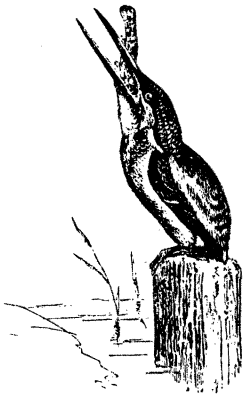
Hydraulic Technologies and the Agricultural Transformation of the English Fens



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To the zoologist or ornithologist whizzing by train through the English fenland north of Cambridge the landscape presents a dreary aspect. Endless plains are broken only by the straight lines of ditches and canals in geometric patterns imposed as if by a cookie cutter on the black soil dough of the flattened earth. The silence is interrupted only by the clacking of the wheels or by the blast of the whistle as the train approaches a cross road. In spring sharp ears may catch the song of a Reed Bunting or Sedge Warbler; in winter a practiced eye may spot the now rare Stonechat. A few willows or alders dot the horizon and the traveller occasionally glimpses a fen farmer plowing the rectangular fields of wheat, oats, and rye.[1]

Yet this same country to the eyes of the engineer presents a rare beauty unequalled in other parts of England. It is a land wholly subdued and improved by technology, transformed from a dismal gnat-plagued swamp-breeding ground for fevers and rheumatisms into a land of smiling farms and prosperous families.[2] Yet the fenlands of Lincolnshire and Cambridgeshire did not always convey the stark geometric quality whose prospect pleases some travelers and appalls others. The pivotal period of change was the 17th century, a time when older traditional modes of fenland subsistence gave way to a newer style of market production, a time in which fenland ecology was irrevocably altered by hydraulic technology.

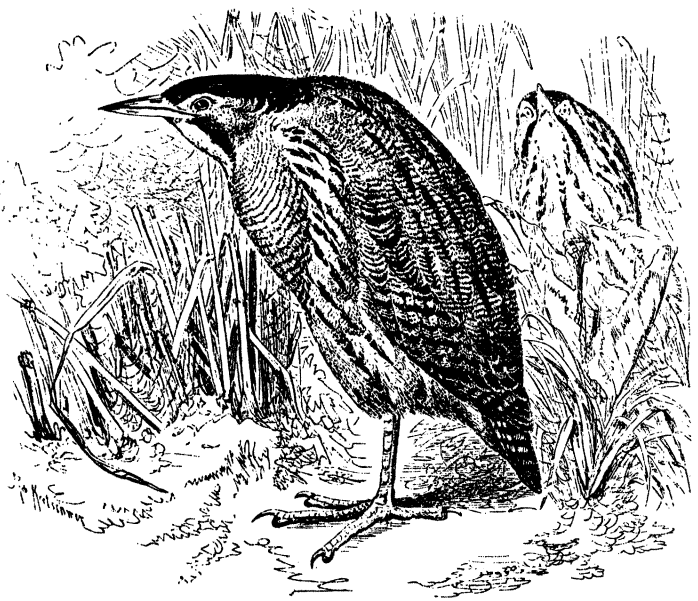
In microcosm the fenland story has been told again and again in developing nations - a story of struggle between ecology and technology as human interventions compete with nature's creations. The case study that follows provides a unique opportunity to examine the effects of technological additions to dynamic ecosystems on modes of production both human and natural. How do new technologies affect the environmental side of the culture-nature equation? How do they alter human modes of production? Should historical case studies play a role in the formulation of environmental impact assessments and the implementation of environmental policies?

The fen country of England, a region north of London and Cambridge, had been in the Middle Ages a vast area of marshes and open waterways fluctuating between pastures in the dry summers and flooded meres in the rainy winters.[3] History books do not customarily recount the teeming natural life of the predrained fens, choosing instead to dwell on the great draining and embankment achievements that have

tamed these marshes and rendered them fit for extensive agriculture. Yet accounts of a rich natural life gleaned from assorted sources throughout the ages vividly recreate a world that has been lost.

