French Wetland Agriculture in Atlantic Canada and Its European Roots: Different Avenues to Historical Diffusion

Karl W. Butzer

Department of Geography, University of Texas at Austin

Wetland reclamation, a form of agricultural expansion and intensification, appeared in estuarine environments of northwestern Europe during medieval demographic expansion, prior to the Black Death. It included sea walls, one-way sluice gates, drainage canals, and fields reclaimed from salt marsh. French settlers introduced estuarine reclamation to Atlantic Canada (Acadia) during the early 1600s. This article examines its readaptation in Nova Scotia. Then, for the first time, it traces the roots of this sophisticated technology back to Atlantic Europe, examining reclamation and the changing role of government in France and the Netherlands. A surge of reclamation towards 1600 reflected a new political ecology, with top-down management and intervention in response to strong economic growth. Medieval reclamation technologies in Atlantic Europe differed mainly in terms of competition or collaboration between communities, church institutions, or the aristocracy. That changed after 1600 as power became centralized and new methods and lifeways were enforced from above. This unequal contestation provoked resistance, resignation, or flight. Whereas the technology implemented in Acadia was grounded in medieval practice, few of the founding settlers came from marsh areas, drawing attention to a single possible "prime mover" who directed reclamation in the style of other professional dikemasters of the era. Didactic in purpose, the study examines changing technologies and the role of institutional structures over time and draws attention to the need for a political ecological perspective in historical diffusion studies. It concludes with a synopsis of recent research on reclamation technologies of the Guinea coast and colonial South Carolina, thereby illustrating how material culture can become part of a counternarrative in settings of sociocultural contestation. *Key Words: Atlantic Europe, cultural and political ecology, estuarine reclamation, French Canada (Acadia), West Africa.*

A millennium ago, give or take a few centuries, wetland reclamation is verified as having been present in high-energy estuarine settings of northwestern Europe and eastern China, and perhaps even earlier, on low-energy lakeshores of Central and South America. Polder reclamation in the Netherlands, reflecting the technical capacities of the industrial era, is widely familiar, but similar large-scale reclamations were already being undertaken in China during the eleventh century (Perdue 1987; Elvin and Ninghu 1998). The successful introduction of traditional estuarine-reclamation technology from northwestern Europe to Atlantic Canada during the seventeenth century (Clark 1968) is little known south of the border and has been ignored by studies of colonial-era reclamation in South Carolina and Georgia (Hilliard 1978; Carney 2001). Agricultural expansion and intensification in such widely separated areas and at roughly similar times immediately raises interesting questions of comparative technology, independent invention, and the relationships between innovation and demographic growth.

This article will address a small subset of these issues, initially focusing on French settlement in the estuarine environments along Canada's Bay of Fundy (L'Acadie), then extending the discussion to its European roots. This involves questions of both cultural and political ecology and—with the benefit of hindsight—matters of conservation. Beyond the regional focus, the goal is a deeper appreciation of the web of experience and ideas reflected in the diffusion, adaptation, and practice of a particular agrotechnology. A limitation of much of the "classical" geographical and historical work on diffusion has been that it tends to view material culture as value-free and information as primarily a matter of economic decision-making, with the assumption that cultural structures were uniform or unimportant. More challenging and ultimately informative are the searching and sorting-out processes relevant to how cultural elements are accepted or rejected, recombined, or transformed (Butzer 1988).

Although material culture has become unfashionable in the world of postmodernity, it can serve as a medium through which to examine the underlying discursive relations that form the basis for the channeling and transference of power (Butzer and Butzer 2000, 30). Material

Annals of the Association of American Geographers, 92(3), 2002, pp. 451–470

Published by Blackwell Publishing, 350 Main Street, Malden, MA 02148, and 108 Cowley Road, Oxford, OX4 1JF, UK.

culture can in fact be used as a counternarrative that emphasizes non-Western perspectives, in place of the Western metanarrative that dominates current studies of domestic architecture in the New World (Butzer and Butzer). Another such alternative metanarrative can readily be articulated for the mutual interdigitation of Old and New World food plants and condiments in both colonial and indigenous agrosystems or cuisines (see Butzer 1995).

These theoretical notions guide the present investigation, which may be of comparative interest for other colonial settings. Patricia Seed (1995) has drawn attention to the distinctive nature of colonial policy, cultural attitudes, and institutional practices of each of the European nations embarking on settlement efforts during the sixteenth and seventeenth centuries. These appear to reflect differences in national ethos, historical experience, and the time of initial colonial activity. French narratives of the 1600s are indeed more informal than Spanish writings of the 1500s. French descriptions of agricultural efforts and related technologies in Acadia are consistently informative—at times chatty or argumentative—and they often identify the role of individuals (see, for example, Denys [1672] 1908; Lescarbot [1617] 1911; Champlain [1613] 1922; Dièreville [1708] 1933). Their cartographic record is also more explicit (see Heidenreich 1976; Dawson 1988). Further, the French did not use indigenous labor, unlike the Spanish, and in Acadia they sought to establish cordial, consistent, and collaborative relationships with the Micmac, native foragers of the region (Lescarbot; Ryder 1966; Stewart 1989; Griffiths 1994; Seed, ch.2). The French New World experience can augment our comprehension of matters other than politics, warfare, and missionization in the wake of colonial settlement.

This article begins with French settlement and reclamation of the tidal marshlands of Acadia, from the early 1600s to the tragic expulsion (*Le grand dérangement*) after 1755.[1] It focuses specifically on the context of technology transfer and adaptation, themes that have precedents in earlier studies by Schott (1955), Clark (1968), and Harris and Warkentin (1974). However, much has been learned since the appearance of Andrew Clark's authoritative volume over thirty years ago.[2] For one thing, French-language authors have assembled valuable ethnohistorical information on reclamation technology in Acadia. Furthermore, family connections between France and Acadia continue to be explored. Finally, the mobilization of environmentalists to save the remaining wetlands of western France has led to the publication of new work and the unearthing of older writings relevant to the history of reclamation efforts and seventeenth-century structural links between the Low Countries and France. It is therefore possible to reexamine conventional understanding of agrotechnology transfer from France to Atlantic Canada, and to do so in an intellectual framework that does not underestimate the originality of French contributions to the North American "frontier" experience.

The first sections below examine early perceptions and experiments, the establishing of a reclamation technology, the role of population growth and social organization on field patterning, and the importance of individuals in technology transfer and adaptation. The second part turns to the history and political ecology of estuarine reclamation in western France and in the Low Countries. The basic methods were similar in both areas until top-down organization replaced more spontaneous grassroots operation when Western Europe was transformed into modernizing nation-states during the course of the seventeenth century. While the roots of Acadian reclamation draw on earlier, medieval practices, their implementation seems to have been driven by a leader with a very modern mindset. The concluding discussion compares the Acadian experience with a similar reclamation system apparently drawn from West Africa and subsequently appropriated by Southern planters (Carney 2001).

Experiments in a New Environment

The tidal range of the Bay of Fundy (Ganong 1903) is the greatest on Earth, owing to a special coastal configuration (Figure 1). Twice a day the tides surge noisily into the Minas Basin at velocities of up to 7 km/hr, raising the water level 14 to 15 m and then receding again. In other embayments, the tidal amplitude is less but also significant—witness 8.5 m in the Annapolis Valley. Tremendous quantities of brick-red silt and clay are swept back and forth across the estuarine mudflats, or carried far upstream to spill onto floodplains. Eroded from submarine sandstones and shales, these tidal deposits represent some of the most fertile soils in an environment dominated by glacially scoured igneous rocks.

A fortified French compound was first set up in 1605 some 8 km downstream of the future site of Port Royal (Annapolis) (see Champlain [1613] 1922, plate 67), where the Annapolis River opens into the tidal bay known as the Annapolis Basin. Further upstream, the French found "almost continuous meadows (*prairies*)" crossed by tree-lined rivulets that descended from the uplands (Lescarbot [1617] 1911, 2:314–16). The rich grass of these meadows grew on an organic mat, some 60 cm thick, composed of interlaced grass roots (*herbes*) and silt (*limon*). Such mats could be used to cut sod blocks (*gazons*) to cover wood being charcoaled (Lescarbot 2:321, 355).

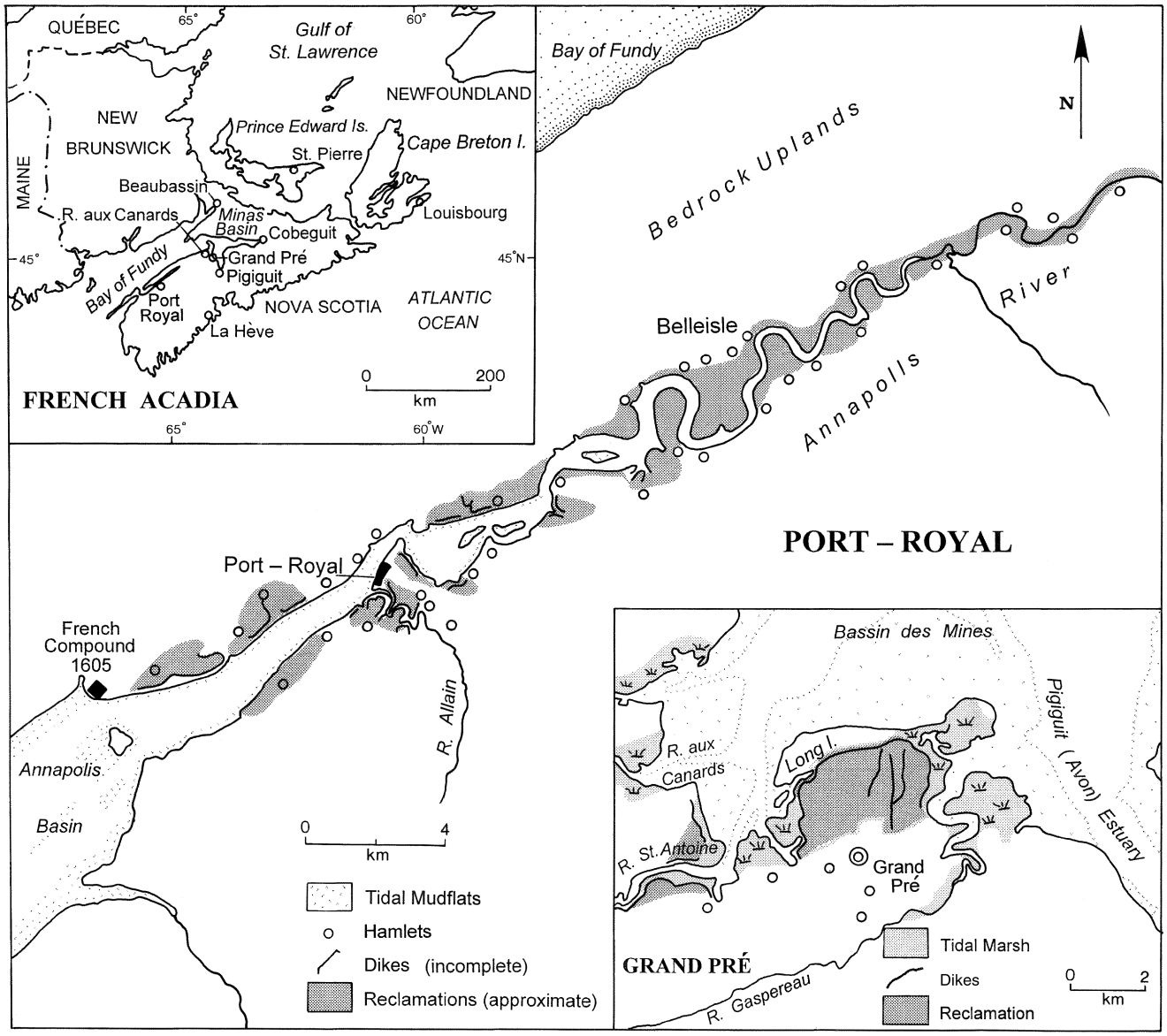

Figure 1. Reclaimed salt marsh at Port Royal and Grand Pré, Nova Scotia, early eighteenth century. *Sources:* Settlement features in part after Harris and Matthews (1987, plates 29 and 31), Dawson (1988, maps 2.3, 4.2), and Gaudet (1974).

The meadows were attributed to the high tides that spilled over the banks, especially during the spring tides of March and September (2 m higher than neap tides). The flooding did not allow trees to take root, since areas not so inundated had timber (Lescarbot 2:321, 555).

