 52864; skull & skeleton); (TCWC 52880; skeleton; TL 176 cm); (TCWC 52882; skull & partial skeleton; TL 220 cm); four ♂ specimens (TCWC 52859; partial skeleton; TL 288 cm); (TCWC 52860; skeleton; TL 270 cm); (TCWC 52861; skull & skeleton; TL 262 cm); (TCWC 52885; skeleton; TL 225 cm); 22 January 1990, three ♂ specimens (TCWC 52865; skull & skeleton; TL 191 cm); (TCWC 52867; skull & skeleton; TL 216 cm); (TCWC 52868; skull & skeleton; TL 269 cm); five ♀ specimens (TCWC 52866; skull & skeleton; TL 282 ± 5 cm); (TCWC 52869; skull & skeleton; TL 261 cm); (TCWC 52888; skeleton; TL 256); (TCWC 52890; skull, scapula & flippers; TL 207 cm); (TCWC 52891; skull & skeleton; TL 254 cm). 3.5 mi E Colorado River Pier, 21 January 1990, one ♂ specimen (TCWC 52878; skull & skeleton; TL 198 cm). 6.4 mi E of Colorado River, 21 January 1990, one ♀ specimen (TCWC 52879; skeleton; TL 235 cm). **NUECES COUNTY**, Corpus Christi ship channel, 23 January 1986, one ♀ specimen (TCWC 50921; partial skeleton; TL 228 cm). Mustang Island, Gulf beach, 1 February 1986, one ♂ specimen (TCWC 50922; skull & partial skeleton; TL 280 cm). Corpus Christi, 17 September 1986, one ♂ specimen (TCWC 50923; skull & skeleton; TL 205 cm). Corpus Christi, Oso Bay, 9 October 1986, one ♂ specimen (TCWC 50924; partial skeleton; TL 144 cm). Corpus Christi Bay, 6 March 1988, one ♂ specimen (TCWC 52900; skull; TL 115 cm). 1.2 mi N of Padre Island National Seashore, 23 March 1988, one ♂ specimen (TCWC 52901; skull & skeleton; TL 261 cm). 4.1 mi N of Padre Island National Seashore, 19 May 1987, one ♂ specimen (TCWC 50925; skull & skeleton; TL 272 cm). Locality uncertain (probably near Victoria, Victoria County), 3 March 1941, one specimen (TCWC 1537; skull). Texas coast, locality unspecified, mid 1970's, 13 specimens (TCWC 43990, 43991, 43992\*, 43993\*, 43994\*, 43995, 43996\*, 43997, 43998, 43999, 44000\*, 44001, 44002; skulls or cranium if marked with \*); one specimen (TCWC 52911; fully articulated skeleton).

*Remarks.*—The 20 specimens obtained from east Matagorda Bay in January of 1990 were probably part of the same stranding event. Varansi et al. (1992) reported the results of biochemical analysis of these specimens.

*Kogia breviceps* (Blainville)  
Pygmy sperm whale

*Material examined.*—TEXAS: **CALHOUN COUNTY**, Port O'Connor, 20 August 1974, one specimen (TCWC 29120; skull; TL ca. 321 cm). **GALVESTON COUNTY**, Galveston beach, 1 January 1984, one ♀ specimen (TCWC 48381; partial skeleton; TL 288 cm). **KLEBERG COUNTY**, Padre Island National Seashore, 19 October 1986, one specimen (TCWC 50949; skull & partial skeleton; TL 282 cm).

*Remarks.*—Unique aspects regarding beaching of the specimen from Calhoun County were discussed by Hysmith et al. (1976).

*Kogia simus* (Owen)  
Dwarf sperm whale

*Material examined.*—TEXAS: **CALHOUN COUNTY**, Matagorda Island, 23 February 1991, one ♂ specimen (TCWC 52908; skull & partial skeleton; TL 216 cm). **MATAGORDA COUNTY**, Matagorda Peninsula, 3 November 1985, one ♀ specimen (TCWC 50950; partial skeleton; TL 142 cm).