> "The Isle of Ely," we discover from a twelfth century manuscript, "is itself plentifully endowed, it is supplied with various kinds of herbage, and for its richer soil surpasses the rest of England. Most delightful for its charming fields and pastures, it is also remarkable for its beasts of chase, and is in no ordinary way fertile in flocks and herds. Its woods and vineyards are not worthy of equal praise, but it is beset by great meres and fens as though by a strong wall. In this isle there is an abundance of domestic cattle and a multitude of wild animals; Stags, Roes, Goats and Hares are found in its groves and by these fens. Moreover, there is a fair plenty of Otters, Weasels and Polecats, which in a hard winter are caught by traps, snares, or by any other device. But what am I to say of the kind of fishes, and of fowls, both those that fly and those that swim? In the eddy at the sluices of these meres are netted innumerable Eels, large Waterwolves - even Pickerels, Perches, Roaches, Burbots and Lampreys, which we call Water-snakes. . . . As to fowls, there are numberless Geese, Fiscedulae, Coots, Didappers, Watercrows, Herons and Ducks of which the number is very great. At midwinter or when the birds moult their quills, I have seen them caught by the hundred, and even by three hundred more or less, sometimes they are taken in nets and snares as well as by bird-line."[4]

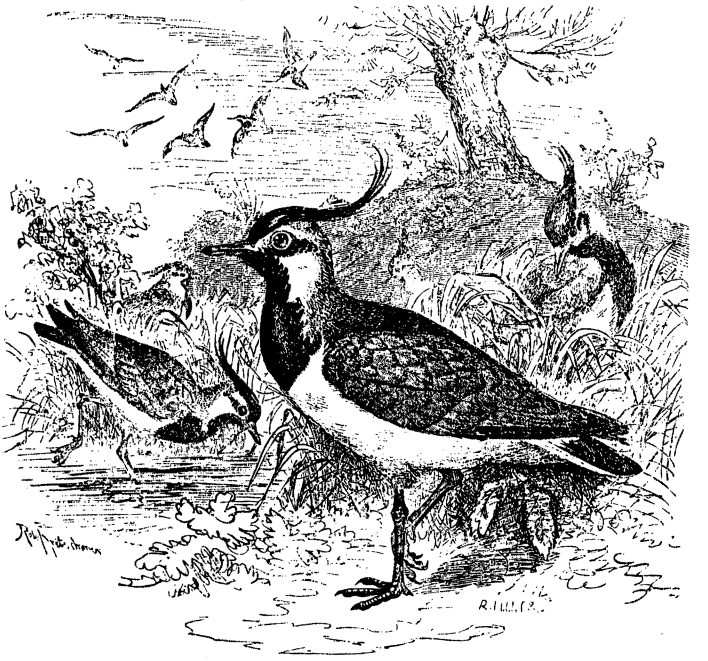
Isaac Casaubon who traveled with the Bishop of Ely through the fens in 1611 was struck by the birds of the marshlands, in particular by the godwit, or Dei ingenium, as he translated it, popular on London dinner tables; by the bittern, a bird of thundering voice, "so horrible" it was thought to be an evil spirit; and the Otis or



Dotterel delicate to the palate and said to mimic the fowler who if he "lifts one of his feet the bird does the same, if he extends an arm the bird extends a wing, and imitates all his actions."[5]

The birdlife of the undrained fens was recounted by Thomas Pennant in 1768 as he traveled through East Fen, "then in a state of nature:"

> The birds which inhabit the different fens are very numerous: I never met with a finer field for the zoologist to range in. Besides the common Wood-duck, . . . wild Geese, Garganies, Pochards, Shovelers, and Teals, breed here. I have seen in the East Fen a small flock of the tufted Ducks; but they seemed to make it only a baiting place. The Pewit Gills and black Terns abound; the last, in vast flocks, almost deafen one with their clamors: a few of the great Terns, or Tickets, are seen amoung them. I saw several of the great crested Grebes on the East Fen, called there Gaunts, and met with one of their floating nests with eggs in it. The lesser crested Grebe, the black and dusky Grebe, and the little Grebe, are also inhabitants of the fens; together with Coots, Waterhens,



Water-rails, Ruffs, Redshanks, Lapwings or Wipes, Redbreasted Godwits and Whimbrels. The Godwits breed near Washenbrough; the Whimbrels only appear for about a fortnight in May near Spalding, and then quit the country. Opposite to Fossdyke Wash, during the summer, are great numbers of Avosettas, called there Yelpers, from their cry. They hover over the sportsman's head like the Lapwing, and fly with their necks and legs extended. Knots are taken in nets along the shores near Fossdyke in great numbers during winter; but they disappear in the spring.[6]

The particular species of fish and fowl found in the undrained fens of the 16th century were products of a highly developed biological ecosystem. Based on energy from the sun that chemically converted material nutrients into biomass, the hierarchy of plants and animals that comprised the marsh's food chain had evolved over thousands of years. Into this natural system, governed by the laws of thermodynamics, the fen dwellers of more recent history had tapped all trophic levels of the food chain for survival, from gathering green plants for fodder and food, reeds for thatching and matting, to trapping pickerels, perches, geese, and otters.