Although tidal mudflats are not explicitly mentioned, Champlain's map ([1613] 1922, plate 67) delineates them along the river, much as they are today: relatively narrow in view of the deep channel (4–6 fathoms, or 7.5–13 m). At some point far upstream, the saltwater high tides change over to a freshwater tidal bore. According to Champlain (258), tidal marshes extended 65–70 km (14 or 15 leagues) upstream (by river), beyond which the banks were forested and channel depth was 1.5 fathoms (2.7 m). As to attention to detail, Lescarbot ([1617] 1911, 2:347, 571) and a map by W. F. Ganong (in Champlain, 440) noted that salmon came up to sport in the fresh water of a gristmill weir, built on a tributary at the outer edge of the marshland, for the two hours of highest tides.

The French promptly experimented with gardening, something that must have been of interest because three individuals with different background experiences attempted to find distinct solutions to the shortage of familiar, fresh foods: (1) Samuel de Champlain (c. 1570–1635), the later founder of New France, was active as an

explorer and cartographer on the eastern seaboard from 1603 to 1609 (Trudel 1966; Heidenreich 1976); (2) Marc Lescarbot (c. 1570–1642), a lawyer and humanist, spent 1606 and 1607 in Acadia as a prominent guest (Baudry 1966a); and (3) Jean de Poutrincourt (1557–1615), aristocrat and military officer, was commander of the first ephemeral colony from 1605 to 1607 (Ryder 1966).

Even as the French compound was being built, Champlain was making "gardens" (*iardins*) in the adjacent marshland. Three or four rectilinear fields are schematically shown on his map, the borders aligned with minor watercourses (Champlain [1613] 1922, plate 67, point "B," and plate 76, as interpreted in a map by Ganong, facing p. 373).[3] One of these he "also surrounded with ditches full of water," which he stocked with trout. Further, "there I made a small sluice against the seashore, to drain off the water when I wished"[4] (Champlain, 371; author's translation). He added a small pond for saltwater fish. Sluices are integral to dikes (see below) and serve to drain fresh waters while keeping out saltwater.

The fact that Champlain was born in the marshlands of western France supports the notion that he introduced some form of estuarine drainage, although he makes no mention of whether his garden was successful or not. He came from Brouage, in his day a seaport 35 km south of La Rochelle, and situated on the major dike (now followed by the highway) that once separated the salt pans of the Marais de Brouage from the open sea (see Morse 1935, 2:121–24; Verger 1988, 350–51, figs. 167–68).

Arriving in Acadia a year later, Lescarbot also kept busy by gardening. "I set myself to prepare the soil, and to make enclosures and garden compartments, in order to sow vegetables and kitchen herbs" (Lescarbot [1617] 1911, 2:319, 554; author's translation). By implication, his plots were closer to the compound, one of two other gardens on Champlain's map ([1613] 1922, plate 67), neither of them shown surrounded by ditches. Lescarbot's description contrasts with the vocabulary and concepts embedded in that of his rival, Champlain. Born and raised in a small town of interior northeastern France (Baudry 1968a), Lescarbot was probably familiar with gardening, but not reclamation.[5]

Poutrincourt chose to demonstrate the fertility of higher lying land, setting up experimental plots behind the future site of Port Royal in midsummer 1606. He even ordered a second tillage (*labourage*), before sowing winter wheat,[6] rye, hemp, and vegetables—which did quite well (Lescarbot [1617] 1911, 2:317–18, 346–47, 552–53, 570; see also Champlain [1613] 1922, plate 67). Although he championed an agricultural colony, Poutrincourt was probably raised at the royal court, and his choice of site was very traditional, but poorly targeted in regard to soil quality. That may help explain why the remaining settlers were found near starvation in 1611 (see Ryder 1966).

Although Champlain provides a tantalizing connection with reclamation, he moved on to Québec, and the British destroyed the settlement in 1613. Whether any French cultivation persisted thereafter is dubious, since thirty of seventy new Scottish settlers during the period between 1629 and 1632 died of malnutrition (Harvey 1966; MacBeath 1966a). But perhaps Champlain planted an idea that bore fruit only later.

The Founding of Acadia

Reminded of the strategic value of Acadia, Cardinal Richelieu supported a fresh colonization in 1632. It was led by Isaac de Razilly (1587–1635), a naval captain and aristocrat from the interior province of Anjou (MacBeath 1966b). He commanded a naval squadron against the Huguenots around La Rochelle between 1621 and 1628 and was subsequently wounded in the siege of that Protestant stronghold, strategically located between several key French marshlands.

In 1632, Razilly landed a group of 200 to 300 soldiers, craftsmen, and workmen at Le Hève, near Lunenburg, Nova Scotia. These included somewhere between twelve and twenty families of colonists, who were set to farming (Massignon 1963; MacBeath 1966b). By the time of Razilly's premature death in 1635, the number of settler families had apparently grown to forty (Denys [1672] 1908, 482). This venture illustrates the systematic nature of French colonization: (a) a large group of contract laborers (usually called *engagés*), who received free passage in order to spend up to three years in Canada, to build the necessary infrastructure; after that, most returned to France, although some remained as settlers (Choquette 1997, 21); (b) a small force of soldiers to protect the settlement, fur-trading activities, and shipping against British attack; and (c) the actual settlers, mainly married, their ranks swelled by those engagés and soldiers who opted to stay.

Razilly was succeeded by his lieutenant and cousin, Charles de Menou d'Aulnay (c. 1604–1650) (Baudry 1966b; Larin 1994, 95–100), who shared some of his naval exploits around La Rochelle during the mid-1620s. D'Aulnay and Razilly's brother recruited further engagés and settlers in 1636, including five salt-makers from Saint Onge, Basque carpenters, twenty craftsmen from Burgundy; forty farm-laborers from Anjou or Touraine, and colonists from the hinterland of La Rochelle (Aunis) (Godbout 1944; Massignon 1963; Roy 1980; Choquette

1997, 84, 260–63). Although almost all of these returned to France, some 120 permanent settlers appear to have come to Nova Scotia by 1650 (MacBeath 1966b), in part via family or seigneurial recruitment, many of these from the d'Aulnay estates south of Loudun[7] (Massignon; more impressionistically, Bujold and Caillebeau 1979). That is the background of the founding settlement, which moved from La Hève to Port Royal between 1635 and 1640.

How does this relate to the initiative and experience necessary to inaugurate marsh reclamation along the Annapolis River? One view is that the "salters" of Saint Onge were instrumental, being skilled in trapping seawater within diked enclosures. The salters arrived in 1636; finding conditions for evaporation poor at Port Royal, they may have turned to the analogous task of draining saltmarsh (Rameau de St. Père 1889, v.1, 115; Erskine 1976, 21; LeBreton 1980; Cormier 1990, 23–29; Leonard 1991). In any event, none of the surnames of the five salters (see Godbout 1944) remained on record in Acadia.

More direct is the eyewitness testimony of Franciscan missionary Père Ignace ([1653] 1883, 138; author's translation) that, in 1650, d'Aulnay himself was personally involved in reclamation, coming out "to set stakes, lay out lines, and mark with cords a new piece of land to drain."[8] In other words, the governor was directly engaged in the surveying of a new dike. Although the salters had presumably returned to France a decade earlier, d'Aulnay may well have learned the procedures from them. Naval officers like d'Aulnay were expected to know instrumentation and at least some surveying, and since the military actions around La Rochelle involved defensive breaching of the dikes and flooding of the marshland, it is plausible that he became familiar with the principles of reclamation during his naval service. Another possibility is that grassroots experience in reclamation was introduced by the minority of settlers from the hinterland of La Rochelle, which directly adjoined the salt marshes of Poitou and the Charente. That is as far as the issue can be followed at the moment: d'Aulnay himself surveyed and directed reclamation works, but he may also have relied on the special skills of salters or marsh farmers from the region of La Rochelle. The derivation of the majority of settlers from well-drained inland areas was not critical.

From 1654 to 1670, Acadia was again under British occupation, and presumably cut off from the peak of French migration to North America (1655–1670; Choquette 1997, 169). What happened in the interim is implicit in the census of 1671 (NAC 1671). The census found some fifty-three farmers scattered along the Annapolis River marshes (see Figure 1), with salt-marsh diking and cultivation documented by twenty-four *boisseaux*—that is, *aboiteaux*, or sluice and dike complexes.[9] It described some forty-seven men as *laboureurs* (farmers), five as *tonneliers* (coopers—i.e., makers of casks and barrels), two as carpenters, and two as *armuriers* (makers of harnesses and weapons), with single entries for a weaver (*texier*), a shoeing-smith (*mareschal*), a sailor (*matelot*), a cutler (maker of iron edge-tools, given as *tailliandier*), a tailor (*tailleur*), and a stone mason (*macon*). Since all of these artisans were actually raising animals and lived along the river, and thirteen of fifteen owned land, their skills were presumably used part-time. One is identified as a sailor, suggesting that, as a group, some of these individuals may have been socially differentiated from the other farmers, because they had come to the colony as craftsmen and so on, rather than as settlers. The emphasis on barrel-making may suggest grain exports, and the presence of four ironworkers implies that iron continued to be available through import. In conjunction with the archaeological evidence for expensive kitchenwares (Choquette 1997, 288–89, n. 53) this speaks for trade with New England during the interim and argues against the idea of a "subsistence" economy during the British occupation. Nor does the number of children—with a ratio of 3.8 per couple (see NAC [1671])—suggest a population chronically stressed by food shortfalls. However, reclaimed land appears to have been scarce, with seven of the laboureurs (aged 21 to 56) owning no farm plot. These were "day laborers," many of them—married or not—working as dependents on the family farm.

The population of the Port Royal colony reached 356 (Trudel 1997, 604), and daughter colonies soon began to drain off the surplus to Beaubassin (Cumberland Basin) after 1671 and Grand Pré (Minas Basin) after 1680.

An Evolving Reclamation Technology

Contemporary and other sources give a good idea of Acadian reclamation technology. The merchant-naturalist Sieur de Dièreville ([1708] 1933) (Rousseau 1966), who spent 1699–1700 in Port Royal, explained the different ecology of marsh and upland soils. He reported that when the forested uplands were cleared, they were unsuited for grain cultivation, requiring scarce manure and even then yielding poorly. Wheat was grown on the marshland (*prairie*), but only after it was first drained, at great expense of labor,

> by means of powerful dikes called *aboteaux* . . . five or six rows of large logs are driven whole into places where the sea enters the marsh, and between each row they place other logs lengthwise, one atop the other, then carefully filling all the voids with packed clay, so that water can no longer pass

> through. They (then) fit a sluice (*esseau*) in the middle of these works in a way that marsh water can push its way out at low tide, while stopping the (high) tide from entering. Works of this type cannot be undertaken except during times when the tide does not rise so high. They cost a great deal and require many days to make, but the abundant harvest reaped as early as the second year, after the rain has flushed out the soils, compensates for all the effort (Dièreville 1933, 258; author's free translation).

What Dièreville described is the specific anchoring of a dike-and-sluice system *within* a tidal inlet, as can be better understood with the benefit of the technology that survives today or is recorded on twentieth-century photographs (LeBreton 1980; NSDAM 1987, figs. 19–32; Cormier 1990, 52–57, figs. 9–21). This is far more difficult than building running dikes *between* inlets. To incorporate a tidal creek within a dike system requires not only a foolproof drainage gate but also a stable bulwark at points where the tidal force is greatest. Yves Cormier (1990, 44–57) explained how stakes are first driven in, parallel to the axis of the inlet, to anchor successive timber mats of spruce branches and beams on the sloping banks; this framework is then extended across the inlet and filled in with packed clay. The sluice (*dalle*) is at the lowest point, and consists of a long wooden box, reinforced in front by heavy beams and incorporating a clapper valve that can only swing open in one direction, to allow draining waters to run seaward (Cormier 1990; LeBlanc and LeBlanc 1993; see also NSDAM 1987, figs. 12–13). Dièreville used the term *esseau*, with its secondary implication of a "shingle," to describe the clapper valve. In functional Acadian diked marshes, the ditched fields drain towards a canal behind the dikes (a *contre-ceinture*) that empties upstream of the completed aboiteau (LeBlanc and LeBlanc 1993, fig.1), which forms the centerpiece of the complex.