*Mesoplodon densirostris* (Blainville)  
Blainville's beaked whale

*Material examined.*—TEXAS: Locality unspecified, one ♀ specimen (TCWC 50856; skull).

*Remarks.*—Based on the preparator's name and number on the tag accompanying this specimen, it is part of a consecutive series of three animals prepared by the same individual. Schmidly (1981) listed Matagorda Island and Nueces County as localities for an unspecified number of specimens of *Mesoplodon europaeus* housed in the TCWC. At the time of publication of the previous work, these specimens were not cataloged. They were, however, the only representatives of this genus in the TCWC until 1979. It is virtually certain that these specimens are those referred to by Schmidly (1981). This specimen is in all likelihood from either the Matagorda Island or Nueces County localities given above, but assignment to a precise locality can not, however, be determined. Subsequent to Schmidly (1981), the specific identification of the specimen (TCWC 50856) was changed to *M. densirostris*.

*Mesoplodon europaeus* (Gervais)  
Gervais' beaked whale

*Material examined.*—TEXAS: CAMERON COUNTY, South Padre Island, 11 May 1989, one ♀ specimen (TCWC 52909; skull & skeleton; TL 415 cm); one specimen (TCWC 52910; skull & skeleton; TL 285 cm). Locality unspecified, two ♀ specimens (TCWC 50855; skull); (TCWC 50857; skull).

*Remarks.*—The circumstances relative to the collection locality of TCWC 50855 and 50857 are discussed under the above Remarks section of *Mesoplodon densirostris*. While assignment of an exact locality cannot be determined, these specimens are in all likelihood from either the Matagorda Island or Nueces County localities given by Schmidly (1981).

*Ziphius cavirostris* G. Cuvier  
Cuvier's beaked whale

*Material examined.*—TEXAS: CAMERON COUNTY, Port Isabel, 19 June 1980, one ♀ specimen (TCWC 37054; skull). JEFFERSON COUNTY, 15 km W of Sabine Pass, 19 December 1984, one ♂ specimen (TCWC 51206; skull). KENEDY COUNTY, Padre Island National Seashore, one ♀ specimen (TCWC 50951; skeleton; TL 578 cm).

*Trichechus manatus* Linnaeus  
West Indian manatee

*Material examined.*—TEXAS: GALVESTON COUNTY, Bolivar Peninsula, 7 February 1983, one ♂ specimen (TCWC 49000; skull & skeleton; TL 274 cm). REFUGIO COUNTY, Copano Bay, July 1928, one ♂ specimen (TCWC 1528; skull & miscellaneous skeletal parts).

*Remarks.*—The occurrence of this species of manatee in the western Gulf of Mexico was reported by Gunter (1941a) and Fernandez & Jones (1990).

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## THE NATURE OF CHANNEL MIGRATION IN BRAZOS RIVER REACHES

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**Abstract.**—This study describes the nature of channel migration in three contiguous alluvial reaches of the Brazos River. The three reaches encompass 260 km and more than 100 years of channel development for the study indicates that the river has migrated since 1939. This change in behavior results from increased sediment loads caused by flow regulation and the effects of flow regulation on channel activity. Channel migration found in studies of freely migrating rivers. When channel migration were found, the interaction of variables responsible for channel migration of greatest significance was that 26% of the channel migration, "i.e., migration toward the base of the channel at a bend. This phenomenon, which is not a new discovery before and its significance lies in the fact that it is a predictive models of migration and planform change.

Since the 1950s, a large amount of research has been directed toward the development of meandering rivers. The study of meandering rivers threats rivers pose to structures, the effects of control structures, and to the land use (Nanson 1975). In addition, channel migration eroded or deposited in the channel. Channel migration or discharge changes can alter the nature of the riparian and aquatic ecosystems (Nanson 1980).

One of the principal problems of channel migration research concerns the nature of meandering rivers. The nature of channel planform change and channel migration research indicates that meander evolution, which few universal principles have been developed. It is generally accepted that meandering rivers migrate laterally until cutoff occurs, and channel migration is often correlated with certain aspects of channel migration.