These estuaries were not only excellent sources of protein, but sinks for nutrient rich silt washed down stream by the fens' major river systems. Commoners practiced agriculture on the summer pastures created as the rivers seasonally drained the fenny waters off to the sea. Peasant tradition had maintained a balance between humans, animals, crops, and soils for hundreds of years as the resources of the commons were shared in exchange for service to the lords. Those who used the fens primarily for sustenance operated close to the natural productive base. Nobles and kings who hunted deer on the Hatfield Chase and traders who fattened godwits for the London market withdrew energy from the higher trophic levels.[7]

The draining of the English Fens during the 17th century provides a vivid example of the effects of technology on human and natural ecology. It is the technologically productive capacities of human beings that make it possible to remove large surpluses from the environmental base for use as resources in human rather than natural production-surpluses that lead to the withdrawal and accumulation rather than the recycling of materials. Disruption of the fen ecosystem abruptly increased with the introduction of Dutch hydraulic technologies that created winter pastures to serve the growing wool and agricultural markets. Over the next three centuries drainage and reclamation transformed the region into rectangular fields of grain, sugar beets, and potatoes outlined by dikes, sluices, pumps, and windmills. Progress, commerce, and technology permanently transformed the ecological balance of nature and the economic livelihoods of the people who had called the fen their own.[8]

Much like the American frontier, the fenlands had seemed to some to be an immense wilderness, filled with thickets, foul streams, and an island "which ofttimes many men had tried to inhabit, but no man could do it on account of manifold horrors and fears, and the loneli-

The Raven

ness of the wide wilderness."[9] The fen dwellers themselves had an equally unsavory reputation, as gloomy and dour as the marshlands in which they had made their home. In 1610 William Camden had painted a picture of the fenmen as "a kind of people according to the nature of the place where they dwell rude, uncivil, and envious to all others whom they call Upland-men: who stalking on high upon stilts, apply their minds, to grazing, fishing, and fowling."[10] William Dugdale dubbed them as "a rude, and almost barbarous, sort of lazy and beggarly people."[11] In the eyes of the drainers, technological improvement could only enhance the condition of both men and mere.

Although sporadic attempts at reclamation had been made for centuries, systematic efforts to drain the fens had been stimulated by visits of Englishmen to Holland in the late 16th century, and by emigrating Dutch who sought refuge from the Spanish. High prices and severe flooding added incentive. Some schemers asserted that God's design for the rivers and channels must be preserved and merely cleansed of silt. Opponents vociferously argued that the flat gradient of the area made it necessary to alter the course of the Deity's rivers to increase their outflow. One of the latter was the Dutchman Cornelius Vermuyden.[12]

In 1626 Charles I contracted with Vermuyden to drain Hatfield Chase, an area famous for its Red Deer, but lacking in agricultural value and inhabited by many poor people. In return Vermuyden was to receive one-third (4554 acres) of the drained ground, and agreement was made to allot 6000 acres to those who had rights of common. Five years later Vermuyden's engineering had transformed the Chase. Its once meandering waters now flowed through drains into the River Trent, a sluice blocking its backflow at flood tide but allowing outflow at ebb. Ditches prevented the sluggish waters from overflowing during periods of heavy rain, and the inflow from the Don River was cut off by embankments forcing it north to the River Aire. Following this apparent success Vermuyden in 1634 was invited to draw up a plan for straightening the natural course of the Bedford River. Using capital solicited from fourteen entrepreneurial adventurers under the direction of the Earl of Bedford, Vermuyden imposed a series of cuts, drains, and sluices to increase the river's gradient, thereby producing summer pasture and lessening the impact of winter flooding.[13]

The benefits were widely heralded - new lands were sown with crops; new houses were erected; harvests, land values and wages increased; and beggars disappeared. On his portion, Vermuyden built a new town that became a refuge for French and Belgian Protestants and took out a lease of 24,500 acres on which Dutch and Flemish workers could settle.

