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Preface: an overview of the Atchafalaya River

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The Atchafalaya River is one of the great rivers of the world but it is virtually unknown outside of Louisiana, USA; it is great yet obscure because of its peculiarity, its size, and its wildness. The Atchafalaya River is peculiar because it originates in central Louisiana and gains only 57 $m^3 s^{-1}$ of water as it flows 275 km to the Gulf of Mexico, yet only four rivers in North America contain more water (Table 1). This is possible because the Atchafalaya River originates where all of the water from the Red River (1,585 $m^3 s^{-1}$) meets 22% of the water from the Mississippi River (4,728 $m^3 s^{-1}$) (Fig. 1; Table 1). Its watershed includes that of the Red River (241,387 km^2) and the Mississippi River (2,978,468 km^2) as well as the floodplain downstream of its origin (4,921 km^2) (Kammerer, 1990). Waters from New Mexico, USA, Saskatchewan, Canada, and New York, USA, mingle in the Atchafalaya River, which makes its watershed the largest in North America. Basic facts of the Atchafalaya River are often obscured because different authors report its discharge, length, and watershed as various combinations of the portion downstream of its origin, the portion associated with the Red River, and the portion associated with the Mississippi River. The Atchafalaya River is also peculiar because inflow to it from the Mississippi River is managed daily, so that the Atchafalaya River contains 30% of the combined flow of the Red River and Mississippi River. This level of control is achieved with the Old River Control Structure, an engineering marvel completed in 1963 to prevent the Atchafalaya River from capturing the flow of the Mississippi River. Such capture would be a natural development in the delta lobe cycle (Roberts, 1998), but would be catastrophic to international trade dependent upon ocean-going vessels that utilize deep draft ports on the Mississippi River downstream of the Old River Control Structure, including those at the Port of Baton Rouge, the Port of South Louisiana, the Port of New Orleans, the St. Bernard Port, and the Plaquemines Parish Port.

In addition to having the largest watershed and the fifth largest discharge of any river in North America, the Atchafalaya River has one of the largest and wildest floodplains in North America. This wildness may seem a peculiar contrast to the daily human control of its inflow, but is a product of the extent of its floodplain and the large seasonal difference in water levels. The floodplain is known as the Atchafalaya

Guest editors: M. Ford & J.A. Nyman / Interactions among rivers, floodplains, and coastal areas examined at the Atchafalaya River

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Table 1 Largest ocean-discharging rivers in North America

River	Average annual discharge ($m^3 s^{-1}$)[a]	Watershed area (km^2)[b]	Length (km)[b]
Mississippi	16,792	2,978,468	3,766
St. Lawrence	9,854	1,025,635	3,058
Mackenzie	11,000	1,841,000	4,241
Columbia	7,306	668,217	1,996
Atchafalaya	6,371	246,308	2,285
Yukon	6,371	849,5416	3,186

[a] Data are from Kammerer (1990) except (1) those for the Atchafalaya which include the 4,729 $m^3 s^{-1}$ diverted annually from the Mississippi into the Atchafalaya at its origin, and (2) data for the Mackenzie are from Encyclopaedia Britannica (2002)

[b] Data are from Kammerer (1990) except those for the Mackenzie, which are from Encyclopaedia Britannica (2002)

Basin and encompasses 3,391 km^2 (ABAC, 1998), but it has almost no permanent human settlements. Agriculture is common within the upstream 20%, but downstream lies the largest intact river floodplain forest in North America (Lockwood, 1984). This wetland forest, with its bayous and lakes, spans 120 km upstream to downstream (north to south) and is 25–35 km wide (Fig. 2). It is constrained to the east and west by levees designed to contain the spring flood. Within these levees, the annual rise and fall of the river dominates biological processes, geological processes, and human activities. Water levels differ seasonally by 9.5 m (range 6.5–11.2 m) at the upstream end of the basin and by 0.9 m (range 1.1–2.1 m) at the downstream end (data from 2003 through 2008 from USGS stations number 07381490 (COE): Atchafalaya River at Simmesport, and number

