1968


Theodore William Kury

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IN THE NEW YORK-NEW JERSEY HIGHLANDS: 1700-
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HISTORICAL GEOGRAPHY OF THE IRON INDUSTRY IN THE
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A Dissertation

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

in
The Department of Geography and Anthropology

by
Theodore William Kury
B.A., Montclair State College, 1959
M.A., Louisiana State University, 1961
May, 1968
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ABSTRACT

The substantial iron industry which developed in the New York-New Jersey Highlands during the eighteenth and nineteenth centuries has long been overlooked by scholars. Past investigations of the American iron industry have dealt largely with the earliest ironworks of New England and Virginia, the rise of the Pennsylvania manufactories, and the tremendous technological evolution and economic expansion which followed discoveries of bituminous coal and hematite iron ore west of the Appalachians.

The present study has a twofold purpose: (1) to describe and explain the processes of landscape change in the Highlands; and (2) to reevaluate the status of iron making as a pioneer activity.

The concept of landscape change is valid only after a frame of reference has been established—in this case, the pre-European setting. The present landscape provides little insight into what the first European may have encountered. Early records, travelers' accounts, and the like often have been limited in areal coverage. Interpolation has been necessary to fill many gaps in knowledge.

Agents of change and resultant features can be pursued easily. State, regional, and local sources of archival materials furnish
important clues. Extensive fieldwork has unearthed many vestiges of man's former occupations. Results of economic and technological evolution are evident in an analysis of vegetation, settlements, and transportation networks.

Time and technology combine to divide the study of changing landscape into two segments. Much of the two-hundred-year dominance of iron in the Highlands results from the growth and maturation of the charcoal industry. Tied closely to natural resources in the area—running water, verdant forests, abundant iron ore, and numerous outcrops of limestone—this era (1720-1840) brought about the most significant physical and cultural changes. The period of the Morris Canal, anthracite technology, and iron mining illustrates the myriad problems which led to the eventual decline of the iron industry within the Highlands.

A reassessment of the ironworker as the pioneer Highlands settler—a thesis espoused by several nineteenth-century chroniclers, including Tench Coxe and Thomas Gordon—is presented. After an examination of the journals of Charles Clinton and John Reading, the perusal of several early maps, and field study in the glaciated and nonglaciated Highlands, the author concludes that the hypothesis is actually modified and complicated by location within the Highlands and other factors. It is the unglaciated, fertile, and easily accessible areas of the southern Highlands that conform most strikingly to the settlement sequence described by Coxe and Gordon. Conversely, the demise of iron manufactories did not result in agricultural settlement of the northern Highlands. More
often than not, abandonment of an ironworks led to general depopulation of the surrounding lands.

The legacy of iron remains evident on the landscape. Much of the original forest cover has been restored after the introduction of anthracite coal. Nevertheless, ecological changes have occurred as a result of numerous cuttings, fires, and other alterations. The valleys have been cleared and are now devoted almost entirely to agriculture and commerce. Many of the towns founded as markets or shipping points for iron still serve important regional functions. Moreover, descendants of miners and ironworkers occupy the lands of former manufactories or may be found engaged in various economic activities within the study area.
INTRODUCTION

During the eighteenth century, incipient industrial development could be seen on the emerging American landscape. Textiles, leather goods, shipbuilding, glassmaking, and the manufacture of salt played prominent roles in the manufactural activities of the American colonies. From a rather inauspicious debut at Saugus, Massachusetts, in 1645, born of European invention and hampered by regulation from England, an American iron industry developed into the established world leader in technology and production.

In this paper the author will deal with a small, but significant area of the eastern seaboard--the Highlands of New York and New Jersey. Within the region, the iron industry evolved from one based on production methods borrowed from seventeenth-century Europe to the achievements of modern iron-making techniques.

The impact of the iron manufactory on the Highlands was great, and, in many cases, produced lasting impressions. As technology changed, so did the landscape, for each progressive step placed additional burdens on the land and altered the perception of its natural resources. The opening of new and potentially valuable lands induced settlement by peoples of diverse skills and varied ethnic and racial backgrounds. Entire economic and social units were established. Towns were founded, manufactories, farms, and mills were developed, and routes of commerce were fixed. The landscape no longer was the province of nature, but rather became the realm of man.
A Statement of Purpose

The importance of the Highlands iron industry has often been obscured because of (1) early colonial developments in New Jersey's Pine Barrens, New England, and Virginia; (2) eighteenth-century manufacturing activity in eastern Pennsylvania; and (3) nineteenth-century ascendancy of the Adirondack Mountains region of New York, the Lake Superior district, and the Upper Ohio River Valley. Hopefully, the present undertaking will give Highlands iron its rightful place in the industrial development of the eastern seaboard.

To many observers in the nineteenth century, European settlement in the study area was a direct outgrowth of its iron potentials. The forge was uniformly the precursor of the farm and after the land had been exhausted of its timber and iron, it was subdivided into farmsteads. Statements by Tench Coxe, published as part of the Third Census of the United States, and Thomas Gordon amply support this sequence. While in several instances the ideas of Coxe and Gordon were valid, the writer will attempt to show that the thesis was actually modified and complicated by location within the Highlands and other factors.

Available literature on the iron industry of the Highlands (see following section) has overlooked many items of interest to a geographer. We seem to know the origins of the iron industry, its technology, and its routes of dispersal in Europe and along the eastern seaboard quite well. However, the processes of landscape
change have not been clearly shown. No attempt has ever been made
to trace the sequential development of the iron industry on a regional
or local scale. As agents of change, what part did economic and
technological evolution play in modifying the landscape? How much of
the present Highlands landscape is attributable to the iron industry?
The magnitude of change wrought by the iron industry in the Highlands
is regarded as a central problem in this study.