Aboiteaux were also distinguished from regular dikes in Colonial times. French-Swiss settler Isaac Deschamps lived near Grand Pré before the Expulsion (Tratt 1969). Writing after 1760, he noted that dikes generally are "eleven or twelve feet thick at the base and slope upward until they become a foot and a half thick at the top, and are five feet in height" (quoted in Morse 1935, 1:46). The massive dams built across large creeks were more massive, however, incorporating "spruce brush and sods from the salt marshes, with large sluices holding two or three gates to stop the seawater and draw off the freshwater" (Deschamps; see Morse 1935, 1:46–47); dimensions were adjusted according to the size of the creek.

Archaeological excavations at Grand Pré confirm this information. In a dike along the Gaspereau River, horizontal tree trunks were found anchored by pairs of stakes on both sides of the dike; mud and salt-marsh sods were then placed between and over the tree branches to a height of at least a meter (Korvemaker 1993, 44–45), much as described by Dièreville. What remains of one Acadian aboiteau on the seaward side of the modern main dike consisted of sawed timbers joined by wooden dowels, with a row of stones as a foundation; this was covered in part by alternating layers of mud and brush, and then by "several feet" of mud (Korvemaker, 43–44). This appears to resemble more recent aboiteaux facing the sea, with both faces of the conduit reinforced by planking (Cormier 1990, fig. 20).

In effect, the technology developed before the Expulsion was elaborate and subsequently maintained with little change, and indeed some of the remaining Acadians in 1764 were hired to supervise construction of aboiteaux (Crane 1819). Similarly, in 1765 some new New England settlers petitioned to allow Acadians to remain through the summer, because they were indispensable for repairing and making dikes and "without their further assistance many of us cannot continue our improvements, nor plough nor sowe our lands, nor finish the Dykeing still required to secure our lands from salt water" (see Innis 1929, 195). When the Acadians were phased out, the British settlers essentially continued diking with the established Acadian methods described by Crane (see also NSDAM 1987, ch. 7).

Acadian reclamation was not primitive but complex, elaborate, and variable. It fits well within the range of premodern reclamation practices documented for Atlantic Europe, as discussed below. The major difference is that Acadian reclamation was implemented on a smaller scale, given the small population. In western France and the Low Countries, medieval reclamation was carried out by communities, religious orders, or minor aristocracy. In Nova Scotia, it was in the purview of one or more extended families, with only one example of more complex community engagement.

Parcellation and the Organization of Marsh Reclamation

A little-noted feature of Acadian settlement in peninsular Nova Scotia is that marsh farmlands expanded rapidly under British control to the very eve of expulsion. The evidence comes not from census data, which were last gathered in 1730, but from cartographic documentation at Port Royal and Grand Pré. The survey maps in question further encode valuable information on the organization of reclamation.

Shortly before the definitive English occupation of Port Royal in 1710, military engineer Jean Delabat

showed the northwest side of the Port Royal peninsula as a tract of tidal inlets, closed off by a running dike and labeled the "*marais des landris*" and the "*marais du Pellerin*" (Dawson 1988, map 2.3, a photocopy of Ayer 90 MS map 78 in the Newberry Library). This version indicates both divisions as cultivated, but another unidentified copy of the same map (redrawn by Jean Daigle in Harris and Matthews 1987, plate 29) shows only the Pellerin part as farmland. On John Hamilton's 1753 survey (Dawson 1988, map 4.2, an indistinct photo of NAC 1753, CAAD, NMC 18312), these marsh tracts have been divided into some fifty units, each with up to a dozen or more parallel fields, covering almost 40 ha in all (Figure 2A). The larger units have a modal size of 40 by 175 m (0.7 ha), although dimensions are highly variable, and widths range from 28–60 m.

On the southern side of Port Royal, on the Allain River, the change from 1709 to 1753 is even more striking in tracts belonging to three other families. The aboiteaux clearly under construction here around 1709 had been expanded to enclose an area about a third greater by 1753, although not all of the enclosed land was subdivided by apparent canals, and some dikes were evidently incomplete.

Expansion of agriculture in the tidal marshland adjacent to the town of Port Royal was apparently related to a shortage of farmland in the Annapolis Valley as well as to conflicts over commonage originally assigned for grazing (see Rameau de St. Père 1889, 2:337–38). Symptomatic of the problem was the outmigration of some 600 settlers to new locations around the Bay of Fundy during the 1680s and 1690s, so much so that the population of the Port Royal colony declined from 592 in 1686 to 447 in 1701 (Rameau 1889, 1:195; 2:399). In the interim, the population of the new outlying settlements grew from a single family in 1671 to almost 700 people in 1701, when internal migration essentially ended. At that point, the number of settlers in the Annapolis Valley exploded, doubling to 914 in 1714 (Rameau 1889, 2:16), despite only minimal immigration from France (sixty-six people from 1671 to 1707; Daigle 1994). Reclamation of the tidal marshes near Port Royal during the half-century before the Expulsion represented an alienation of commonage, at a time when good land was at a premium.

In the Annapolis Valley, the reclaimed marshland lay below the farmsteads of extended families that evolved into clustered or linear hamlets along the base of the upland. Given the distribution of estuarine land along the alternating convex and concave bends of the Annapolis River, reclamations were discontinuous or segmented, but linear in the bigger picture. The pattern at Grand Pré (Horton Township) (Figure 1), surveyed by the British from 1761 to 1764 (McNabb 1986; Harris and Matthews 1987, plate 31), was very different. Here, the subdivisions of the diked marshland, which represent close to 200 abandoned Acadian lots, form a large, dense cluster of almost 1100 ha (Bleakney forthcoming).

On first impression, this large-scale system at Grand Pré resembles a planned settlement, dominated by alternating strips of long lots or by blocks of rectangular ones, averaging about 3.5 ha in size (Figure 2B). However, there is no historical evidence that a parish priest, *seigneur* (nobleman), or other government agent was engaged in the process of subdivision or allocation.[10] Sherman Bleakney (forthcoming) reconstructed the traces of original tidal creeks on the basis of aerial photography. By comparing this with the pattern of dikes and canals, he was able to identify a dozen or so stages in the construction of new dike walls, each of which allowed reclamation of new tracts ranging in size from 43 to 138

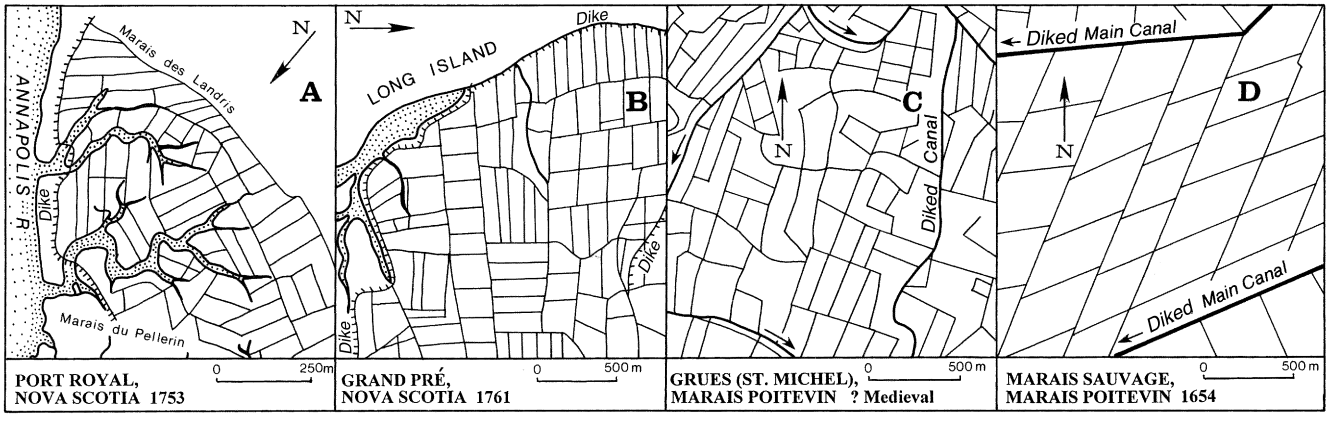

Figure 2. Field parcellation in Nova Scotia compared with that of the Marais Poitevin, France. *Sources:* (A) based on Dawson (1988, plate 4.2); (B) in part after Harris and Matthews (1987, plate 31); (C) and (D) modified after IGN (1999).

ha. In effect, this was a grassroots effort, realized in progressive increments through the efforts of the whole community.

Excluding Gaspereau and other valleys of the Minas Basin, Grand Pré had 48 families and 287 people in 1714 (Rameau 1889, 2:403–11). The population in the early 1750s can only be estimated: 1000 communicants (i.e., about 1300 people) but a little reduced by emigration, according to parish records (Rameau 1889, 2:381), and 200 families by the British estimate (Clark 1968, table 6.3), widely thought to be on the low side. Accepting the 200 figure, for 1093 ha of reclaimed land as of that year (Bleakney forthcoming), each nuclear family should have had an average of 5.5 ha—that is, access to two or three lots. Since soil fertility had to be periodically renewed, either by pasture-fallow or inundation, not all such land could have been cultivated at any one time. Access to upland resources, especially for grazing, would partially compensate for this. However, the population had been expanding geometrically, while reclaimed lands were increasing only arithmetically, and it is unclear whether the pace of reclamation could keep up with demographic growth (see also Herbin 1911). Each of the last three stages of new dike construction created an average of 107 ha of fresh land (Bleakney), or space for some 19 families. It is therefore noteworthy that, though parcel size had previously remained constant, a good half of the final stage of expansion (Bleakney's eleventh enclosure) was given over to lots only a sixth of the original size, averaging 0.63 ha. This new microparcellation appears to have been used for "sizing"—that is, to compensate farmers who had received undersized lots (Bleakney).

Like the extended family clusters of the Annapolis Valley, other Acadian settlements around the Bay of Fundy were arranged in linear fashion along estuarine bays, inlets, or valleys. These included the Canard River, the Avon (Pigiguit) estuary, Cobequid Bay, and the Cumberland Basin (Beaubassin) (Figure 1). The last is adjacent to the one reclamation project begun under the impetus of an influential individual and heavily subsidized by the French government: the great Tantramar marsh, between the Aulac and Tantramar (Titamare) rivers. Aboiteaux were partly constructed between 1752 and 1755 by Acadian refugees from Beaubassin. The controversial missionary Jean-Louis LeLoutre (Finn 1966; Rumilly 1955, 399–437) was largely responsible for instigating this flight and then attempting to resettle the people on what was still French domain. A map of around 1754 shows the area as "*Aboiteau projetée*"; another of 1755 identifies bounding dikes along the shoreline and the lower river courses (Dawson 1988, maps 4.3 and 6.4). However, the project was abandoned in that year and only finally realized during the nineteenth century. This is the one exception to the rule that reclamation was locally planned and incrementally carried out through communal efforts.

Although frequently misunderstood by French observers, aboiteau reclamation represented a substantial investment of skilled labor to assure a productivity greater than that of other soil categories available in Nova Scotia. The New England settlers who replaced the Acadians (see Harris and Matthews 1987, plate 31) had little taste for this particular practice of intensified agriculture, preferring mixed farming on the uplands, which had poorer soils than in New England. Even Grand Pré (now Horton Township) had only 634 new settlers in 1766, and within a few years less than a third of them were able to produce sufficient food for their own subsistence (Harris and Matthews 1987, plate 31). The net result was disintensification in many of the estuarine settlement tracts, reflecting the new settlers' lack of experience in reclamation agriculture.

It is significant that the Acadians created two distinct landscape geometries. Along the river or seashore, settlement was linear and segmental, with reclaimed marsh expanding from an initial running dike into an irregular complex of plots adjusted to the local topography. The associated farmsteads clustered as hamlets at the base of the upland, commonly representing several nuclear units of a few extended families (see Gaudet 1974). If not terminated by the expulsion of 1755, the reclamations along the Annapolis River would probably have merged into subcontinuous chains of bounding dikes.

Grand Pré, however, was differently situated and focused on a larger estuarine zone, anchored between the mainland and Long Island, once located 2 km offshore. This unique ecological opportunity elicited a novel socioeconomic response. Here all the families of the settlement appear to have participated in a community reclamation project, which was progressively expanded to accommodate the growing member of young couples. Instead of contiguous groups of fields belonging to a single, extended family, newlyweds presumably sought land in new enclosures as they opened up. Given the partible inheritance pattern, that would ensure scattered holdings after several generations.[11] In other words, a different geometry of landholdings resulted from an alternative strategic solution within the same social system and at the community level.