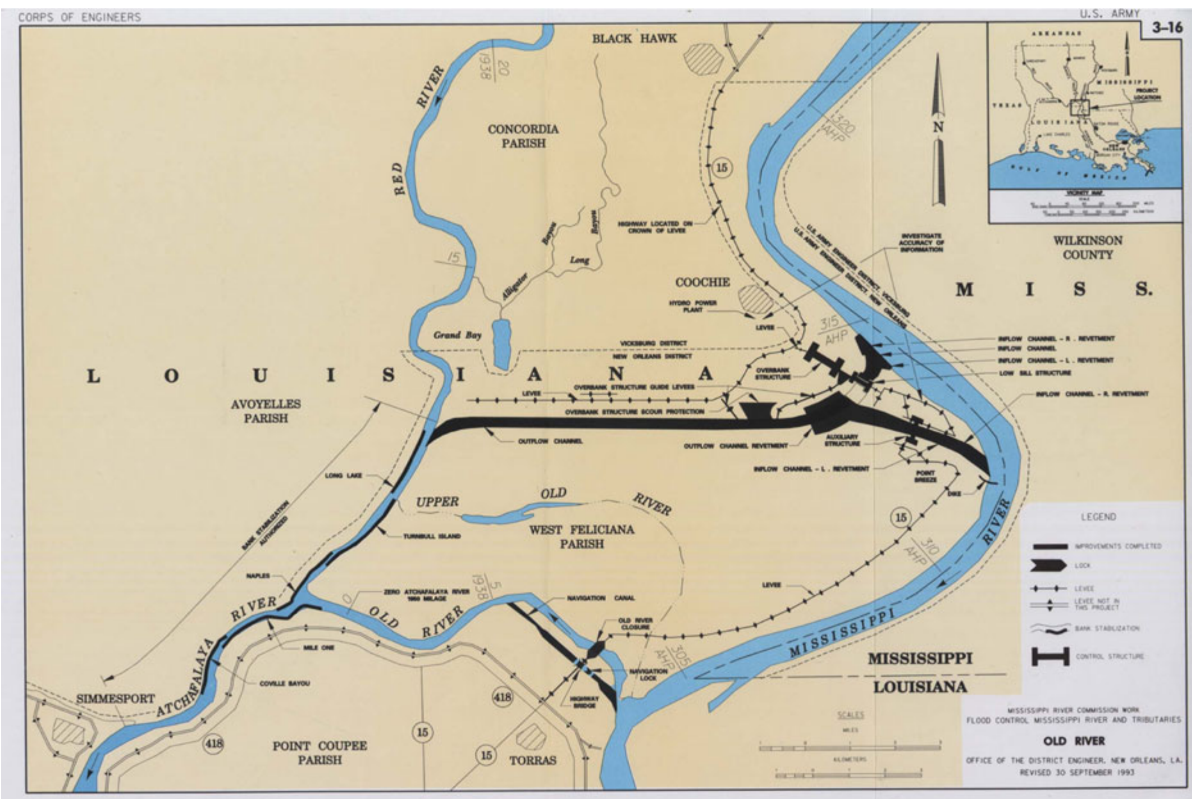

Fig. 1 Origin of the Atchafalaya River in central Louisiana, USA. From 1900 through 1950, flow from the Mississippi River through Old River into the Atchafalaya River was unregulated and increased from 7 to 25% of the flow of the Mississippi River (Reuss, 2004). Subsequently, Old River was dammed (including a navigation lock) and a new channel was built between the Mississippi River and Red Rivers (shown in *black*). This map was originally published by the U.S. Army Corps of Engineers in 1993 and is available from http://www.mvn.usace.army.mil/eng2/edsd/proj_maps/pmap_mrt2.htm. Since this map was made, a hydroelectric dam that generates electricity from the fall of the water from the Mississippi River into the new channel has been added