Survey of the Pertinent Literature

The literature dealing with the iron activities along the
eastern seaboard has largely been contributed by scholars in fields
other than geography. Pioneering works by Lesley, Bishop, Pearce,
Swank, and Clark were either devoted to general surveys of the
industry or descriptions of the most notable manufactories of the
period. In more recent years, volumes have been devoted to economic
problems of the eighteenth and nineteenth centuries, types of iron
manufactories, or studies of specific iron-producing sites.

Historians have also contributed substantially to the inform­
ation relevant to the Highlands iron industry. Since its publication,
the work of Boyer has been regarded as the definitive compilation of
New Jersey's forges and furnaces. Recently, a similar volume was
devoted to the manufactories in the Hudson Highlands and Ramapo
Mountain. Although geographers have exhibited greater interest in
the Highlands iron industry than that of other areas on the eastern
seaboard, these studies are only portions of a larger work. It seems
that few geographers have studied the iron industry of this period per
se; even fewer have written about it.
Methods and Procedure

Time and technology combine to divide the study into two major segments. Much of the two-hundred-year dominance of iron in the Highlands resulted from growth and maturation of the charcoal iron industry. Tied closely to the natural resources of the area, this era (1720-1840) brought about the greatest cultural and physical changes. The period of anthracite technology and iron mining illustrates the myriad problems which led to the eventual decline of the iron industry within the Highlands.

The concept of landscape change is valid only after a frame of reference has been established--in this case, reconstruction of the pre-European setting. Unearthing of essential information on the region often proved to be an arduous and discouraging task. The present landscape provided little insight into what the first Europeans may have encountered. Surveyors' records, travelers' accounts, early newspaper descriptions, and the like were perused, but the sources were limited in their areal coverage. Interpolation was a necessity in filling the many gaps in knowledge. The author was mindful of the dangers of using data of diverse origins in order to complete a picture. Possibly the pitfalls were avoided.

The agents of change and resultant features were more easily pursued. State, regional, and local sources of archival materials provided important clues. Pictures, drawings, and daguerreotypes presented ample illustrations of the magnitude and kinds of change. Extensive fieldwork throughout the Highlands proved most rewarding. In many localities vestiges of man's former occupations were to be
found. Excellent examples of manufactories, waterwheels, houses, fencing, and settlements were viewed. Iron mines were explored and excavated forge and furnace sites were visited. Usually the discoveries were made only after several conversations with local folk and deviations from the present main roads of the region.

A study based on changing landscape due to economic and technological factors seems to have support in the methodology of geography.

The investigation of geographic phenomena within a region largely defined on economic grounds was initially presented by the German, Eduard Hahn. In this country, Kirk Bryan advocated the study of economic factors which might influence a region's development. Carl O. Sauer, in the presidential address to the Association of American Geographers, meeting in 1941, pointed out that geographers cannot study the present landscape without knowing its origins and this can only be done through historical reconstruction. Derwent Whittlesey devoted much energy to the study of sequent occupancy. Whittlesey concluded that it was necessary not only to discern population distribution, but also to detect why and when distributional changes occurred. The writer believes the principle is applicable to the forms of landscape change set forth in this study.
NOTES


CHAPTER I

PHYSICAL SETTING

The Highlands of New York and New Jersey constitute a portion of the Reading Prong of the New England Uplands. They are akin to the Blue Ridge Mountains in age, topography, and geomorphic history; however, the Highlands are more like the Uplands in rock composition and general elevation.

Politically, the study area is partly in the New York counties of Orange and Rockland and partly in Passaic, Sussex, Morris, Warren, and Hunterdon counties, New Jersey (Plate I).

Stretching from the Hudson River, below Cornwall, to the Delaware River, some twenty miles above Trenton, the northeasterly-southwesterly trending mountains are confined by the Great Valley (Kittatinny Valley) on the west and the Triassic Lowland on the east. Within the boundaries, the width of the chain varies from eight to twenty miles and extends some eighty miles in length.

Projecting notably above their surroundings, the highest and sharpest ridges and mountain masses are to be found in the north and west, then gradually diminish to a hilly or rolling character in the south and east. Numerous broad, rounded, or flat-topped ridges form rather discontinuous chains which are separated by deep and generally
narrow valleys. Individual mountain masses are somewhat oblique to the general trend which makes it possible to cross from one side of the range to the other in a north-northeast direction without surmounting any considerable elevations, while it is impossible to cross from southeast to northwest without rising over a succession of steep ridges.3

The geology and tectonic evolution of the Highlands have produced a varied topography. Precambrian extrusive and intrusive materials rich in iron dominate the hills and ridges. The intermontane valleys are floored with rather extensive sedimentary rocks--primarily limestone (Plate II). Evidence of metamorphism is found throughout the study region. Repeated folding and faulting have added to the area's complexity and diversity.4

Divisions of the Highlands

While the Highlands are essentially a physical unit, numerous valleys conveniently separate the region into three parts--the Western, the Central, and the Eastern Highlands (Plate I). Additional subdivisions have been recognized; however, they are usually based on local nomenclature.

Commencing north of the New Jersey state line, the Western Highlands consist of a series of more or less continuous, steep-sided ridges. Small valleys and depressions divide the range into Pochuck, Alamuche, Scott's, and Upper and Lower Pohatcong mountains. The broadest separation occurs near Franklin, New Jersey, where the valley of the Wallkill River effectively detaches Pochuck Mountain from the rest of the section.
New York-New Jersey

HIGHLANDS

Geology

- Gneiss
- Limestone
- Sandstone and Shale

Compiled from numerous sources
Differential erosion of the metamorphosed igneous and sedimentary rocks has produced a topography accentuated by moderate to strong relief. Throughout the range, crest lines are notably irregular. Nowhere are there extensive flats at high levels, and the highest elevations are more or less isolated. Nevertheless, this variability embraces an element of regularity in that the individual mountain crests are consistently even, being 1100 to 1200 feet high in the north, and somewhat lower in the south (Fig. 1).