The French Connection

Some of the first Acadian colonists came from the marshlands around La Rochelle, and most of the others

came from elsewhere in Poitou or Anjou. Detailed genealogies are less important than the critical information that can be derived from patterns, practices, and history of estuarine reclamation in western France, a subject that has not yet been addressed in discussions of Acadian wetland agriculture. Two of the reclaimed marshes, the Brouage and the Seudre estuary (Figure 3), had already been converted into salt works in medieval times and can be excluded from the discussion. The several marsh tracts of the lower Charente River appear to have been primarily drained during the seventeenth century (Dienne 1891, ch. 2) and show little variability in parcellation patterns. This leaves the great Marais Poitevin, north of La Rochelle, an area with intricate patterns of subdivision and one illuminated by a good historical record. Furthermore, as a focus of modern environmentalist concerns, it is documented by an ethnographic study (Le Quellec 1993). It is therefore chosen here as a representative prototype of how traditional reclamation technology worked and how it has been modified.

The Marais Poitevin (Figure 4) extends 75 km along the small Sèvre River and covers some 97,000 ha. Cut into adjacent Cretaceous rocks during repeated Pleistocene regressions of the sea level, a deep bay had already been infilled with clay by early Holocene times (Verger 1988, 376). The western half formed almost level mudflats, contested by both the sea and river flooding, while the eastern half was a freshwater peat marsh. Mean tidal amplitude at La Rochelle is 2.9 m, with spring tides of up to 3.3 m—much less than in the Bay of Fundy.

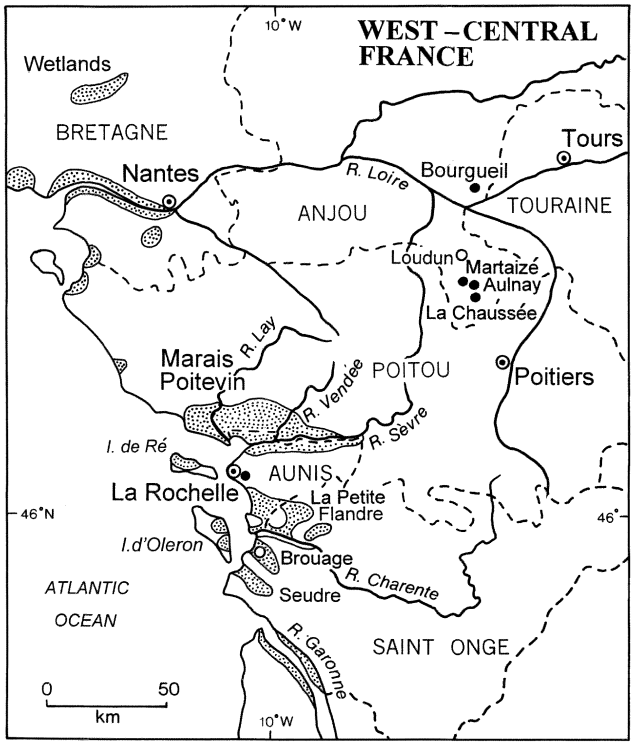

Figure 3. The wetlands of West-Central France. *Source:* In part modified after IGN (1999).

Nothing is known about land use in Roman times, but after A.D. 508 abbeys began to be founded in and around the Marais, and in 1090 a Benedictine priory was awarded a tract of marsh "to plow, sow, and harvest" (Riou 1907, 21). The active role of the monasteries in reclamation is explicit in an 1199 grant to the Cistercians of Moreilles: "to construct dikes and canals . . . and entrusted to make a drainage canal . . . toward the sea" (Riou, 24–25). Upland parishes with land down in the Marais also were involved. A number of large canals were dug between 1192 and 1283 through the collaborative efforts of several communities or a constellation of abbeys (Riou, 26–33; Billaud 1984, 31–32). In fact, one required the intervention of the king; called the Achenal le Roy, it ran transversally through the upper marshland to drain upland runoff into the longitudinal canals that ran to the sea (Figure 4).

The local and regional archival material (Dienne 1891; Riou 1907; Billaud 1984) reflected in Figure 4 leaves no doubt that river flooding was more difficult to control than the tides or occasional storm surges. Most of the projects of the eleventh to the thirteenth centuries were intended to alleviate freshwater floods, especially those of the Vendée River. These kept the marshes under water for six to eight months, after which they became mudflats and mires during the summer (Riou, 60; Billaud, 20–23; Le Quellec 1993, 117). That was immensely complicated by the need for cooperation between communities, by the rapacious intervention of minor local aristocrats, and by the damages incurred to upstream communities when downstream river courses were diked.

Reclamation was organized in sections (*prises*), protected by dikes (*bots*) with a relief of 1.5–2.5 m (Verger 1988, fig. 159; LeQuellec 1993, 14–18), built of mud or clay, and possibly faced by sod bricks. A network of ditches or canals drained the reclaimed land toward a contreceinture, from which it was emptied into an external canal (*chenal*). In combination with the topographic maps of the Marais (Billaud 1984, maps on pp. 258–59; IGN 1999), it becomes apparent that the Acadians organized their reclamation units in much the same way. In all probability, the term "aboiteau" derives from *bot*, judging by the medieval Latin term *abotamentum*, used in a twelfth-century diking document from the Marais (Riou 1907, 27, 112), which in turn comes from the Latin *butum* (Dienne 1891, 535), with its English cognates "abut" and "buttress."

Despite the preoccupation of the literature with freshwater flood control, at the base of the upland the marsh-

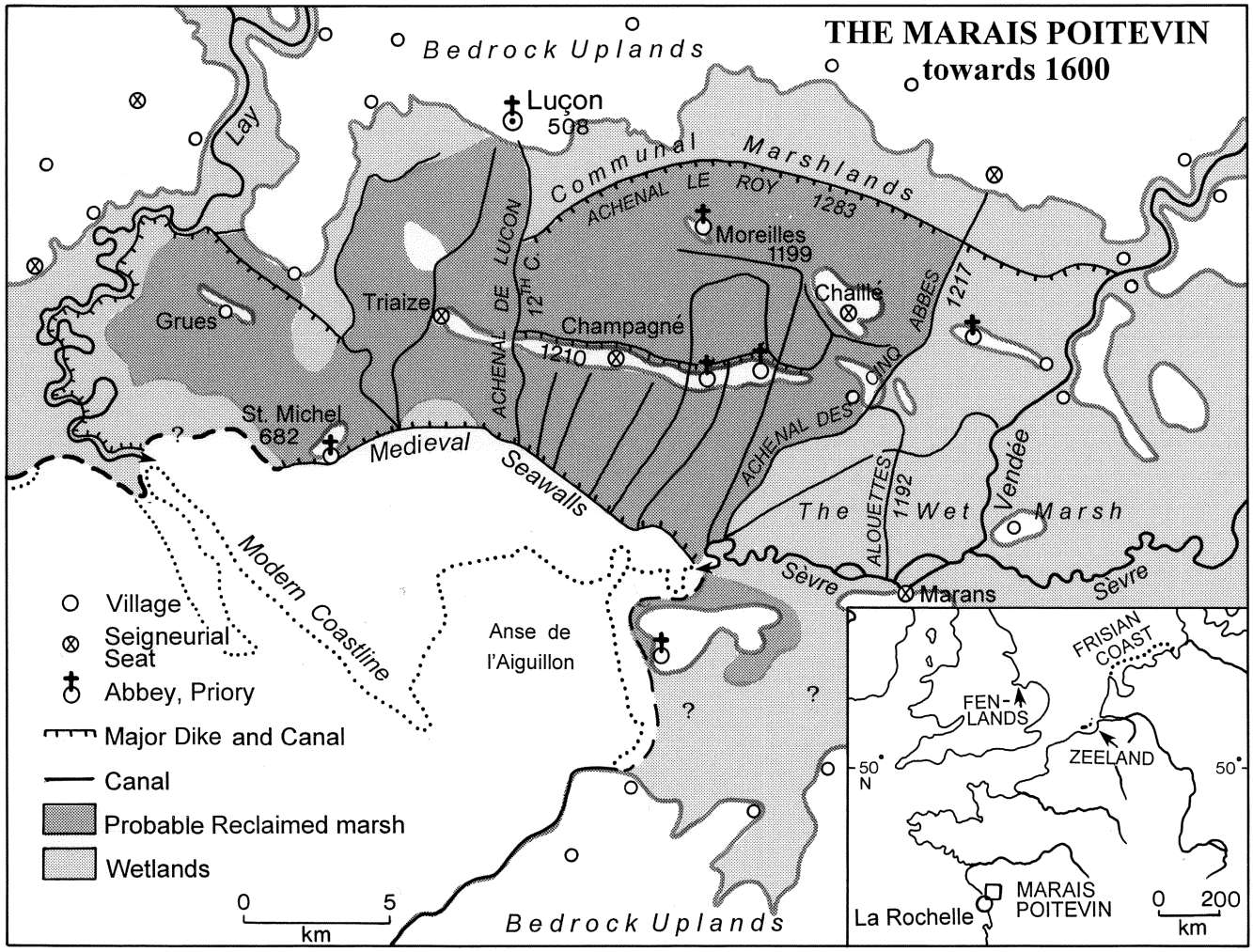

Figure 4. The Marais Poitevin of West-Central France around A.D. 1600. *Sources:* In part after IGN (1999) and data provided by Dienne (1891), Riou (1907), and Billaud (1984).

land is 60 cm *below* spring tide level (Le Quellec 1993, 19). Consequently, the reclaimed land of Figure 4 would be flooded by seawater twice annually without seaward dikes (*bots de garde*). Once in place, the seawalls would contain the spring tides, except during exceptional gales. The French literature therefore assumes the stability of the coastal dikes and provides no information as to what materials were traditionally used to construct them prior to the rock-and-cement seawalls of the late nineteenth century (Le Quellec, 19).

Fortunately, an explicit description of the tidal flux and the role of the clapper valve does exist. La Popelinière (1573, 5:156; cited by Riou 1907, 36) writes that the sluice gates of the seawalls

> are well reinforced with iron . . . but made in a way that the sea cannot press them back, finding no gap or opening to pass through. [The sea] calms its agitation by flowing every six hours, growing and rising. When that is over, [the sea] makes its way back during the same number of hours. It then opens the gates and draws down the water in the canals which diminishes little by little. That is how all these lands are kept safe from flood and inundation by the sea, as it comes and goes twice a day. (author's translation)

This is exactly the same as the *dalle* and clapper of the Acadian aboiteaux, although we have no French information as to how such a traditional aboiteau was constructed. It is likely that the Acadian variant had to be substantially stronger and more elaborate, to contend with a much greater tidal amplitude.

The prosperity of the Marais ended with the Hundred Years' War (1337–1453), as people fled, dikes collapsed, and the marshes were flooded. In 1409 and 1438, royal commissioners were ineffective in reestablishing the dikes; but another effort in 1455 saw repair of the seawalls; the

marshes of Luçon and St. Michel (Figure 2C) were brought under control in 1481, and several canals were reopened in 1530 and 1568 (Riou 1907, 32–36; Billaud 1984, 35–38). However, dikes were cut and marshes flooded between 1569 and 1572 during the Huguenot wars, with rehabilitation delayed until after 1600. These vicissitudes illustrate how vulnerable wetland agriculture was to insecurity or wanton destruction. More significantly, they clarify that the reclamation system in place by 1300 was in fact refurbished, if on a smaller scale than before, between the 1450s and 1560s. Acadia, too, was no stranger to military devastation, in its case by repeated British raids and occupation.

King Henry IV had personal ties with the Marais, and one of his first decisions, in 1599, was to reclaim the coastal marshes of France (Dienne 1891, 31–35, 79–80; Riou 1907, 37–39). Instead of sending out commissioners to attempt to coordinate competing local authorities, he appointed a charter company invested with the power to expropriate the holdings of uncooperative landowners. As director of this national enterprise, he chose Humfroy (Humphrey) Bradley (fl. 1589–1639), "gentleman of Brabant," born in Bergen-op-Zoom in the Netherlands; much of the venture capital appears to have been Dutch (Dienne, 33–49; Riou, 38–41). A different era in French reclamation had begun, one that was top-down and increasingly international.

A Dutch/Flemish Model?

The notion that the Acadians introduced Dutch reclamation technology, via France, owes its origin to an incidental comment by Schott (1955, 28) that the "settlers came from areas . . . with extensive marsh landscapes, the cultivation of which was primarily advanced by Louis XIII through the engagement of Dutch engineers" (author's translation). That remark was echoed by Clark (1968, 103, n. 66), and taken up by Leonard (1991, 40), who wondered whether the clapper sluice was in use in Poitou during the sixteenth century or was introduced by the Dutch. Implicit in these suggestions is that western France was relatively backward in reclamation, requiring Dutch intervention.