USGS 07381600: Lower Atchafalaya River at Morgan City). The basin is managed primarily as a floodway for the Mississippi River, but also partly for regional navigation, recreational and commercial fishing, wildlife habitat, and timber harvests. Approximately 1,619 km^2 of the basin are publicly owned, including state and federal fee title lands, federal easement lands, and state water bottoms. The remaining 1,772 km^2 are privately owned, including upland forest habitats as well as deep-water bald-cypress swamps. Forty-five species of mammals inhabit the basin, including bobcat, coyote, fox, and beaver. Small game animals like the fox squirrel, gray squirrel, and swamp rabbit live here, as well as big game species such as the white-tailed deer. Raccoon, mink and nutria are so abundant in the swamps and marshes that Louisiana was ranked first in the USA in fur production until the 1990s, when the popularity of fur garments declined worldwide. Parts of the basin also are home to the American bald eagle, in addition to the endangered Louisiana black bear, peregrine falcon, and Bachman's warbler, and are a haven for an estimated nine federal- and state-recognized endangered/threatened wildlife species, six endangered/threatened bird species, and twenty-nine rookeries. Over 40 reptilian species, including the American alligator and western cottonmouth, can be found in the basin, along with twenty species of amphibians. The wetlands of the Atchafalaya Basin provide excellent feeding and resting areas for migratory waterfowl and neo-tropical migrant birds. Over 250 species of birds can be found in the basin, including wood ducks, great blue herons and great egrets, which are common inhabitants of the shallow lakes and bayous (Atchafalaya Basin Program, 2009). Human activity in the basin also is somewhat wild, with a long history of humans living off the land, and was recently described in a memoir by Rowland & Lockwood (2006); squatter's shacks and no-trespassing signs continue to emerge on what appears to be publicly owned land (Nyman, personal observation). Management issues include, but are not limited to, the river's ever-changing channel morphology, sedimentation that is converting lakes to bald-cypress swamps and bald-cypress swamps to bottomland hardwood forests (Reuss, 2004; Hupp et al., 2008), seasonal hypoxia that kills nekton (Rutherford et al., 2001), invasive exotic plants that inhibit navigation and promote hypoxia (Colon-Gaud et al., 2004), effects of global sea-level rise and local subsidence on regeneration of bald-cypress swamps (Keim et al., 2006), and a history of unrestricted access by recreational and commercial fishers to private lands each spring when flood waters make over 1,000 km^2 of the basin accessible only by boat.

Water and sediment from the Atchafalaya River affect geomorphological, biological, and ecological processes across thousands of square kilometers of central Louisiana, south-central Louisiana, and the Gulf of Mexico. In addition to filling the basin (Reuss, 2004), sediments carried by the Atchafalaya River are driving growth of the Atchafalaya River Delta and the Wax Lake Outlet Delta, which constitute the most rapidly developing river deltas on the North American coast, as well as causing rapid progradation of parts of the coastline 100 to 150 km west of those deltas in the Louisiana Chenier Plain (Roberts & Coleman, 1996). The Atchafalaya River is thus simultaneously creating new tidal, freshwater wetlands in its delta (Shaffer et al., 1992) and creating new tidal, saline wetlands on the Louisiana Chenier Plain (USACE, 2004).

In addition to creating new coastal wetlands, the Atchafalaya River spreads freshwater and sediments across hundreds of square kilometers of existing coastal marshes in south-central Louisiana (Fig. 2). The Mississippi River historically spread freshwater and sediments across thousands of square kilometers of coastal marshes in southeastern Louisiana (Nyman et al., 2009), but those marshes now are isolated from such waters (Fig. 2) by navigation levees designed to reduce dredging costs by confining the river's flow. Such isolation, combined with rapid local subsidence, contributes to extremely rapid wetland loss in southeastern Louisiana (Day et al., 2000). Sediments from the spring flood of the Atchafalaya River indirectly help coastal marshes in south-central Louisiana offset global sea-level rise and a slower local subsidence there by promoting marsh vertical accretion via vegetative growth (Nyman et al., 2006). Freshwater from the Atchafalaya River also contributes to a slower rate of wetland loss on the central Louisiana coast than in southwestern Louisiana (Nyman et al., 2009).