The Central Highlands begin immediately south of the junction of the Kittatinny and Greenwood Lake valleys, near Monroe, New York. From that point, the chain follows an almost uninterrupted path to the Delaware River. Over much of its course, this range is much broader--often meriting the term "plateau"--and is much less dissected than the previously described Western Highlands. The plateau-like character is further enhanced by evidence of peneplanation, especially in the neighborhood of Schooley's Mountain. Steep slopes, of up to 400 feet, are largely confined to the margins of the section. Interior portions of the Central Highlands are dominated by moderately sloping hills and mountain masses, although several minor, near-vertical cliffs do appear. Elevations within the Central Highlands vary from approximately 1500 feet in the north to near half that figure in the south. Appreciable tilt and elevational decline toward the southwest contrast markedly with the Western range.

The last portion of the study area--the Eastern Highlands--is actually composed of two parts: the Passaic Range and Ramapo Mountain. Flowing diagonally across the eastern range, the narrow, incised valley of the Ramapo River effectively disconnects the latter from the former.
Gradually rising from the Hudson River to elevations over 1600 feet, the Eastern Highlands extends in a broad, dissected chain to its southern terminus along the South Branch of the Raritan River, near High Bridge, New Jersey. Although wider than its Western and Central counterparts--varying from seven to twelve miles--the plateau-like appearance of the latter range is almost entirely absent. However, the isolated mountain masses common in the other regions also appear here (Fig. 2).

Irregular topography and rather steep slopes combine to furnish some of the strongest relief found anywhere in the Highlands. Nevertheless, much of the eastern sector lies less than 1000 feet above sea level. The elevations are quite conspicuous along the eastern edge where the trenching of small streams has isolated the highest lands. The presence of a fault scarp facing the Triassic Lowland accentuates the relief and elevational differences over much of the eastern margin. Once again the even crest line, so characteristic of the western segment of the Highlands, provides an element of regularity in a disordered landscape.

Several river systems and their tributaries occupy the limestone-floored depressions which separate and cut the three primary Highlands chains (Plate I).

Lying within a discontinuous depression between the Western and Central Highlands, known as the Musconetcong and Vernon-Sparta valleys, are two streams--the Musconetcong and the Wallkill. Flowing southwesterly from Lake Hopatcong into the Delaware River, the
Musconetcong River is the longest of the Highlands watercourses. Its valley is composed largely of limestone, although shales are exposed south of Hackettstown. Valley depth is inconsistent, generally lying 300 to 400 feet below the adjacent mountains (Fig. 3). A rather wide, flat floodplain is dotted by numerous rolling hills of moderate elevation. Slopes everywhere tend to be gentle, although in the headwaters region, sharper, steeper slopes can be found.

The Wallkill River occupies the northern portion of the valley, coexistent with a belt of limestone materials. The stream escapes the Highlands near Franklin, and, as stated before, separates Pochuck Mountain from the remainder of the Western Highlands. Drainage throughout the Wallkill basin is somewhat disorganized and numerous swamps appear. A great deal of glacial material—till and outwash—is scattered over the valley floor and on small knolls. Due to the greater elevational differences between mountain and valley—up to 500 feet—slopes are far steeper than those seen in the Musconetcong area.

Portions of the other major Highlands rivers flow within the second great intermontane depression, the High Bridge-Greenwood Lake Valley. It has been described as one of the most remarkable valleys in New Jersey, not only for its continuity, but also for the absence of an uninterrupted stream of any sort. In the north, drainage is oriented toward Modna Creek and the Hudson River. Near the New York-New Jersey boundary, running water is directed into Greenwood Lake and the Wanaque River. The central sector drains into the important Pequannock River, flowing northwest-southeast across the Highlands. Drainage is somewhat less well defined in the southern portion; nevertheless, much
of the water ultimately empties into the Rockaway, Black, or South Branch of the Raritan river. The situation results from the undulating topography of the valley caused by the varying erosional resistances of sandstone, shale, and limestone (Plate II).

Valley width is coincidental with the band of sedimentary rocks which compose the depression's lithology. Somewhat constricted in the north, the valley widens considerably in the vicinity of Newfoundland, New Jersey. Near Wharton, it narrows again; however, some widening does take place a few miles to the south, in the German Valley. The limestone belt ends at High Bridge and the valley terminates there.

Along its entire extent, the valley is an imposing topographic feature, for it is generally situated from 300 to 600 feet below the summits of the Central and Eastern Highlands. The higher elevations of the former range provide slopes on the western side of the valley that are often greater and steeper than those along the eastern margin. In truth, the western slopes are so steep in places as to suggest escarpments formed by faulting. The following description of the valley near Green Pond, amply illustrates this point:

... [Green Pond Mountain] rises on the northwest side of the Pond, in abrupt, almost perpendicular bluffs, to the height of thirty, and sometimes forty, feet, and is composed of conglomerate and sandstone. These bluffs, which present an appearance very similar to the Palisades of the Hudson River, extend the entire length of the pond ... On the southeastern side the hills are more sloping, running down to water at an angle of not more than twenty or thirty degrees, and present many spots capable of cultivation.
In several places throughout the valley, grassy or sparsely timbered knobs of resistant sandstone or intrusive igneous material rise from the floor. Swamps and numerous lakes dominate the northern regions, while natural meadows are in evidence in the south.

All Highlands streams are subject to freshets or moderate floods in the spring as they try to accommodate the melting snow and ice of the region. Only in the event of unusually heavy snow accumulations or sudden melting do serious flooding and heavy damage take place.

Events during the Pleistocene did much to alter the configuration of Highlands landforms and topography. Glaciers once covered about two-thirds of the region as shown by the position of the terminal moraine (Plate I). The scouring and scraping action of the moving ice sharpened landforms, steepened slopes, and exposed large patches of bedrock near the tops of ridges. With glacial retreat, only the highest summits were spared a mantle of debris and morainal material. Scattered ponds, lakes, and wetlands occupy depressions in the glacial drift. Drainage is quite disoriented as the drift dammed many of the river valleys.