Yet this idyllic scene created by the most advanced drainage technology of the time was both technically and socially flawed. As the creative force by which humans attempt to rise above their material conditions, technology is seldom separable from the particular social, political, and ecological situations into which it is introduced. Vermuyden soon discovered that the problem of river regulation made fen drainage more complex than the polder, canal, and sluice construction needed to hold back the sea in his native Netherlands. The increased northern flow of the Don caused flooding in adjacent lands making necessary an expensive new canal to repair the damage. Further, as the exposed peat surface dried, it shrank, lowering the land and altering the gravitational outflow thus requiring a technological fix - the pump. Drainage mills, operated by wind, man, or horsepower, driving scoops or chains of buckets were soon require in the drained lands. Dutch technology was again imported.[14]

In addition, technological innovation initiated a struggle between two modes of human production as the subsistence use-value economy indigenous to the fens was undermined by an expanding commodity-oriented market agriculture. Landlords, capitalist adventurers, and a few of the wealthier peasants who could afford pasture leases were the primary beneficiaries of the newly drained lands, soon planted with oats, other grains, and coleseed. But most of the projects had irrevocable effects on "the faces of thousands of poor people."[15]

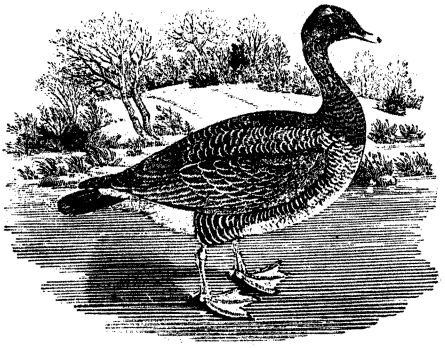
Increasing population, combined with land enclosures through which the landlords exercised their seigneurial grazing rights, had already created a shortage of pasture for commoners. The drainage operations cut these common lands to one-third their former size. Near the villages drier lands previously harvested for winter fodder were depleted by summer grazing. With the shortage of fodder, fewer animals survived the winter, making less manure available the following spring. Soil fertility and crop yields on the commons declined.[16]

Leasing the newly drained land to capitalist adventurers antagonized the native fenlanders whose forefathers had held rights of common. In 1631 fendwellers took action against a drainage project in

the north sponsored by Sir Anthony Thomas. Seven years after their lands had first been planted with crops of the intruders, rioting fen people took up arms against the drainers, "broke sluices, laid waste their lands, threw down their fences, spoiled their corn, demolished their houses, and forcibly retained possession of the land."[17] In 1642 as the English Civil War was breaking out, the commoners of the region of Hatfield Chase, asserting that their commons had been violated, broke down the fences that enclosed the drained lands, and destroyed the crops and homes of the newly settled Dutch and Flemish immigrants. Thereupon they demolished the flood gates that controlled the tides on the River Trent and flooded the Chase, forcing the new inhabitants to swim "like ducks" to safety. Guarding the area with muskets they controlled the gates, opening them to flooding at high tide and closing them at ebb to insure that floods remained on the plain. Rallying to the cause, inhabitants of nearby Millerton destroyed another sluice causing additional overflows of the Trent onto fields stacked high with grain. Three years later residents of Axholme releasedcattle into the pastures of the adventurers. At the Manor of Epworth, commoners devastated 14,000 acres of land planted in rape and grain, and numerous houses and plows.[18]

To the aid of the fenlanders' rebellion came Daniell Noddel, solicitor for the inhabitants, who with 400 persons turned back the parliamentary forces sent to quell the rioters. Confiscating cattle and inciting riots, the fenlanders demolished houses, barns, stables, and outhouses along with vast amounts of wheat and rape. A local Justice of the Peace, saw to it that only minimal fines were imposed on the guilty.[19]

In another instance, frustrated commoners who had tried by petition to halt the projects, destroyed all the "drains and buildings," of the Earl of Lindsey, devastating his "crops then ready to be reaped, . . . to the great decay and ruin of those costly works."[20]



The Grey Lag Goose

Fen people maintained solidarity in the taverns where they composed drinking songs against the drainers and the Dutch:

> Come Brethren of the water, and let us all assemble,
> To treat upon this matter, which makes us quake and tremble
> For we shall rue it, if't be true, that Fens be undertaken,
> and where we feed in Fen and Reed, they'll feed both Beef and [Bacon.
>
> . . . .
>
> The feather'd fowls have wings, to fly to other nations;
> But we have no such things, to help our transportations;
> We must give place (oh grievous case) to horned beasts and [cattle.
> Except that we can all agree to drive them out by battle.[21]

Buttressing these social protests and technological problems were the ideological arguments of the objectors and anti-projectors who opposed the fen projects on both "ecological" and social grounds. To some, interfering with the design of nature could not be justified because "fens were made fens and must ever continue such." "It the wisest and best course . . . not to intermeddle at all with that which God hath ordained." Winter floods, served an important function in making the summer meadows more fruitful: "overflowing much enricheth those grounds, so that more draining would be very hurtful to them. These grounds . . . cannot be spared or bettered by the industry of the undertakers." Draining the fens often made them too cold for pasture and their value decreased.[22]

Fodder grown in the summer fed cattle in winter, whose manure enriched the soil and increased grain yields. The fens made it possible for upland cattle to survive a dry summer and to maintain needed supplies of butter, cheese, beef, hides, and tallow. Moreover the undrained fens harbored a "great plenty and variety of fish and fowl, which have their seminaries and nurseries; which will be destroyed on draining." Reeds were useful for mats, beds, and hassocks in the village cottages and churches.[23]

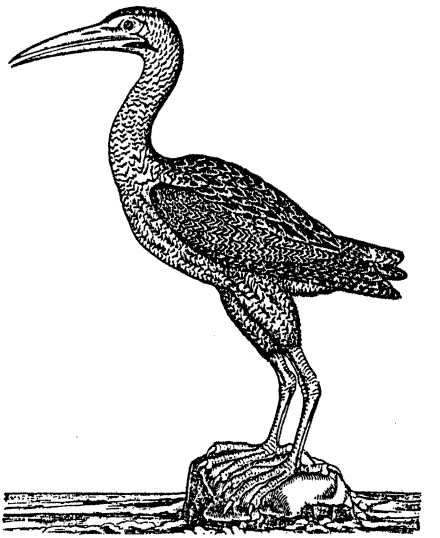
The drainers disagreed. Domesticated sheep were more useful than wild fowl; cattle provided more food than eels; grain was superior to sedge. The dank air and boggy earth of the fens produced illness, while the putrid water was "muddy and full of loathsome vermin."

"Swarms of stinging gnats and troublesome flies" were a constant nuisance. In winter when ice blocked boats, no woman in labor could be aided, no child baptized, no sick person nursed.[24]

One need not worry, prophesied William Dugdale in 1662, about the decrease in abundance of some birds and fish. There were plenty of other meres and lakes "still continuing." Moreover, "the rivers, channels, and meres... being now increased will rather augment than diminish their store."[25] Great profits from the drained meadows would accrue to the commonwealth, asserted the unknown H.C., in the form of "wool, hides, tallow, hemp, [and] rape." Horses, sheep, and cattle would be cured of rot making the poor rich.[26]

During the ensuing years, drainage projects continued in the name of progress, commercial growth, and national supremacy. Advancing "the trade of clothing and spinning of wool," increasing "manufactures, commerce, and trading at home and abroad," they relieved the "poor by setting them on work,...redound[ing] to the great advantage and strengthening of the nation."[27]

But these increases in the productivity of the land were not shared by the original occupants of the marshes--the fish, fowl, and marsh plants that over thousands of years had evolved a complex set of ecological interdependences. Gone today are as many as twenty percent of the birds once abundant in the area of Cambridgeshire. Almost the entire region is cultivated and flat, with few hedgerows and no large stretches of open water for breeding, the last mere having been drained in 1851. The once common Bittern had decreased markedly by 1800; the Grey Lag Goose, formerly a regular resident, last bred there in 1773. The last recorded nest of the Black Tern was in 1825; the Black-tailed Godwit vanished soon after. The Corn Crake and the once abundant Quail have been reduced to local occurrences, their near demise a product of altered ariculture. Removal of waste materials from the fens has discouraged the Kite and the Raven. Drainage has been responsible for the disappearance of the Bearded Tit, Savi's Warbler, Marsh Harrier, Water Rail, and Spotted Crake. The few species that have increased or been attracted to the new environment are vastly outnumbered by those lost.[28]