Given that Acadian reclamation was quite similar to that identified above for the medieval Marais, including the clapper sluice, two basic questions must be raised: (a) what impact, if any, did "the Dutch" have on estuarine drainage in the Marais? and (b) were reclamation processes and patterns in the Low Countries similar to those of western France, and if so, why?

But Bradley's consortium was never operationalized, since its authority was curtailed upon the death of Henry IV in 1609. Dutch/Flemish engineers were only engaged on the ground in the Charente marshes, where a number of Flemish and Dutch families were settled in La Petite Flandre after 1607, despite local resistance (Dienne 1891, 46–49, 81; Billaud 1984, 39–40; Verger 1988, fig. 167). Yet that reclamation is not tangibly distinctive. In the face of local sabotage of new dikes, work in the Marais Poitevin made no progress before religious warfare was reignited in 1628.

With Bradley's death in 1639, a new society was chartered in 1641 and entrusted locally to Pierre Siette of La Rochelle, royal engineer and geographer, with Dutchmen now involved only at the financial level. It was reputed to be heavy-handed and effective: 15,300 ha of marshland were rehabilitated or drained across the next twenty-five years, exclusively to the east of the Luçon canal (Riou 1907, 57–103). However, since half of this reclamation was completed in only five years, Siette clearly only restored existing structures at first, before embarking on the "wet" or "wild marsh" (*Marais sauvage*) that had resisted medieval methods (Figure 2D). Parcellation around the medieval towns is irregular, in contrast to the rigid geometries of the newly drained marsh tracts. The change of name from Achenal le Roy to Ceinture des Hollandais is a misnomer, reflecting local perceptions of outside intrusion. There were no "Dutch polders" in the Marais Poitevin, nor is there reason to believe that the work of 1641–1665 introduced any specific technology from the Low Countries. What was new was the invasive but indirect role of big government, in the guise of a chartered company.

The monks of St. Michel and the bishop of Luçon successfully resisted intrusion, probably because their reclamation works were already functional (Riou 1907, 104–8). Indeed, the parcellation around St. Michel and Gruës is distinctive, with smaller and more irregular parcels interspersed with patches of long lots (Figure 2C). Working within the limits of their property, without an overarching strategy, the monks had followed the sinuosities of river channels and taken advantage of any rise in the topography (Riou, 110). Also distinctive are the marshes north of the Achenal le Roy, unaffected by the reclamation of the mid-1600s; these include a maze of communal tracts of unreclaimed marsh belonging to villages located on the adjacent upland.

Reclamation continued after 1700 (Le Quellec 1993, 44–45), including progressive encroachment on the saltwater tidal flats of the Bay of l'Aiguillon, which has lost about half of its surface. Increasingly, any disputes were resolved in Paris, which approved or even instigated actions. With a new industrial technology, seawalls were converted to mortared rock and then reinforced concrete,

while simple sluices were expanded into high-technology barrages with tiers of gates. Environmentalists are currently locked in a struggle with proponents of development in order to preserve what remains of the wetland and its traditional society (see Le Quellec).

The Dutch did not come to teach the French how to reclaim marsh. Neither did they bring updated technology. Sometimes they offered organizational skills, at times perhaps heavy-handed. For the most part, what they brought was venture capital. The story of the Marais Poitevin after 1640 is one not of Dutch impacts, but of changing political ecologies and resistance.

Reclamation in the Low Countries

The coasts of Flanders and the Netherlands are entirely formed by unconsolidated Quaternary sediments. Sand plains interfinger with riverine estuaries on a large scale, with the proximity of strong commercial centers making land more valuable and indirectly stimulating reclamation. Not surprisingly, geological and archaeological investigation has also been more concentrated and sustained than in western France (see Vos and van Heeringen 1997; Ervynk et al. 1999). Salt-making in the tidal flats and peat-cutting in freshwater marsh go back to the Iron Age, but no evidence for diking exists until the eighth or ninth centuries. More systematic reclamation by A.D. 1200 can be verified (Te Brake 1985, 93–103, ch. 5), as secular authorities collaborated with local communities or invited new settlers. This was in phase with reclamation in the Marais Poitevin, but without the conflicts between abbeys, competing parishes, and the local aristocracy. Given more harmonious sociopolitical circumstances in the Low Countries and a virtually unlimited expanse of estuarine environments, the takeoff was far more rapid: 36,000 ha of reclamation in the Netherlands during the thirteenth century (Veen 1955, 57), in contrast with less than 19,000 ha in the Marais (see Figure 4). Thereafter, reclamation in the Netherlands continued to accelerate until the 1620s, reflecting the high commercial incentives, whereas little further expansion took place in the Marais until the mid-1600s.

The basic dike technology was also similar in both areas, initially based on sloping clay embankments, the material for which was derived from the cutting of parallel canals into estuarine "muds." Clay dikes are impervious and—given the typical mix of clay minerals—stable; their inherent plasticity meant that they vibrated but did not crack when battered by waves. However, the scale of reclamation in the Low Countries created an increasingly unstable landscape (Lambert 1971). River flood levels rose as channels were sealed off by dikes, while flood basins were lowered by relentless cutting of peat. Reclamations in the salt-marsh were starved of fresh sediment, and dewatering led to compaction and subsidence, leaving such basins below sea level, requiring higher dikes, which are less stable, since their sloping faces are steeper. Excavation of dike material from their seaward margin made that slope even steeper.

The result was that periodic storm surges devastated existing polders to expand marine environments, and in some parts of the Netherlands more land was lost than gained between the 1280s and 1430s. The technology of seawall construction had to be improved. This was accomplished by embanking sod bricks, with coffers of wattled branches and seaweed, or palisades of planks, anchored by wood pilings (Vierlingh [1570] 1920, xxxvi–xli; Lambert 1971, 239–41, fig. 65). Except for the paucity of seaweed in the Fundy, these innovations in the form of brush-matting and plank-facing were shared in Acadia (see Schott 1955; LeBreton 1980; NSDAM 1987; Cormier 1990),[12] where the impetus was different—namely, a tidal amplitude up to six times greater than in the Low Countries.

Sluice conduits were either single or double-barreled (in larger basins), and two kinds of one-way openings were known, with horizontal or vertical clappers; the conduit casing could be of wood or stone (Vierlingh [1570] 1920, xli–xlv, 423). Although only explicitly documented since 1253, one-way valves with a vertical, hinged flap were already known in first-century Rome (Landels 2000, 77, 81–82, fig. 25). The Dutch information complements that of the Marais Poitevin in regard to seawalls and sluices, while confirming that Acadian practices were mainstream by European standards.

Early medieval settlements in the Low Countries were arranged and continued to expand in close relationship to the topography, with corresponding changes in field patterns (Verhulst 1966; Lambert 1971, ch. 3; Te Brake 1985). As the scale of reclamation increased, new landscape patterns emerged. Suites of long lots were the most common, initially disposed in curving sweeps adjusted to the contours; later patterns were regular and geometric, but also dominated by long lots. Colored by differences in geographic expression and land tenure, the continuing evolution of Low Country parcellation differed from the Marais Poitevin in all but its increasing regularity over time.

By the mid-1500s, the larger and more ambitious reclamation works of the Low Countries required complex organizational arrangements, including professional dikers for labor and maintenance, performed under the direction of experienced dikemasters and financed by venture capitalists (Lambert 1971; de Vries 1974).

Technological modification allowed a new type of windmill to pump water out of the expanding inland lakes. This process was stimulated by the growing market for agricultural products in the hinterland of wealthy cities. In turn, various administrative and commercial bodies began to steer reclamation, internal colonization, and agricultural "modernization" with an eye to greater productivity and profits. In short, towards 1600, reclamation became increasingly institutionalized and top-down.

It is no accident that, at about the same time, Henry IV appointed Bradley to oversee draining of the French wetlands. Indeed, it is surprising to find that Bradley had previously been hired as a consultant by British aristocrats in regard to draining the English Fenlands. His 1589 recommendations were published by Darby (1939, 18–19, 261–67), who makes no mention of Bradley's role on the continent. Although medieval monasteries had begun to drain the Fens (Darby 1940), the problem of conflicting authorities required an Act of Parliament in 1600, and then a coordinated plan. Cornelius Vermuyden (c. 1595–1683), a leading Dutch dikemaster, became part of this effort in 1620, and in 1642 he was appointed to oversee full implementation of the Fenlands project. As in France, there was intense local resistance and repeated sabotage, to the point of rioting, reflecting both xenophobia and concern over the loss of a traditional way of life in the wetlands (Darby 1940, ch. 2). Whereas Vermuyden was eventually knighted for his role, efforts by Dutch engineers to reclaim estuarine tracts in eastern Frisia and Italy's Pontine Marshes failed due to local hostility (Veen 1955, 47–49, 52–53).

These structural changes were closely linked to a new round of agricultural intensification in the Low Countries, with farmers specializing in agricultural production and experimenting with combinations of crops or selective stockbreeding (Slicher van Bath 1960; de Vries 1974, 121–54). England imported much of this "new husbandry" during the seventeenth century. In the same decades, the Marais Poitevin adopted similar crop rotations, fodder plants, cash crops such as flax, and Belgian wool sheep (Billaud 1984, 48, 54–59). The old inhabitants of the Marais had few alternatives: they had to adapt, be marginalized, or leave. Some sought refuge in the remaining unreclaimed marshland, their ranks replaced by new French colonists from elsewhere.

Commonalities of Atlantic Reclamation

This comparative examination of reclamation in Atlantic Europe serves to highlight strong commonalities:

1. Vigorous traditional reclamation was under way in both the Low Countries and western France by A.D. 1200, and expansion was rapid in both areas during the thirteenth century. Similar drainage efforts were apparent in the British Fenlands at the same time (Darby 1940).
2. The basic methods employed (diked enclosures, drained strips or blocks of fields, one-way sluice gates, and drainage canals) were the same in each region, despite differing local concerns such as tidal control, flood surge protection, and coping with river flooding. These methods appeared simultaneously in France, the Low Countries, and England. Any innovation and diffusion happened long before the twelfth century, and at least some component parts of the technology were available in Roman times.[13]
3. Medieval wetland reclamation in France was organized and implemented at the local level, through cooperative arrangements between monasteries, aristocrats, and parish communities. The emerging patterns were adapted to local environmental variability rather than dictated by abstract strategies. Regardless of the vision or leadership of priors, barons, or town councils and their facilitation of a particular enterprise, these were grassroots efforts that depended on the will, labor, and skills of common people.
4. The fundamental unity and synchronicity of this Atlantic reclamation process—from the tidal estuaries and coastal wetlands of western France to the Frisian Islands and the Fens—was neither political nor ethnocentered. Instead, it coincided with rapid demographic growth in Western Europe between the eleventh and early fourteenth centuries, which spurred settlement expansion into marsh, woodland, and montane environments and included the multiethnic colonization of East-Central Europe (see, e.g., Randsborg 1992). Sponsored by a mix of church and secular institutions, this expansion was not centrally directed but buoyed by expanding economies, good agricultural prices, and urban demand.[14]
5. Given the demographic check of the Black Death after 1348, a shortage of labor, and stagnant commodity prices (Abel 1980), estuarine reclamation lagged until the exploitation of New World gold and silver stimulated another surge of economic and demographic growth. This coincided with the emergence of nation-states and first attempts to "direct" economies from above.

The "professionalization" of Dutch reclamation during the late 1500s was part of a socioeconomic transfor-

mation that saw Henry IV appoint Bradley and the British parliament ordain drainage of the Fens. Dutch engineers were also invited to drain wetlands elsewhere, expanding the realm of Atlantic reclamation into Eastern Europe. However, all of this was a top-down rather than spontaneous process, and it reduced the autonomy of local communities and met determined social resistance. The attendant commercialization of agriculture suggests analogues to the Green Revolution of the 1960s, just as the extroverted confidence of its strategists recalls the excesses of modern development. Willingly or not, the peoples of Western Europe were becoming part of the Atlantic world economy.

Roots of Acadian Agrotechnology

Our information and inferences on Acadian reclamation technology can now be recapitulated, in the much broader European canvas that it requires and deserves.