Several conspicuous topographic features owe their existence to the irregular distribution of the drift. Flatlands, notably those at Succasunna, are seen in various segments of the Highlands. Hills line the terminal moraine and are carved from drift accumulations in the Musconetcong Valley. Smaller drift-produced surface irregularities are found in the Vernon-Sparta Valley. Salisbury believed that the important topographic features had been developed before the deposition of the drift. Thus, features relating to the drift are strictly subordinate to those due to the lithology.
Distribution of the Iron Deposits

Location and formation of the veins of iron ore have been related to metasedimentary, crystalline limestone, and intrusive igneous formations. The ore zones are not sharply defined and some evidence for structural control has been found. Iron deposits consist of many short, parallel veins which form discontinuous belts, usually cropping out on ridges. Few important mineral occurrences can be found outside of these districts. The most productive mines were found near Andover, Dover, Franklin, Oxford, and Ringwood, New Jersey, and at Sterling Lake, New York (Plate III).

The primary iron ore in the Highlands is magnetite, and it is an essential constituent of the Precambrian rocks. The ore has been described as being massive, compact, and hard, although it occurs as granular aggregates—"shot ore"—and occasionally as crystallized cubes and octahedrons. The widespread nature of rocks stained by iron oxide indicates that metasomatism, or replacement of minerals by percolating waters, was responsible for the deposits of ore.

The ore bodies are pencil-like pods called "shoots" separated by lean vein rock, or "pinches." The dimensions of the concentrations vary considerably; however, the ore pods average five to twenty feet in width and are about 200 feet deep.

In addition to magnetite, deposits of limonite and hematite are evident in the Highlands. Limonite ores occur as small, scattered deposits in many valleys of the north. They are usually formed as a residual crust on decaying vegetation in areas of poor drainage. By their nature, the ores were never regarded as profitable by the Highlands ironworker.
New York - New Jersey
HIGHLANDS

Distribution of Iron Mines
- One iron Mine

Sources: Bayley (1910), Colley (1928)
Practically all of the hematite ore is a specular type of dark grey or black color, arranged in thin, parallel plates or rather finely ground scales and somewhat magnetic. Most occurrences are found in shallow, irregularly shaped basins near the tops of ridges. The mines at Andover were the only deposits successfully exploited in the study area.14

Soils

A modern soils map of the Highlands would bear a striking similarity to a geologic map of the region.15 The primary difference is between the glaciated and unglaciated portions of the study area. Many of the soils in the north are derived chiefly from glacial drift. This material is closely related to the underlying rock, particularly in those areas where the till tends to be thin. The southern soils almost wholly result from disintegration of bedrock. In the vicinity of the terminal moraine, soils are derived in part from glacial drift, outwash materials, decomposed bedrock, and muck, a remnant of ancient hydrographic features.

On the highland ridges and mountain masses, the presence of the gneissic bedrock is evident in the soils. Rock fragments—to boulder size—frequently pierce the thin soil cover on the slopes. Stoniness is a general characteristic everywhere. North of the terminal moraine, the land is covered by glacial till of variable depth. Accumulations of sand and gravel are found in shallow depressions, producing weak, droughty soil conditions. Some marshy hollows are also present.
South of the moraine, grittiness and stoniness prevail in the soils. Rock disintegration is well advanced and some bedrock fragments can be seen on the steeper slopes, where the finer materials have been washed away. On the broad highland ridges and gentle slopes, the soil is deep, loamy, and not very stony. These areas have been extensively cultivated, whereas, the steeper lands have been left uncleared. Some wetness appears in swales and on many broad, flat surfaces.

The intermontane valleys, too, show marked contrasts in their glaciated and nonglaciated sections. Glacial till is quite deep, and the bedrock--limestone, sandstone, and shale--is exposed only as knobby ridges or as fragments on slopes. Old terraces composed of drift lie adjacent to floodplains of alluvium derived from gneissoid materials. Limestone soils in the valleys of Pohatcong Creek and the Musconetcong River may be the richest in the study area. Even though much free lime has been removed, there is a fine, granulated texture in the present soils. Partly composed of material eroded from surrounding gneiss rocks, the loamy or silty surface material is deep and not very stony. Fertile and well drained, the land has been cultivated by white men for over two centuries.

Several areas of slate are found south of the terminal moraine, notably in the region of Hackettstown. Producing neither as well developed nor as deep a soil as that of the limestone districts, these sectors have not been intensively cultivated. Brownish in color, the soil often tends to thinness. In many places only rock fragments, a few inches deep, form the ground cover.
The region around the terminal moraine has certain characteristics of its own. Great complexity is to be found where stratified sands and gravels are intermixed with masses of unsorted fine and coarse materials. Although found elsewhere in the glaciated Highlands, nowhere are the conditions as pronounced as in the one- to three-mile-wide belt marking the southernmost advance of the glacier.

Along the southern margin of the moraine are scattered deposits of outwash materials. Notable are those located near Hackettstown, Morris Plains, and Succasunna—the last named being the largest. Sand and gravel of gneissoid origin predominate. Limestone is present only in minute amounts. Usually well drained, locally the plains are rather wet and marshy.

Mucklands in the Pequest River Valley are also associated with the Pleistocene glaciation. Inadequate drainage following glacial retreat produced shallow lakes. The lakes provided excellent sites for vegetation growth and the accumulation of partially decomposed plant remains. Draining uncovered masses of black, heavy clay. Prone to wetness, the lands were usually avoided by the early European settlers.

Climate

The climate of the Highlands is generally more severe in winter but little different in summer when compared to neighboring sections of New York and New Jersey. Several representative stations are given in Tables 1 and 2. Topography and elevation furnish ample possibilities for microclimatic variations within the study area.