Most of the sediment from the Atchafalaya River continues beyond the coastal marshes (Fig. 2) and blankets the continental shelf up to 60 km from the delta (Neill & Allison, 2005). Nutrients carried by the river fuel phytoplankton production and the resulting extensive hypoxia that develops each summer in this

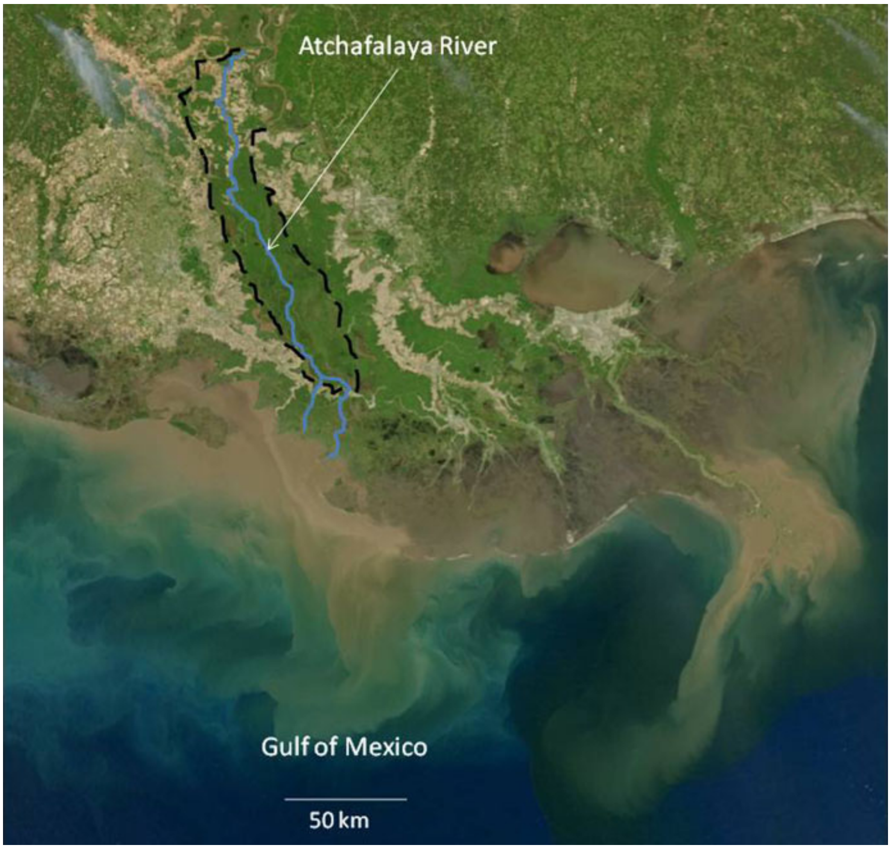

Fig. 2 Satellite image (Aqua Modis) taken on 7 April, 2009 of the south-central coast and south-eastern coast of Louisiana, USA. The location of the Atchafalaya River is indicated by the solid blue line; flood protection levees used to confine the spring flood to the floodplain are indicated by the *dashed black line*. Within these levees lies the largest river basin swamp in the USA. Muddy water from the Atchafalaya River can be seen on this image extending over 150 km into the Gulf of Mexico. For the first 50 km after water and sediments are discharged, the water depth is less than 10 m. The sediment plume from the Mississippi River, to the east, is smaller even though it delivers more sediment to the Gulf of Mexico because it is within 50 km of the edge of the continental shelf and water depths that exceed 1,000 m

region of the Gulf of Mexico (Walker & Rabalais, 2006). As with sediments, the basin is more than a conduit; it also affects nutrient dynamics and removes 14% of the nitrogen that flows into it (Xu, 2006). Some of this nitrogen is stored in the basin but some of it is near-permanently removed from the biosphere by denitrification (Lindau et al., 2008).

Understanding this complex ecosystem is challenging, not only because it is being constantly changed by the Atchafalaya River itself, but because it also is being changed by the people who use its resources.

In January 2008, The Coalition to Restore Coastal Louisiana and the Louisiana State University Agricultural Center hosted a two-day symposium: “Ecosystem Functions and the Dynamic Atchafalaya River from the Old River Control Structure to the Continental Shelf.” The symposium offered 32 presentations from experts to over 150 attendees, highlighting various functions and values of the Atchafalaya River. The purposes of this meeting were to review what was known about the river and its associated environments, to report on recent and ongoing research, and to identify information gaps that complicate decision-making by land managers, water managers, and policy makers. In this special section of *Hydrobiologia*, we present five papers presented at that symposium. Scores of other papers based on various aspects of the Atchafalaya River are almost universally published in the context of their various fields of academic study rather than in the context of a river. We offer this special section in the hope of creating synergy in understanding the functions and dynamics of rivers in general and of the great Atchafalaya River in particular.

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