1. The settlers of Acadia came mainly from western France, many of them from the upland plains of Anjou. However, some came from Aunis or Saint Onge, areas with extensive coastal marshes. Further, contract laborers from all over France, some of whom remained in the colony, came from a diversity of professions, including salt-makers who also practiced a form of wetland management. Familiarity with marsh reclamation would have been limited to a very few individuals among the forty or so families that settled in Acadia during the 1630s and 1640s.
2. Against this background of potential information appears the dramatic contemporary account of the active role of Charles d'Aulnay, the founder of the permanent colony at Port Royal. It places him as a surveyor, with the basic tools of that profession, measuring out the site of a new dike, rather than as an overseer directing a group of settlers. D'Aulnay did not come from a marsh area, but as a naval officer he had spent years in military actions along the marsh coasts around La Rochelle, and he would be expected to know survey instrumentation. D'Aulnay would appear to have been the catalyst in turning the colonists towards reclamation.
3. Contemporary accounts, as well as archaeological and ethnographic evidence, sketch out a fairly complete picture of established Acadian reclamation that was every bit as complex and sophisticated as that in traditional use in estuarine environments of France, the Low Countries, and Britain around 1600. This technology, which had come into place by the eleventh century or earlier, was shared by various ethnic groups in the Atlantic estuarine zones of Europe, and the key Acadian elements of that technology remained in use in Atlantic Europe until the industrial era, despite ongoing changes in the organization of labor, decision-making, and the scale of drainage works, which involved a regional network of communities with competing aspirations.
4. By European standards, Acadian technology was state-of-the-art in the early 1600s, not a rustic and even backwards practice, as it was seen by uninformed French and British observers. It ranks among the very first introductions of European intensified agriculture to North America.[15] Its success can be measured in the strong demographic growth (more than 4 percent per year) of the marshland communities until their expulsion after 1755.
5. Acadian field patterns that were recorded cartographically tend not to be systematic. This was particularly the case along the Annapolis River, where reclamation was focused on concave meander bends but constrained by the proximity of bedrock uplands (Figure 1). Diking proceeded incrementally over several generations, as extended families grew and required more farmland. Over time, the more difficult parts of such irregularly shaped tracts were brought under control by dikes and aboiteaux. This resulted in a patchwork of rectangular or long lots (Figure 2A). In the exceptional case of the larger and more complex community reclamation at Grand Pré, the different stages of outward expansion into a tidal marsh include clusters of rectangular fields, long lots, and approximately square segments (Figure 2B) that may reflect either local differences in drainage or experimentation. Grand Pré field patterns represent alternative strategic solutions developed at the grassroots level, in response to variable ecological opportunities. The closest French analog in the Marais Poitevin is the traditional pattern of parcellation preserved on the former monastery lands of St. Michel (Figure 2C), presumably little changed since Medieval times. The complexity of field parcellation observed in the realms of Atlantic reclamation can be attributed to mosaics of ecological microvariation, different institutional ownership (but not necessarily of land tenure) and, above all, temporal change and divergent evolution.[16]

Whatever regional adaptations the first settlers in Acadia made to accommodate a much greater tidal range

and local construction materials is limited to the impression that the key sluice structures—the aboiteaux—may have been more elaborate than in Europe and that they used a larger amount of undressed timber.

However, the issue of transatlantic transfer of a traditional, premodern reclamation technology was complicated by the sociopolitical changes under way in Atlantic Europe. When Andries Vierlingh wrote his "Treatise on Dykology" around 1570 (1920), Dutch reclamation had moved from grassroots organization to professional management, appointed by top levels of the Dutch Republic. Another articulate dikemaster, Jan Leeghwater (1575–1650), was responsible for the most innovative reclamations of the seventeenth century, using windmill pumping. Vermuyden was active in England after 1620. And in 1601 Henry IV appointed Bradley as royal dikemaster of France. As shown above, this appropriation of reclamation by central governments did not impact the Marais Poitevin until after 1641, and Siette, who was then appointed in charge, built upon existing structures on the ground. Similarly, in the English Fens, Vermuyden did not conceive a systematic master plan, implementing bold but incremental changes that were to continue across several centuries.

What was new was the unprecedented authority of high government officials to coerce local communities or to expropriate landholders until, by the time of the French Revolution, all actions in regard to reclamation at the local level in France had to be approved by Paris. This resulted in local resistance in both England and western France, including dispossession and the introduction of new colonists as far east as Russia. The perspective and questions therefore shift from cultural to political ecology.

The early settlers of Acadia left France before these changes had been implemented, Nonetheless, Charles d'Aulnay now deserves a second look. Ignace's eyewitness description ([1653] 1883, 138) has him striding confidently across the marsh after surveying a new *prise*, covered with mud up to his waist, with the rain driving on his back. That smacks of a man with unusual charisma and authority, someone in the mold of a Bradley or a Vermuyden. It is difficult to avoid a sense that the initial technology transfer to Acadia was largely driven by one person.

More certain is that agrotechnology transfer is immensely complicated, and that firm conclusions are hardly possible. A more appropriate goal would be a nuanced understanding of the broad range of issues that can be partially illuminated by a particular study. So, for example:

1. It is easy to underestimate the potential role of individuals in envisioning the possibilities or enabling the processes of information diffusion. Were such individuals prominent or anonymous? Will not the role of anonymous agents, however critical it may have been, be subsumed under the designation of "spontaneous" diffusion? Archival sources may help single out a prominent innovator, but we can rarely know whether such a person's role was primarily symbolic.
2. Belated recognition that apparent innovations were widely known, and much earlier than "expected," may derive only from the cumulative sum of decades of cross-disciplinary research, often after fresh lines of investigation have been opened. At that point, the investigation must proceed with other assumptions and perhaps different methods. How does one deal with identical innovations of great age found disjunct and isolated, on distant continents? Does one "insist" on long-distance diffusion in the past, or instead examine the possibility of ecological convergence—namely, that common problems may be independently confronted in analogous ways, given the limited range of available materials and methods to solve a particular task?
3. Technologies evolve over time while institutional structures change, so that solutions may eventually diverge, perhaps accentuated by minor ecological differences. "Traditional" practices reflect historical experience, but they are not cut off from the marketplace of ideas; they respond to both ecological opportunities and sociopolitical contexts.
4. Finally, this case study has dealt with regions that shared similar values and priorities, despite their distinct ethnicities. In medieval times, there was no apparent dissonance about implementing new technologies in places such as western France, the Low Countries, or eastern England. Any contestation was limited to local agencies, such as competing communities and rival aristocrats or institutions. That all changed radically when power began to be centralized and new methods and lifeways were enforced from above. Responses included resistance, resignation, or flight. These noncontemporary issues of political ecology deserve more detailed attention than world-systems models can offer.

In an era when many spokespersons for geography emphasize cross-disciplinary contacts and ideas, it would be a cop-out to dismiss such questions and issues as not being "geographical." We cannot rely on historians and anthropologists to do our work for us, to put questions of cultural and political ecology into an adequate

diachronic context. Political ecology, I would suggest, does not begin with nor should it be limited to subaltern peoples in the postcolonial global South.

The theme of Atlantic reclamation technology does not address agrotechnology transfer in the context of competing cultural constellations with unequal socioeconomic status. Therefore, this article's closing discussion turns to reclamation on the Guinea and Carolina coasts, to identify the potential of historically grounded diffusion studies to elicit other cultural and ecological insights.

Concluding Discussion: The Guinea Coast and South Carolina

By identifying the role of Africans in pioneering tidewater rice cultivation in South Carolina, Judith Carney (2001) draws attention to a long tradition of estuarine reclamation on the Upper Guinea coast of West Africa. A maze of tidal inlets is found between The Gambia and Guinea-Bissau, demarcating a vast expanse of mangrove swamps, parts of which have been converted into rice paddies (Mota 1954, fig. 22). The coast of Guinea-Bissau is shallow and intricate, so that tidal amplitudes vary from 2 to 6.5 m, with tidal bores penetrating far upstream. The paddies are protected by networks of large dikes, and the seasonal excess of rainwater is drained by *bombas*, sluices made of hollowed-out logs (plug trunks), with a small external hole covered by a wicker flap that holds out the seawater but opens to allow rainwater to drain (Marques Mano 1947, 482–84; Mota, 292–93). In The Gambia, drainage is effected by hollowed palm trunks plugged with thatch (Carney, 58, fig. 2.12). The estuarine silts within reclaimed fields become fertile once the heavy rains have leached the salts. Air photos of the paddies reveal clusters of roughly rectangular fields adapted to the microtopography (Mota, figs. 68–70; Carney, fig. 2.14), the plots separated by low berms (Carney, fig. 2.15).

This "typical" estuarine reclamation landscape of the Upper Guinea coast has considerable time depth. Early Portuguese travel reports, compiled around 1506, describe the coastal perimeter as densely settled and producing much rice, "like in our huertas" (*como nos pera horta*) (Monod, Mota, and Mauny 1951, 54), while in 1456 salt-making was noted in former rice fields (Monod, Mauny, and Duval 1959, 42, 66). A 1594 Portuguese description mentions extensive dikes that ran along the rivers, controlling the tidal ebb and flow (Almada [1594] 1964, 280), while later European accounts refer to causeways on dike embankments (Carney 2001, 18–25). The particular species of wet rice grown, *Oryza glaberrina*, may have been domesticated before A.D. 300 in the middle Niger marshlands (Carney, 34–39). Like China, this presents an example of a non-Western center of estuarine reclamation with a technology analogous to that of Atlantic Europe. Yet even today it remains associated with minor ethnic groupings that lack complex sociopolitical organization. All of this increases the probability that evolution of such an agrotechnology was opportunistic and incremental, coming together by ecological convergence in suitable coastal sectors with very different macroenvironments.

The case for African introduction of estuarine reclamation to South Carolina with the first slave imports of the late 1600s is based on more indirect evidence, such as *glaberrina* rice and the initial use of plug trunks for sluice gates, still called "trunks" (Carney 2001, chs. 3 and 5). By contrast, Anglo rice-planting began on the uplands, and only later appropriated African reclamations and their technology along the tidal rivers. That set in train a lucrative plantation rice economy, with plug trunks eventually replaced by elaborate sluice gates of uncertain but possibly Dutch origin (Hilliard 1978). This chain of arguments is consonant with current archaeological findings that show that African slaves managed to retain a measure of cultural integrity, despite the horrors of enslavement and the Middle Passage, the aggregation of individuals from different parts of Africa, and the arbitrary circumscription of their social life by Anglo masters (Ferguson 1992). African slaves probably introduced a new subsistence repertoire based on an effective reclamation technology. This opens a potentially significant window onto the role of a subordinated people in fashioning the agricultural landscape of colonial America.

French transplanting of estuarine reclamation to Acadia did not intersect with indigenous land use or labor. This makes the Carolinian case even more intriguing: a colonial amalgam of juxtaposed subaltern and dominant groups, the one pioneering, the other appropriating information and resources from the first. It is an alternative model for historical diffusion in which information is not value-free and material culture becomes part of a counternarrative.

Acknowledgments

Birgitta Linderoth Wallace (Halifax) kindly helped to start this project by identifying key sources and people to contact, and by making in-house reports of Parcs Canada available. Sherman Bleakney (Wolfsville, NS) generously shared his unpublished research and provided an annotated copy of Jonathan Crane's article, "On Diking."

The National Archives of Canada were helpful in supplying photocopies of microfilmed documents. Etienne Paulissen (Leuven) provided copies of various recent Flemish and Dutch publications on coastal history and archaeology. I thank Joshua Muldavin (Los Angeles) for his advice on literature about China. Susan Long drafted the maps. Gina Slinger was indefatigable in searching for articles and books, with the customary effective collaboration of the Inter-Library Loan Service of the University of Texas, and despite the scarcity of French-Canadian materials among the cooperating American university libraries. Elisabeth Butzer provided feedback and assistance. The research was supported by the Raymond C. Dickson Centennial Professorship no.1.