Winter conditions are influenced largely by a succession of storms crossing the Great Lakes and moving along the St. Lawrence Valley.
### TABLE 1

**SELECTED HIGHLANDS TEMPERATURES**

<table>
<thead>
<tr>
<th>County</th>
<th>Station</th>
<th>Temperature (degrees)</th>
<th>Growing Season (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orange</td>
<td>West Point</td>
<td>28.3</td>
<td>74.6</td>
</tr>
<tr>
<td>Morris</td>
<td>Boonton</td>
<td>27.1</td>
<td>71.9</td>
</tr>
<tr>
<td>Morris</td>
<td>Dover</td>
<td>27.6</td>
<td>71.9</td>
</tr>
<tr>
<td>Passaic</td>
<td>Charlottesburg</td>
<td>27.7</td>
<td>70.9</td>
</tr>
<tr>
<td>Sussex</td>
<td>Newton</td>
<td>27.1</td>
<td>72.5</td>
</tr>
<tr>
<td>Warren</td>
<td>Phillipsburg</td>
<td>28.4</td>
<td>73.9</td>
</tr>
</tbody>
</table>

## TABLE 2
SELECTED HIGHLANDS PRECIPITATION

<table>
<thead>
<tr>
<th>County</th>
<th>Station</th>
<th>Precipitation (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orange</td>
<td>West Point</td>
<td>3.18</td>
</tr>
<tr>
<td>Morris</td>
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<tr>
<td>Morris</td>
<td>Dover</td>
<td>4.01</td>
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<tr>
<td>Passaic</td>
<td>Charlottesburg</td>
<td>3.74</td>
</tr>
<tr>
<td>Sussex</td>
<td>Newton</td>
<td>3.37</td>
</tr>
<tr>
<td>Warren</td>
<td>Phillipsburg</td>
<td>3.47</td>
</tr>
</tbody>
</table>

Coastal storms, which might provide a moderating effect, are deflected by the first range of mountains and rarely penetrate the Highlands except in areas bordering the Delaware and Hudson rivers. Monthly temperatures in December, January, and February average well below freezing, causing ice to form on smaller streams and at the headwaters of the major Highlands rivers. In the era of the waterpowered iron manufactory, icing was a chief cause for suspending operations.

Precipitation is well distributed throughout the winter months. Much of it occurs as snow—over fifty inches in some places—but seldom in individual falls of as much as ten or twelve inches.

Summers are usually quite warm, and prevailing winds blow from the southwest. Several days with temperatures above ninety degrees and high humidity can be counted on each year. A growing season of 160 to 170 days is to be expected, allowing ample time for growing most foodstuffs. Precipitation reaches a slight maximum during the warmest months; yet, periodic droughts have been experienced. Often coupled with a lowering of the water table, droughts cause severely restricted stream flowage.

Vegetation

The extent, if not the composition, of the pre-European Highlands forest was quite different from the present day. Human habitation and cultivation, especially in the southern Highlands, has obliterated much of the forest in the valleys and on the arable slopes.17

Present forest remnants may not give an accurate indication of what early forests were like; however, Raup suggests that the vegetational covering on sparsely settled hilltops and slopes in the Hudson Highlands has not changed significantly since precolonial times.18
A predominantly broadleaf deciduous forest covered much of the region. Ridges, slopes, and many of the valleys were clothed in various species of oak (Quercus alba, Q. rubra, Q. velutina, Q. prinus), hickory (Carya ovata, C. glabra), maple (Acer rubrum, A. saccharum), and birch (Betula lenta, B. lutea, B. populifolia). White ash (Fraxinus americana), basswood (Tilia americana), beech (Fagus grandiflora), black cherry (Prunus serotina), American chestnut (Castanea dentata), American elm (Ulmus americana), and yellow poplar (Liriodendron tulipifera) were prominent. Interspersed among the hardwoods were coniferous types such as pitch pine (Pinus rigida), white pine (P. strobus), red cedar (Juniperus virginiana), and hemlock (Tsuga canadensis). Dogwood (Cornus florida) and sassafras (Sassafras albidum) were found in the understory. The forest floor consisted of wild berries, mosses, ferns, flowers, and grasses. Oaks (Q. coccinea, Q. ilicifolia), sumacs (Rhus typhina, R. vernix), mountain laurel (Kalmia latiflora), blueberries (Vaccinium sp.), and ferns covered the patches of exposed country rock or thin soils on steeper slopes.

Well-drained valleys were covered extensively by woodlands and dotted with grassy, or sparsely timbered knolls. Black walnut (Juglans nigra) was a common forest species in the limestone areas. Immediately adjacent to a watercourse was a narrow margin of grasses, mosses, ferns, willow (Salix nigra), and woody shrubs.

Scattered in the valleys and occupying many upland depressions were swamps and natural wet meadows. Most numerous north of the terminal moraine, these features resulted from events during the Pleistocene. Moist conditions encouraged thickets of American elm, red maple, water
ash (*F. pennsylvanica*), sour gum (*Nyssa sylvatica*), swamp white oak (*Q. bicolor*), and rhododendron (*Rhododendron maximum*). Furnishing excellent pasture and hay when adequately drained, these lands were eagerly sought by early European settlers.
NOTES


CHAPTER II

TECHNOLOGY AND IRON

The role of technology, its effect on the iron industry, and in turn, its effect on the early American landscape was striking. Changes wrought by the earliest and most primitive iron communities were minor when compared to those produced by an increasingly efficient technology and larger iron manufactories.

The area of the Atlantic Coastal Plain--especially in Massachusetts, southern New Jersey, Virginia, and Maryland--presented iron makers with far different conditions for mining and smelting than did later sites in the highlands of New York, northern New Jersey, and Pennsylvania.