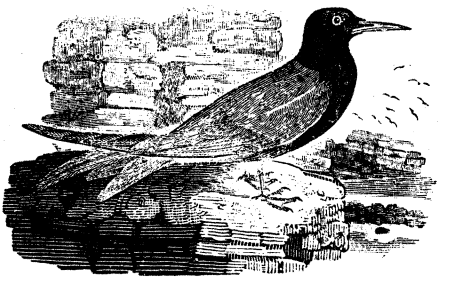


The Bearded Titmouse

The twentieth century has inherited many of the technological problems already apparent in the seventeenth. Constant peat shrinkage lowers land and drains, necessitating installation of powerful steam and diesel engines. Weakened river banks need constant maintenance against seepage and flooding. Yet the rich black peat soil has made the fenlands among the most properous in the country for wheat, sugar beets, fruits, and vegetables.[29]

What does a case history such as the drainage of the fens reveal about technological additions to dynamic ecosystems? Technology as an act of human production functions, first of all, to distance people from their natural surroundings and to render human dependence on the ecosystem less visible. In the fens, drainage technology created a new resource - soil - for use in the production of agricultural surpluses for export from rural to more distant cities to feed an expanding urban population. The windmill and later the steam and diesel engine substituted inanimate energy for human labor in the maintenance of an artificially created agricultural ecosystem. This amplification of energy further decreased apparent dependence on nature and increased apparent control over it. Yet each successive energy amplification is accompanied by increased entropy and disorder in the surroundings.

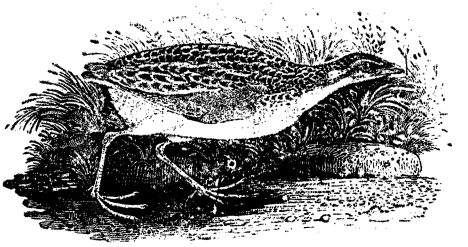
Secondly, technological additions to ecosystems tend to reduce diversity. Estuaries serve as breeding grounds for edible fish and shellfish and are among the most productive protein sources in the world. Traditionally such areas have been dredged, drained, polluted, poisoned, and filled. Drainage technology resulted in withdrawals from the fen ecosystem by removing energy niches from the trophic pyramid, thereby decreasing the diversity of natural species. More and more of the original fenland was drained and reclaimed resulting in fewer niches along borders for beneficial birds, insects, and their life support bases. The fenlands of England, of course, were not in a static state nor had they reached a mature stage of ecosystem succession by the time they were drained. But after drainage their diversified food webs necessarily reverted to a more simplified stage of



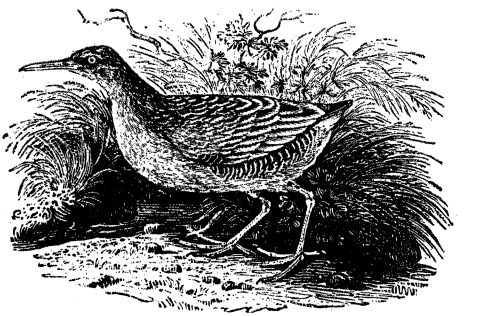
The Black Tern

succession characterized by monocultures of wheat, oats, rye, flax, and sugar beets. The rich soil made them highly productive of a few crops for human use, but diversity and stability were low, hence vulnerability to pests and weeds high. Today the ecosystem withdrawals created by drainage are accompanied by ecosystem additions in the form of chemical fertilizers, herbicides, and pesticides with long lasting side-effects.

Thirdly, technology intervenes in human modes of production. The uprisings of the fen dwellers, as part of the struggle between subsistence and early capitalist modes of production are illustrative of the disruptions in human ecology that occur as nature is subdued in the name of profit, individual status, national power, and human welfare. Built into the emerging capitalist market economy that arose in England in the early modern era was an accelerating force of expansion and accumulation advantageous to many, but ultimately achieved at the expanse of the local community and the local environment. Damned by the fen dwellers and eulogized by the adventurers, drainage technology played a pivotal role in the struggle.