Notes

1. For recent syntheses of the historical geography of French Canada to the mid-1800s, see Harris (2001) and McIlwraith (2001).
2. Only eleven of the references cited in this essay can also be found in Clark's (1968) bibliography.
3. The size of these fields was apparently about 850 m^2.
4. Original French text: "I'en fis aussi un . . . entouré de fossez plains d'eau" and "I'y fis une petite escluse contre le bort de la mer, pour escouler l'eau quand ie voulois."
5. An anonymous referee suggested that this statement is a form of environmental determinism, denying the power of ideas. I would counter that the specific practices of gardening are primarily a matter of experience from an early age. My father, although he was an engineer, believed in deep spading and embanked beds, which he learned as part of a family tradition of flower gardening near Düsseldorf, Germany. I learned these and other garden techniques from him as a boy in Montréal. By contrast, our Scottish-Canadian neighbor used a hoe instead of a spade, and worked up only a few inches of soil; he lost many of his seedlings to rain puddling, and had a lower yield from plants that did survive (see Butzer 2002).
6. A group from the compound visited the fields and played in the snow during January (Lescarbot [1617] 1911, 318, 346, 553, 570), so this had to be typical French winter wheat. However, the winter of 1606–1607 was an unusually "mild" one, and winter wheat would have required considerable adaptation to thrive in the severe winters of Atlantic Canada.
7. The French source areas for emigrants to Acadia remain poorly understood because the records of departing settlers are fragmented according to different authorities in a number of different ports of embarkation. The key notarial records for the period in question are either lost or missing (Godbout 1944), and the voluminous data preserved in Québec do not cover Acadia (Choquette 1997, ch. 1). This has focused attention on the surnames of the established settlers in Port-Royal during 1671 (NAC 1671). If we sort out those individuals most likely to have contributed significant agricultural information during the formative years, they would be born by 1625 and holding more than a hectare of land in 1671. That covers a scant nineteen people. Of these, Louis Blanchard was a winegrower from La Rochelle (Godbout 1944), linked to Jérome Guérin by marriage prior to embarkation (see NAC 1671). Guillaume Trahan was from Bourgueil (Figure 3) and emigrated with his family as a contracted farm-laborer but together with a valet (Godbout 1944). Massignon (1963) identified ten of the remaining male surnames as appearing in contemporary church records in the Aulnay villages (Aulnay, Martaizé, La Chaussée), yet these include Blanchard and Guérin, as well as the commonplace French name Bertrand (135 listings in the telephone book of Liège, Belgium, in 1986). That leaves seven likely candidates: Bourc, Brun, Gaudet, Girouard, Landry, Rimbault and Terriau. The nine surnames not included by Massignon are regional ones and could derive from anywhere in west central France, including the backcountry of La Rochelle and the northern periphery of the Marais Poitevin, from communities known to have supplied emigrants to Québec during the second half of the seventeenth century (see Harris 1972, fig. 5; Choquette 1997, 78–85). Note that until the French Revolution the Razilly and Aulnay estates south of Loudun were not in Poitou, but in Anjou (Figure 3) (see Atlas historique et géographique Vidal-Lablache 1952, 28, 35).
8. Original French text: "Il venoit de poser des piquets, trace les lignes et tendre les cordeaux pour faire un nouvel assechement de terre." The naval officer and later fur-trader Nicolas Denys gives another contemporary statement, noting "the great extent of meadows that the sea used to cover, and which the Sieur d'Aunay [sic] had drained (*fit desecher*)" (Denys [1672] 1908, 123, 474).
9. This census reports a total of 380.5 *arpents* of farmland, not including that of the governor. An arpent is best considered as a strip of land about 60 m long, but of variable width. Even by a generous conversion estimate—at a time when the area of the arpent was only loosely defined—this would be less than 200 ha. However, "cultivable land" was commonly underreported to avoid tax liability (Choquette 1997, 289–90 and n. 59). The area actually cultivated was probably greater.

   To the best of my knowledge the census comment on 24 *boisseaux* has never been published or noted, not even in the two editions of Rameau, despite repeated publication of the list of family members and professions. It appears on folio 2 of NAC (1671), as the second item under *recolte* (results).
10. The impetus for the foundation of new settlements varied from case to case. At Beaubassin, Jacques Bourgeois, a leading citizen of Port Royal, together with several relatives and their families, established a small colony shortly after 1671. However, in 1676 the Cumberland Basin was granted to a *seigneur*, who opposed this settlement. He initiated litigation that led to decrees by the French council of state in 1703 and 1705, in favor of the colonists, who were liable only to the usual, token obligations to the seigneur, La Vallière (Rameau 1889, 1: 167–82; 2: 333–37). The first settlements in the Minas Basin in 1682 also were a result of private initiatives, including a larger group led by Pierre Terriau, occupying the shores of the St. Antoine (Cornwallis) and Canard rivers, and a smaller one headed by Pierre Mélanson, at Grand Pré. Mélanson was commander of the local militia and appears to have been the fiscal agent of the local seigneur (Rameau 1889, 1: 182–89; 2: 333). Cobeguit, near modern Truro, was granted in 1689 to a new seigneur who was the first child born in Acadia and who encouraged

settlement, although growth here was slower (Rameau 1889, 1:189–94; 2:323).

11. British land allocation during the 1760s replicated the French system to some degree by subdividing the existing lands of Grand Pré into four categories, with individuals drawing ballots for each type. Such holdings were widely scattered, and there was much trading in land (McNabb 1986; Harris and Matthews 1987, plate 31). Depending on rank, individuals received from 3 to 12 ha of reclaimed marshland, and an additional 100 to 400 ha of upland.
12. This should not imply that these methods were unique to Acadia and the Low Countries, only that information on traditional seawalls in western France is scarce.
13. Although tidal amplitudes are minimal in the Mediterranean Basin, marshland is common along some coasts, with an expansion of coastal wetlands as a result of Graeco-Roman soil erosion (Abbott and Valastro 1995). Early reclamation efforts are inadequately documented in the classical literature (see Traina 1988), and require substantially more archaeological attention. However, reclamation of lakes, such as the Kopais Basin of Greece, may have been first attempted in Mycenaean times, some 4000 years ago.
14. To put Atlantic reclamation technology into perspective, key concepts such as polder-dikes and sluices were also part of the Chinese vocabulary in medieval times (see Elvin and Ninghu 1998). For example, an 85-km-long seawall was built on Hangzhou Bay in A.D. 1047, and in 1341 a 65-km-long stone dike, 18 m wide at the base and 4.5 m high, was constructed there. Such gigantic works, done on a much larger scale than in the Low Countries, reflected spectacular economic and demographic growth under the Sung and Yuan dynasties (960–1368). Abu-Lughod (1989) would attribute such parallel growth in China and Europe, at opposing ends of the Eurasian continent, to hemispheric economic integration in the "thirteenth-century world system." Of course, this is a simplifying, macroeconomic model, which ideally should generate attention to other systemic variables as well as to the complex dynamics that cut across the positivistic grain.
15. Contrary to a government publication's assertion (NSDAM 1987, 21), Acadian dikeland farming did not mark a break with European traditions. Indeed, Acadian practices were mainstream by European standards.
16. Observation of abandoned field patterns, if uninformed by direct historical evidence or archaeological excavation, can easily underestimate change over time or misunderstand spatial or temporal shifts in patterning. Field parcellation alone may not reveal whether organization was bottom-up or top-down, as evidenced by the unresolved anthropological debates about field patterning in the *chinampas* of Mexico or the reclaimed fields around the shores of Lake Titicaca.

References

Abbott, James T., and S. Valastro 1995. The Holocene alluvial records of the chorai of Metapontum, Basilicata and Croton, Calabria, Italy. *In Mediterranean Quaternary river environments*, ed. J. Lewin, M. G. Macklin, and J. C. Woodward, 195–205. Rotterdam: A.A. Balkema.

Abel, Wilhelm. 1980. *Agricultural fluctuations in Europe from the thirteenth to the twentieth centuries*. London: Methuen.

Abu-Lughod, Janet L. 1989. *Before European hegemony: The world system A.D. 1250–1350*. New York: Oxford University Press.

Almada, A. Alvares de. [1594] 1964. *Tratado breve dos Rios de Guiné* (Brief account of the rivers of Guinea). Edited by A. Brásio. Monumenta Missionaria Africana, Africa Occidental, 2nd series, vol. 3. Lisbon: Agéncia–Geral do Ultramar.

Atlas historique et géographique Vidal-Lablache (The Vidal-Lablache historical and geographical atlas). 1952. Paris: Armand Colin.

Baudry, René. 1966a. Lescarbot, Marc. In *Dictionary of Canadian biography*, vol. 1, 469–72. Toronto: University of Toronto Press.

———. 1966b. Menou d'Aulnay, Charles de. In *Dictionary of Canadian biography*, vol. 1, 502–6. Toronto: University of Toronto Press.

Billaud, Jean-Paul. 1984. *Marais Poitevin: Recontres de la terre et de l'eau* (The Marais Poitevin: Encounters with the land and waters). Paris: Editions l'Harmattan.

Bleakney, J. Sherman. Forthcoming. *Sods, soil and spades: Origins of Acadian nationhood and their dykeland legacy*.

Bujold, Nicole T., and Caillebeau, Maurice. 1979. *Les origines françaises des premières familles acadiennes* (The French roots of the first Acadian families). Poitiers, France: Imprimerie l'Union.

Butzer, Karl W. 1988. Cattle and sheep from Old to New Spain: Historical antecedents. *Annals of the Association of American Geographers* 78:29–56.

———. 1995. Biological transfer, agricultural change, and environmental implications of 1492. In *International germplasm transfer—Past and present*, ed. R. R. Duncan, 3–25. Madison, WI: Crop Science Society of America.

———. 2002. Center, periphery, and back. In *Geographical Voices*, ed. P. Gould and F. R. Pitts, 53–80. Syracuse: Syracuse University Press.

Butzer, Karl W., and Elisabeth K. Butzer. 2000. Domestic architecture in early Colonial Mexico: Material culture as (sub)text. In *Cultural encounters with the environment*, ed. A. B. Murphy and D. L. Johnson, 17–37. Lanham, MD: Rowman and Littlefield.

Carney, Judith A. 2001. *Black rice: The African origins of rice cultivation in the Americas*. Cambridge, MA: Harvard University Press.

Champlain, Samuel de. [1613] 1922. *The works of Samuel de Champlain*. Vol. 1, *1599–1607*. Translated and edited by H. H. Langton and W. F. Ganong, including the French text. Toronto: The Champlain Society.

Choquette, Leslie. 1997. *Frenchmen into peasants: Modernity and tradition in the peopling of French Canada*. Cambridge, MA: Harvard University Press.

Clark, Andrew H. 1968. *Acadia: The geography of early Nova Scotia to 1760*. Madison: University of Wisconsin Press.

Cormier, Yves. 1990. *Les aboiteaux en Acadia: Hier et aujourd'hui* (The *aboiteaux* of Acadia: Yesterday and today). Moncton, NB: Université de Moncton, Chaire d'études acadiennes.

Crane, Jonathan. 1819. On diking. *The Acadian Recorder* 27 Feb: n/a.

Daigle, Jean. 1994. 1650–1686: "Un pays qui n'est pas fait." In *The Atlantic region to confederation: A history*, ed. P. A. Buckner and J. G. Reid, 61–77. Toronto: University of Toronto Press.

Darby, H. Clifford. 1939. *The draining of the Fens*. Cambridge, U.K.: Cambridge University Press.

———. 1940. *The medieval fenland*. Cambridge, U.K.: Cambridge University Press.

Dawson, Joan. 1988. *The mapmaker's eye: Nova Scotia through early maps*. Halifax: Nimbus Publishing Ltd. and Nova Scotia Museum.

Denys, Nicolas. [1672] 1908. *The description and natural history of the coasts of North America (Acadia)*. Translated and edited by W. F. Ganong, including the French text. Toronto: The Champlain Society.

de Vries, Jan. 1974. *The Dutch rural economy in the Golden Age, 1500–1700*. New Haven, CT: Yale University Press.

Dienne, Le Comte de. 1891. *Histoire du Desséchement des lacs et marais en France avant 1789* (History of the drainage of the lakes and rivers of France before 1789). Paris: H. Champion.

Dièreville, Sieur de. [1708] 1933. *Relation of the voyage to Port Royal in Acadia or New France*. Translated and edited by J. C. Webster, including the French text. Toronto: The Champlain Society.

Elvin, Mark, and Su Ninghu. 1998. Action at a distance: The influence of the Yellow River on Hangzhou Bay since A.D. 1000. In *Sediments of time: Environment and society in Chinese history*, ed. M. Elvin and Liu Ts'ui-jing, 344–407. Cambridge, U.K.: Cambridge University Press.

Erskine, John. 1976. *In forest and field*. Halifax: The Nova Scotia Museum.

Ervynck, A., C. Boeteman, H. Demiddele, Y. Hollevoet, M. Pieters, J. Schelvis, D. Tys, M. Van Strydonck, and F. Verhaeghe, 1999. Human occupation because of a regression, or the cause of a transgression? *Probleme der Küstenforschung im südlichen Nordseegebiet* (Coastal research problems in the southern North Sea area) 26:97–121.