The basic techniques of iron manufacture used in America were developed in Europe. In most instances, this technology diffused into the colonies with the migration of ironworkers, usually English, Scotch-Irish, and Germans. The following paragraphs describe those iron-making techniques which were brought into the Highlands by the eighteenth-century ironmaster. Wherever pertinent, significant American innovations are included.
Iron Mining

The coastal ironworks produced iron from bog ore, a type of limonite found in the numerous shallow lakes, swamps, and wet meadows which abound in the region. Beginnings of the ore can be traced to the ferruginous deposits, primarily greensands and marls, through which percolated waters enriched with organic material. The waters caused the iron to oxidize and go into solution. When exposed to the air, the iron-rich solution was deposited as a "sludge" on twigs, roots, and other matter in the shallow basin. In some deposits the iron formed individual nodules rather than crusting on the bottom materials. Since the latter form was purer, it was the most highly prized. A traveler to Batsto, in southern New Jersey, during the late nineteenth century observed that bog ore appeared to have renewed itself three times in the span of twenty-eight years.¹

Disregarding the rather wet environment, mining was relatively simple. The ore was dredged from a basin, sorted to remove unwanted material, and then dried. Drying was done by exposing the material to the air and allowing the moisture to evaporate. Somewhat later in time, heat was applied in order to drive off the moisture. Bog ore prepared in this manner contained about fifty percent iron and could be used directly in the iron manufactory.

The iron ores of the interior lands presented a far different picture. As the metal was usually incorporated into the country rock, mining procedures and techniques changed. Many ore bodies were exposed in accessible outcrops. Because of ease in handling, these sites were sought out and exploited quickly. Generally the rocky ore was pounded and blasted loose in successive step-like terraces.² Crumbling of the
mine walls was avoided either by maintaining a proper degree of slope or by utilizing props of timber. The result of the operations was an open pit, variable in size and depth (Fig. 4).

As the demand for iron grew, the open-pit mines were unable to furnish the necessary ore to a burgeoning iron industry. Shafts and adit tunnels replaced open pits in most large-scale mining operations by the beginning of the nineteenth century (Fig. 5).

An anonymous traveler to the mines at Hibernia, New Jersey, in the mid-nineteenth century described the procedures used there:

The mode of extracting the ore here . . . is called 'stoping' by the miners, and there are two ways of doing it--one called 'overhand', and the other 'underhand stoping'. In the former the ore is removed from below upward, and in the latter . . . from above downward. The last is most generally practiced in this region, being considered the most economical. As the ore is removed timbers are inserted, reaching across from wall to wall, and upon these are piled the rubbish and 'lean ore', forming . . . 'stulls'. In many of the mines the deposit is so pure that it is removed without leaving sufficient rubbish to support the walls, and so much stoping surface being exposed renders the mines dangerous to the workmen.  

The adit tunnels, as they are termed, utilized small carts, drawn by man and animals--horses, mules, or oxen--to get out the ore. Ventilation was supplied by vertical shafts connecting adit with surface and the workings were kept free of excess water by gravity--the gentle inclination of the tunnel allowing any water to flow from the mine opening.

The shaft mine was essentially like those operating today. A vertical or slightly angled shaft was sunk into the ore body, the ore loosened, loaded into buckets, and hauled to the surface by means of a
hand- or animal-operated windlass. Such mines usually were kept clear of water by pumps and of gas by a chimney fire and flue connected with the shaft.

Iron Making

Once the iron had been raised to the surface, it was transported to the iron manufactory. Frequently, the ironworks were located on a site convenient to a stream which furnished power, amid woodlands which were converted into charcoal, and within a few miles of one or more mines which supplied the ore.

The early manufactories were generally patterned after those in the mother country, i.e., England, Germany, and Austria. Exploration of new landscapes for materials so necessary to their occupation left ironmasters little time for experimentation and less for consideration of untried theories. Bining, in his work on the Pennsylvania ironworks of the eighteenth century, pointed out that this was especially true of blast-furnace production, including type of furnace, blast, fuel, and methods of casting.  

Iron ores were manufactured into saleable products by either smelting, forging, or a combination of the two. Smelting required a blast furnace in which high temperatures would cause the ore to melt and separate into molten metal and slag. After being drawn from the hearth, the iron was cooled as pigs or various cast-iron items. Forging operations did not separate metal from slag, but only made the mass soft and malleable. In this state, impurities were removed by a large tilt hammer and wrought iron was produced. In conjunction with the furnace, a forge used pig iron and refined it into bars. This commodity was in much demand at the marketplace.
Forging came first in the technological development of the iron industry. Primitive methods of ore reduction had been practiced by the Hittites, Romans, and various north Europeans. These changed little, except for the enlargement of operations and the development of specialized labor, until the appearance of the Catalan forge or bloomery. The concept of the Catalan forge was brought to the American colonies by settlers from Great Britain. Usually built beside a stream or raceway, the forge consisted of a stone fireplace lined with cast-iron plates or refractory material and a waterwheel which supplied the power to operate a pair of bellows. The hearth measured twenty to thirty inches square and fifteen to twenty inches deep (Figs. 6 and 7). Two, four, or more fires were operated within the same building.

Ore, charcoal, and limestone were placed in the hearth, and reduced in the following manner:

... the hearth was heated by keeping it two-thirds full of ignited charcoal for four or five hours. The fuel was then pushed up against the air-blast inlet (tuyère) and sloped in an incline towards the opposite side, and upon this bed of hot coals was placed the ore, flux and charcoal. The air blast was then gradually applied. The charge of iron was now slowly worked with a bar so as to allow the air current to come into contact with all parts of the mass. The 'loop' [bloom], as it was called, while largely metallic iron, contained many impurities. This mass was lifted out and subjected to the blows of a heavy hammer by which some of the foreign matter was hammered out and the iron wrought into a more regular shape.