The Land-Rail or Corn-Crake



The Water Rail

Along with the long-range costs to the environment and subsistence fenlanders, immediate benefits to other humans have occurred. The diseases and inconveniences of insects, the dank air of the marsh, and the inconvenience of travel have disappeared. Thousands of urbanites can now be fed, increasing their well-being and releasing their labor for other productive work and cultural contributions.

Today it is not feasible to return to the conditions of the undrained fens. Nevertheless environmental policy must consider the long-term historical results of the drainage of estuaries, marshes, and bogs in arriving at decisions that affect the future. Important for fish and shellfish production, as gene reservoirs, and as sources of ecological diversity, estuaries and bogs cannot be dredged, drained, or filled without considering both the long-range ecological implications and the impact of such policies on local populations and indigenous peoples. ER

ENDNOTES

1 [Alfred Newton], "Review of Samuel H. Miller and B.J. Skertchly, The Fenland Past and Present (London, 1878)" in The Zoologist, 3rd series, 3 (1879): 69-70.

2 William Dugdale, History of Imbanking and Drayning of Divers Fens and Marshes (London, 1662), preface; Samuel Smiles, James Brindley and the Early Engineers (London, 1864), pp. 1-2, 18.

3 H.C. Darby, The Medieval Fenland (Cambridge, 1940).

4 Liber Eliensis, 12th century, quoted in The Zoologist, op. cit., pp. 71-2.

5 Isaac Casaubon, Ephemerides, ed. John Russell (1850), vol. II, pp. 867-8, 873, quoted by H.C. Darby, "Note on the Birds of the Undrained Fen" in David Lack, The Birds of Cambridgeshire (Cambridge, 1934), pp. 21-2.

6 Quoted in The Zoologist, pp. 76-7.

7 On ecology, marshes, and the food chain see G. Tyler Miller, Jr., Living in the Environment (Belmont, Ca.: Wadsworth, 1975), pp. 43-64, 173-6; On technology and ecology see Allan Schnaiberg, The Environment: From Surplus to Scarcity (New York: Oxford University Press, 1980), pp. 9-44, 113-121.

8 Joan Thirsk, English Peasant Farming:The Agrarian History of Lincolnshire from Tudor to Recent Times (London: Routledge and Kegan Paul, 1957), pp. 6-7, 111-29; H.C Darby, The Draining of the Fens (Cambridge, England: Cambridge University Press, 1956). See also Michael Williams, The Draining of the Somerset Levels (Cambridge, England: Cambridge University Press, 1970).

9 Life of St. Guthlac, ed. Goodwin (1848), p. 21, quoted by Darby in Lack, Birds of Cambridgeshire, p. 19.

10 William Camden, Britannia (1637 ed.), p. 491, quoted in Darby, Draining of the Fens, pp. 23-4.

11 Dugdale, History of Imbanking and Drayning (1662), p. 171.

12 L.E. Harris, Vermuyden and the Fens (London: Cleaver-Hume, 1953), pp. 41-53; idem "Land Drainage and Reclamation," in Charles Singer, ed. A History of Technology (New York: Oxford University Press, 1957), vol. III, pp. 300-323. Richard Hills, Machines, Mills, and Uncountable Costly Necessities: A Short History of the Drainage of the Fens (Norwich: Goose & Son, 1967), pp. 1-19.

13 Dugdale (1662), pp. 144-5; Harris (1953), pp. 44-7, 59-70.

[14] Dugdale (1662), pp. 145-6; Smiles, pp. 24-5, 47; Harris (1957), pp. 320-2. For a contemporary critique of Vermuyden see Andrewes Burrell, Exceptions Against Sir Cornelius Vermuyden for the Draining of the Great Fennes (London, 1642), 19 pp.

[15] Quoted in Darby, Draining of the Fens, p. 53, from The Anti-Projector (1646), p. 8.

[16] Thirsk, pp. 9, 125-9.

[17] Quoted in Darby, Draining of the Fens, p. 46.

[18] Dugdale (1662), p. 146.

[19] Ibid., p. 147.

[20] Ibid., p. 419.

[21] Quoted in Smiles, p. 35. An anti-Dutch ballad is quoted on p. 36.

[22] Quoted in Darby, Draining of the Fens, p. 49, 51. William Camden, Britannia (1637), p. 492.

[23] Darby, Draining of the Fens, pp. 52, 69.