Ferguson, Leland. 1992. *Uncommon ground: Archaeology and early African America, 1650–1800*. Washington, DC: Smithsonian Institution Press.

Finn, Gérard. 1966. Le Loutre, Jean-Louis. In *Dictionary of Canadian biography*, vol. 1, 453–58. Toronto: University of Toronto Press.

Ganong, William F. 1903. The vegetation of the Bay of Fundy salt and diked marshes: An ecological study. *Botanical Gazette* 36:161–86.

Gaudet, Placide. 1974. Notes to accompany the plan (by George Mitchell) of the river of Annapolis Royal. In *An historical journal of the campaigns in North America by Captain John Knox*, vol. 1, ed. A. G. Dougherty, 2–6. Toronto: The Champlain Society.

Godbout, Archange. 1944. Le role du Saint-Jéhan et les origines acadiennes (The roster of the [ship] Saint- Jéhan and Acadian origins). *Mémoires de la Société généalogique canadienne-française* (Memoirs of the French-Canadian Genealogical Society) 1:19–30.

Griffiths, Naomi E. S. 1994. 1600–1650: Fish, fur, and folk. In *The Atlantic region to confederation: A history*, ed. P. A. Buckner and J. C. Reid, 40–60. Toronto: University of Toronto Press.

Harris, R. Cole. 1972. The French background of immigrants to Canada before 1700. *Cahiers de Géographie de Québec* (Geographical memoirs of Québec) 16:313–24.

———. 2001. France in North America. In *North America: The historical geography of a changing continent*, ed. T. F. McIlwraith and E. K. Muller, 65–88. 2nd ed. Lanham, MD: Rowman and Littlefield.

Harris, R. Cole, and Geoffrey J. Matthews. 1987. *Historical atlas of Canada*. Vol. 1, *From the beginning to 1800*. Toronto: University of Toronto Press.

Harris, R. Cole, and John Warkentin. 1974. *Canada before confederation: A study in historical geography*. New York: Oxford University Press.

Harvey, D. C. 1966. Alexander, Sir William. In *Dictionary of Canadian biography*, vol. 1, 50–55. Toronto: University of Toronto Press.

Heidenreich, Conrad E. 1976. *Explorations and mapping of Samuel de Champlain, 1603–1632*. Cartographica Monograph 17. Toronto: Department of Geography, York University.

Herbin, John F. 1911. *The history of Grand Pré*. 4th ed. St. John, NB: Barnes and Co.

Hilliard, Sam B. 1978. Antebellum tidewater rice culture in South Carolina and Georgia. In *European settlement and development in North America*, ed. J. R. Gibson, 91–115. Toronto: University of Toronto Press.

Ignace, Père. [1653] 1883. Lettre du Rev. Père Ignace, Capucin (Senlis, 6 Aug. 1653) (Letter of the Rev. Father Ignace, Capuchin [Senlis, 6 Aug. 1653]). In *Collection de manuscripts relatifs à l'histoire de la Nouvelle-France* (Collection of manuscripts relating to the history of New France), vol. 1, 136–40. Québec: Imprimerie A. Coté.

Innis, Harold A., ed. 1929. *Select documents in Canadian economic history, 1497–1783*. Toronto: University of Toronto Press.

Institut Géographique National (IGN). 1999. La carte touristique locale: 39, La Rochelle. Royan (1:100,000) (Local tourism map: No. 39, La Rochelle and Royan, 1:100,000). Paris: Institut Géographique National.

Korvemaker, E. Frank. 1993. *Report on the excavation of two Acadian houses*. Manuscript Report Series no. 143. Ottawa: Parks Canada, National Historic Park and Sites Branch.

Lambert, Audrey M. 1971. *The making of the Dutch landscape*. London: Seminar Press.

Landels, J. G. 2000. *Engineering in the ancient world*. Berkeley: University of California Press.

La Popelinière, Lancelot Voisin, sieur de. 1573. *La vraye et entière histoire des troubles et choses mémorables avenues tant en France qu'en Flandrès et pays circumvoisins depuis l'an 1562* (The true and complete history of the turmoil and noteworthy events happening in France as well as in Flanders and adjacent countries since the year 1562). La Rochelle: Davautes.

Larin, Robert. 1994. *La contribution du Haut-Poitou au peuplement de la Nouvelle-France* (The contribution of Upper Poitou to the settlement of New France). Moncton, NB: Editions d'Acadie.

LeBlanc, Bernard V., and Ronnie-Gilles LeBlanc. 1993. La culture matérielle traditionelle en Acadie (Traditional material culture in Acadia). In *L'Acadie des Maritimes*, ed. Jean Daigle, 601–48. Moncton, NB: Université de Moncton, Chaire d'études acadiennes.

LeBreton, Clarence. 1980. Civilisation matérielle en Acadie (Material culture in Acadia). In *Les Acadiens des Maritimes*, ed. Jean Daigle, 467–520. Moncton, NB: Centre d'études Acadiennes.

Leonard, Kevin. 1991. The origin and dispersal of dykeland technology. *Les Cahiers de la Société historique Acadienne* (Memoirs of the Acadian Historical Society) 22 (1): 31–59.

Le Quellec, Yves, ed. 1993. *Le Marais poitevin entre deux eaux* (The Marais Poitevin between two waters). Mougon, France: Geste Editions.

Lescarbot, Marc. [1617] 1911. *The history of New France*. Translated by W. L. Grant, including the French text. 3 vols. Toronto: The Champlain Society.

MacBeath, George. 1966a. Forrester, Andrew. In *Dictionary of Canadian biography*, vol. 1, 310–11. Toronto: University of Toronto Press.

———. 1966b. Razilly, Isaac de. In *Dictionary of Canadian biography*, vol. 1, 567–69. Toronto: University of Toronto Press.

Marques Mano, M. 1947. Visita à Guiné (View of Guinea). *Boletim Cultural da Guiné Portuguesa* (Cultural Bulletin of Portuguese Guinea) 11:467–512.

Massignon, Geneviève. 1963. La seigneurie de Charles de Menou d'Aulnay, gouverneur de l'Acadie, 1635–1650 (The seignory of Charles de Menou d'Aulnay, governor of Acadia, 1635–1650). *Revue d'histoire de l'Amérique française* (Historical Review of French America) 16:469–501.

McIlwraith, Thomas F. 2001. British North America, 1763–1867. In *North America: The historical geography of a changing continent*, ed. T. F. McIlwraith and E. K. Muller, 207–34. 2nd ed. Lanham, MD: Rowman and Littlefield.

McNabb, Debra A. 1986. Land and families in Horton Township, Nova Scotia. M.A. Thesis, Department of Geography, University of British Columbia.

Monod, Théodore, R. Mauny and G. Duval. 1959. *De la première découverte de la Guinée: Récit par Diogo Gomes (fin xv siècle)* (The first discovery of Guinea: Recounted by Diogo Gomes [late fifteenth century]). Bissau: Centro de Estudos de Guiné Portuguesa.

Monod, Théodore, A. Teixeira da Mota, and Raymond Mauny. 1951. *Description de la Côte occidentale d'Afrique par Valentim Fernandes (1506–1510)* (Description of the west coast of Africa by Valentim Fernandes [1506–1510]). Bissau: Centro de Estudos da Guiné Portuguesa.

Morse, William I., ed. 1935. *Acadiensia Nova, 1598–1779: New and unpublished documents and other data relating to Acadia*. 2 vols. London: Bernard Quaritch.

Mota, A. Teixeira da. 1954. *Guiné Portuguesa* (Portuguese Guinea). Vol. 1. Lisbon: Agéncia Geral do Ultramar.

National Archives of Canada (NAC). 1671. Familles establies a l'Acadie (Families established in Acadia). Ottawa: National Archives of Canada, G1–466, reel F–768, folios 1–13.

Nova Scotia Department of Agriculture and Marketing (NSDAM). 1987. *Maritime dykelands: The 350-year struggle*. Halifax: Nova Scotia Department of Agriculture and Marketing.

Perdue, Peter C. 1987. *Exhausting the Earth: State and peasant in Hunan, 1500–1850*. Cambridge, MA: Harvard University Press.

Rameau de St. Père, Francois-Edmé. 1889. *Une colonie féodale en Amérique: L'Acadie, 1604–1881* (A feudal colony in America: Acadia, 1604–1881). 2 vols. Montréal: Granger.

Randsborg, Klavs. 1992. *From Roman Empire to medieval society*. Cambridge, U.K.: Cambridge University Press.

Riou, René. 1907. *Les marais desséchés du Bas-Poitou* (The drained marshes of Lower Poitou). Paris: Librairies des Facultés, A. Michalon.

Rousseau, Jacques. 1966. Dièreville. In *Dictionary of Canadian biography*, vol. 1, 188–89. Toronto: University of Toronto Press.

Roy, Muriel K. 1980. Peuplement et croissance démographique en Acadie (Settlement and demographic growth in Acadia). In *Les Acadiens des Maritimes*, ed. Jean Daigle, 135–209. Moncton, NB: Centre d'Etudes Acadiennes.

Rumilly, Robert. 1955. *Histoire des Acadiens* (History of the Acadians), vol. 1. Montréal: Imprimerie St. Joseph.

Ryder, Huia. 1966. Biencourt de Poutrincourt et de Saint-Just, Jean de. In *Dictionary of Canadian biography*, vol. 1, 96–99. Toronto: University of Toronto Press.

Schott, Carl. 1955. *Die kanadischen Marschen* (The Canadian marshes). Schriften des Geographischen Instituts der Universität, vol. 15, no. 2. Kiel: Geographisches Institut der Universität.

Seed, Patricia. 1995. *Ceremonies of possession in Europe's conquest of the New World, 1492–1640*. Cambridge, U.K.: Cambridge University Press.

Slicher van Bath, B. H. 1960. The rise of intensive husbandry in the Low Countries. In *Britain and the Netherlands*, ed. J. S. Bromley and E. H. Kossmann, 130–57. London: Chatto and Windus.

Stewart, Frances L. 1989. Seasonal movements of Indians in Acadia as evidenced by historical documents and vertebrate faunal remains from archaeological sites. *Man in the Northeast* 38:55–77.

Te Brake, William H. 1985. *Medieval frontier: Culture and ecology in Rijnland*. College Station: Texas A&M University Press.

Traina, Giusto. 1988. *Paludi e bonifiche del mondo antico: Saggio di archeologia geografica* (Marshes and reclamation in the ancient world: Essay in geographical archaeology). Rome: L'Erna di Bretschneider.

Tratt, Grace M. 1969. Deschamps, Isaac. In *Dictionary of Canadian biography*, vol. 2, 250–52. Toronto: University of Toronto Press.

Trudel, Marcel. 1966. Champlain, Samuel de. In *Dictionary of Canadian biography*, vol. 1, 186–99. Toronto: University of Toronto Press.

———. 1997. *Histoire de la Nouvelle-France IV: La seigneurie de la Compagnie des Indes occidentales, 1663–1674* (History of New France IV: The seignory of the West India Company, 1663–1674). Montréal: Fides.

Veen, Johan van. 1955. *Dredge-drain-reclaim*. 4th ed. The Hague: Martinus Nijhoff.

Verger, Fernand. 1988. *Marais et wadden du littoral francaise: Etude de géomorphologie* (Marsh and mudflats of the French coast: A geomorphological study). 3rd ed. Caen: Editions Paradigme, Collection Terre et Société.

Verhulst, Adriaan. 1966. *Histoire du paysage rural en Flandre de l'époque romaine au xviiie siècle* (History of the rural landscape in Flanders from the Roman period to the eighteenth century). Brussels: La Renaissance du Livre.

Vierlingh, Andries. [1570] 1920. *Tractaet van Dyckagie* (Treatise on dykology). Edited and with extended summary in modern Dutch by J. de Hullu and A. G. Verhoeven. The Hague: Martinus Nijhoff.

Vos, P. C., and R. M. van Heeringen, 1997. Holocene geology and occupation history of the province of Zeeland (SW Netherlands). *Mededelingen Nederlands Instituut voor Toegepaste Geowetenschappen* (TNO) (Communications of the Netherlands Institute for Applied Geosciences) 59:5–109.

Correspondence: Department of Geography, University of Texas at Austin, Austin, TX 78712, e-mail: laguna@mail.utexas.edu.