By this method saleable wrought iron was manufactured directly from the ore without requiring additional processing. The production of the colonial bloomeries was as high as two tons per week for each forge fire, although they operated only while streams were not blocked by ice.
The tilt hammer, so vital to successful operation of a Catalan forge, was situated in close proximity to the fireplace. The hammer was about fourteen inches square and three feet in height with a hole near the upper end, through which a heavy beam was inserted. Pivoted so that it could swing up and down, the handle was connected to a shaft which led to an outside waterwheel. The shaft had a large iron band with four cogs and, as the wheel turned, the cogs in rotation engaged the hammer handle, lifted it about a foot, and then let it drop onto the anvil. The hammer rose and fell four times for every turn of the wheel. Speed of the blows was regulated by the flow of water against the waterwheel (Figs. 6 and 8).

As the demand for iron products increased and iron technology expanded, the true forge evolved from the bloomery and assumed the task of refining pig metal which issued from the blast furnaces. Once pig iron was manufactured it was taken to the "finery" (refining forge), where it was heated to a semi-molten state in an attempt to decarburize the metal. The resultant bloom of iron was then shaped into a rough bar form, or ancony, by a tilt hammer. The ancony was passed to the "chafery" forge where it was successively heated and pounded into refined bar iron or prepared for the rolling or slitting process (Fig. 9). The several heatings and hammerings effected a weight loss of thirty percent in the conversion of pigs into bars. Coupled with an increase in the amount of charcoal per ton of iron made and a greater use of labor, it came as no surprise to find bar iron often sold for several times the price of pig metal.
The advent of the blast furnace occurred in Europe some three centuries after the development of the Catalan forge. Its invention was motivated by a desire on the part of the ironmasters to improve upon the bloomery. Numerous experiments were undertaken to attain the high temperatures necessary for melting iron. The blast furnace culminated these efforts.

The first step in the evolution of the blast furnace was the development of the Stückofen, or high bloomery. Probably a German introduction, it was found in the Lahn Valley by the end of the eighth century. Use later spread into France, England, Sweden, and the Low Countries. The quadrangular or cylindrical structure differed little in outward appearance from the later blast furnace (Fig. 10). By extending the sides upward ten feet or more in an attempt to utilize a portion of the wasted heat of the bloomery and produce a stronger blast, a pasty, malleable mass of metal was produced. Quite popular for a time, the Stückofen was never able to compete with its more effective and slightly larger offspring--the blast furnace.

The transition to the blast furnace, or Hochofen, took place about the middle of the fourteenth century at an undetermined place in the Rhineland provinces of Germany. Within two hundred years it had been perfected and its use had spread throughout the continent and into England. It was now possible to liquify and completely separate iron from the gangue. The furnace was later introduced into the American colonies by iron makers of various nationalities. Diffusion had changed European furnaces little, and those found in the Highlands could be deemed type examples (Fig. 11 and 12).
The furnace was a four-sided stack of native stone about twenty to thirty feet in height, with a base of twenty to twenty-five feet square tapering toward a top of two-thirds the base dimensions. Within this structure, separated from the outside wall by mortar, broken stone, or sand, was a furnace core lined with firebrick, slate, or other refractory material. Dimensions of the core varied from three to ten feet at its widest part—the larger size being a later development. Arches were constructed into the four sides of the masonry through which the air blast (tuyère) extended and from which the molten iron and slag could be drawn off (Fig. 13). The casting arch—the side which tapped the iron—was enclosed by a large shed which was frequently destroyed by fires ignited by sparks emitted from the furnace (Fig. 14).

The "blowing in" or starting of a furnace was a most difficult procedure and one of the best accounts of how it was accomplished was given by Bining:

The stack was first filled with charcoal and lighted from the top. After several days, when the fire had burned down and reached the tuyère opening, the furnace was refilled with charcoal. The fire now worked back up to the top. The blast was then applied, and ore and flux put in from the tunnel head in gradually increasing quantities. After a few days slag and iron ran into the hearth below. The proportion of ore and flux to charcoal was gradually increased until the furnace was working normally.

Since it was necessary to apply the air blast to produce the heat required to maintain the charge in a molten state, the furnace was operable only as long as the waterwheels were ice free. During the "blown out" period of winter, the furnace was relined and repaired.
A continuous supply of water and charcoal necessitated the placement of early furnaces near waterways and within well-forested regions. Also, the Highlands furnaces were usually built on the side of a hill to facilitate recharging with the necessary materials. Bushels of iron ore, charcoal, and limestone were carted over a log or plank bridge built from the hillside to the top of the stack.

A single charcoal furnace was capable of producing from ten to a maximum of twenty-five tons per week by the conclusion of the American Revolution. Because of refinements by individual ironmasters and the varying efficiency of the furnaces, it is difficult to give more than a rough estimate of the amount of material demanded for successful operation. According to tradition, one of the oldest furnaces in the Highlands at Oxford, in the mid-eighteenth century, consumed 300 to 400 bushels of charcoal for each ton of pig iron. A similar, but more efficient, furnace on the same site in the 1830's used only 275 bushels per ton of iron. Kitchell's survey of the iron industry cited the needs of the Wawayanda Furnace in Sussex County during the 1850's as being:

<table>
<thead>
<tr>
<th>Material</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charcoal</td>
<td>160-200 bushels</td>
</tr>
<tr>
<td>Magnetic iron ore</td>
<td>2 tons</td>
</tr>
<tr>
<td>Limestone</td>
<td>0.25 tons</td>
</tr>
</tbody>
</table>

The basic charcoal furnace continued to be used in the Highlands until the middle nineteenth century with but two major changes: the substitution of hot air for cold in the air blast and replacement of leather bellows by wooden tubs.

Devices for injecting air into an iron manufactory to aid combustion and increase temperatures had been used throughout Europe for many centuries. Credit for the introduction of the air blast
into the American colonies must go to English and German ironmasters, who utilized the bellows on all forges and furnaces.

The earliest blast mechanism used on an American manufactory was a pair of large, leather bellows. Operating by means of a shaft connected to a waterwheel, the bellows alternately injected intermittent blasts of air into the forge or furnace as the raceway revolved the wheel (Figs. 11 and 15). Difficulty in replacing the leather of the bellows initiated a search for an alternative means of delivering the necessary air blast.