[24] Dugdale (1662), preface; H.C. A Discourse Concerning the Drayning of the Fennes (London, 1629), p. A4.

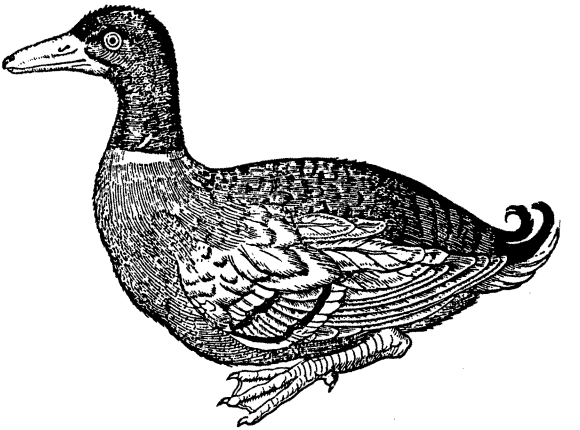
[25] Ibid.

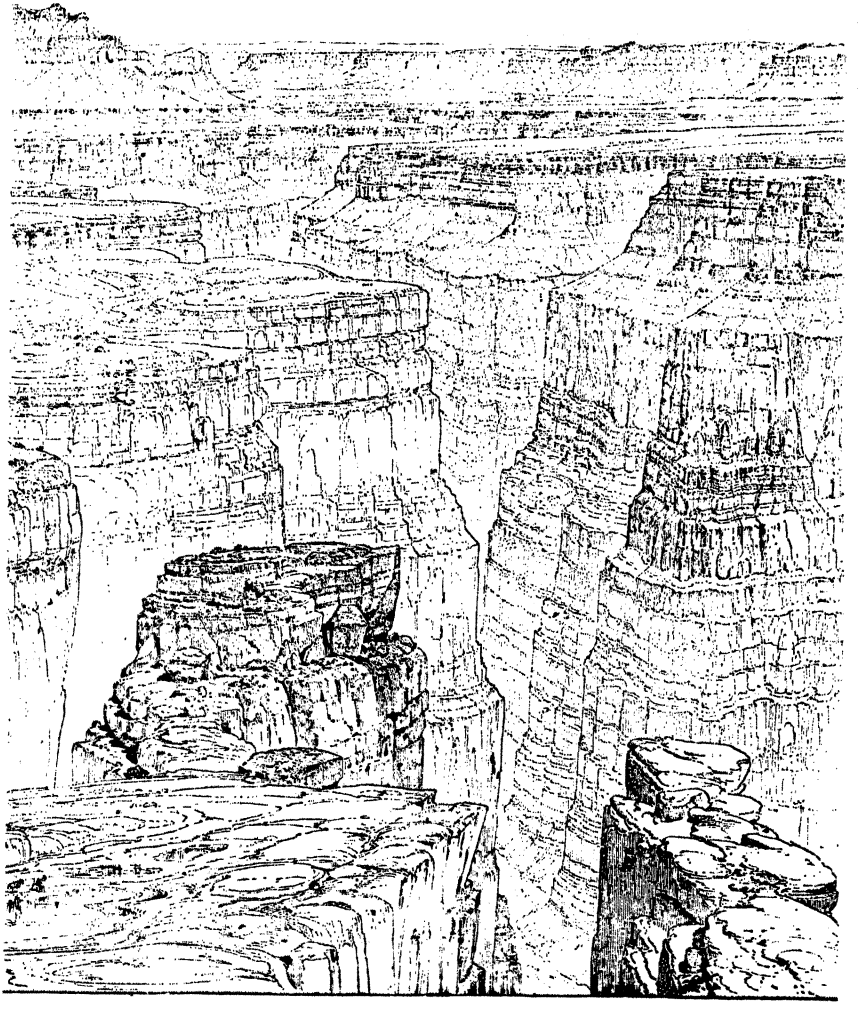
[26] H.C., Discourse Concerning Drayning, p. B.

[27] Quoted in Darby, Draining of the Fens, p. 68. See also William Dodson, The Design for the Perfect Draining of the Great Level of the Fens (London, 1665).

[28] Lack, Birds of Cambridgeshire, pp. 11-18, 25-8.

[29] Darby, Draining of the Fens, pp. 253-7.





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