Toward the end of the eighteenth century a new device was introduced. Two wooden tubs or drums were attached to a waterwheel and connected to the manufactory via an iron pipe, the tuyère (Figs. 16 and 17). Each tub had a tight-fitting bottom with a leather inlet air valve, an outlet pipe, and a circular piston, around the circumference of which was fastened a leather collar to make an airtight enclosure. The pistons moved up and down on a vertical shaft attached to a pivot beam, which was operated by a waterwheel in a manner similar to the hammer. The alternate strokes of the piston furnished an almost continual air blast.

The blast obtainable from water-driven bellows, however, was insufficient to maintain the heat needed in coal-using furnaces and was supplanted by more elaborate devices.

Application of a hot blast first appeared in America at Oxford Furnace in 1834. The manager of the operation, William Henry, experimented with several methods of heating the air before introducing it into the furnace. Finally Henry settled on a process which was
widely copied during the following generation. An oven containing cast-iron pipes was placed atop the manufactory stack and air was heated by the flame which issued from the tunnel head. The innovation raised blast temperatures 500°, increased production by almost fifty percent, and effected a similar saving in fuel. Unrealized at the time, this invention spelled the beginning of the end for the charcoal furnace. The hot blast made possible the use of immense quantities of anthracite coal and coke as fuel. Ironically, a Highlands invention would cost that region its position of eminence in iron production.

Manufacture of Charcoal

Charcoal necessary for the operation of forges and furnaces was produced by methods common in Europe prior to the introduction of the iron industry to the New World. The dominant method was first brought to New England from the mother country and spread throughout the eastern seaboard. Initially a pit, which consisted of a pile of wood fifteen feet in diameter and about ten feet high, was constructed (Fig. 18). Eight to ten cords of four-foot logs were needed. The pile was covered with turf and ignited, was allowed to burn for eight to ten days, and was continually watched by a team of colliers. Several pits were kept going at one time and each, when opened, might yield 200 or more bushels of charcoal.¹⁸

A second method of burning originated in continental Europe. It was not widespread within the Highlands, being found only among settlers not exposed to the English method. Pits were dug into the ground, filled with logs, and covered with earth. Once ignited, the pits were allowed to smolder for two or three weeks and yielded about 500 bushels of charcoal.¹⁹
Charcoal proved to be an ideal fuel for use in the manufacture of iron. Almost entirely free of sulphur, wood ash consisted largely of lime and alkalis providing some of the flux needed in the smelting process. However, as the iron industry grew, the vast forests of eastern America could never have met the potential demand for fuel.
NOTES


2. Black powder was used in the operation. In virtually all account books and ledgers examined, black powder constituted a major expenditure for mine owners.


4. Often several shafts were sunk into the same vein of ore and each was enumerated in reports of iron production as separate mines.


6. The forge was developed within the old iron districts of Catalonia, Spain, before the tenth century.

7. Boyer, op. cit., p. 3.


10. The primary difference between the Stückofen and the Hochofen was the end product, not appearance. An apparatus which produced molten iron was a furnace; all others were bloomeries.


12. In all probability the first blast furnace was an enlarged Stückofen capable of maintaining the high temperatures necessary to produce a molten product.


CHAPTER III

COLONIAL ANTECEDENTS OF HIGHLANDS IRON INDUSTRY

Prior to the introduction of ironworking into the Highlands, its manufacture had spread over much of the eastern seaboard. The growing colonial demand and the lure of foreign markets—a prospect strengthened by the inability of English ironmasters to meet their country's needs—encouraged many entrepreneurs to pursue the manufacture of iron.

The idea of cultivating an iron industry in the New World first came to light with Sir Walter Raleigh's second expedition in 1585. Abundant forests and bog ore near Roanoke Island might have supported ironworks, but when the aspiring colony failed, the suggestion passed into history.

Establishment of a permanent settlement at Jamestown afforded the Virginia Company an opportunity to send a number of workers in order to construct facilities for the manufacture of iron. A site on Falling Creek, about sixty-five miles above Jamestown, was chosen for the experiment. No evidence has been uncovered regarding the type of manufactory; nevertheless, Swank felt it included a furnace and finery and chafery forges—a complex common in England about this time.
Interest in expanding the initial operation was wanting due to a lack of capital and need for workers in farming the various plantations. However, enthusiastic supporters felt an iron industry was good for England and the colonies, as it would provide raw and semifinished goods for the mother country and a means of payment for English wares needed in North America.

Subsequent developments in the manufacture of iron shifted to New England. Although one of the intents of the Massachusetts Bay Colony from its inception, the first ironworks was not built near the bog ore deposits of Saugus until 1643. The completed works consisted of a furnace, a two-fire forge, and a rolling and slitting mill. Iron of good quality was manufactured, but expansion was deterred by lawsuits, Indian attacks, lack of skilled labor, opposition to the large amount of wood consumed, and a preference for English iron.

The limited success and myriad problems encountered at Saugus hindered establishment of additional manufactories throughout the seventeenth century. Many of those attempted failed outright or, at best, operated intermittently and finally lapsed into inactivity. Real development began with the first years of the eighteenth century. Within two decades progress had been made in some of the colonies sufficient to alarm the English ironmasters.

The migration of settlers from Europe and New England to other colonies along the coast embraced ironworkers carrying on a search for deposits of iron ore, copious forests, and a dependable source of power. North of the Carolinas, several areas were gradually to assume a greater measure of importance.
One such location was the Pine Barrens region of southern New Jersey. The immense quantities of ore, continually flowing streams, untapped forests, and a profusion of oyster and clam shells necessary for fluxing furnished a beachhead from which the iron industry could later turn inland. With the establishment of the first ironworks at Tintern Falls in 1674, the industry spread along the major waterways of South Jersey. Within fifty years the region became one of the leading industrial areas in the colonies.

Special inducements to ironworkers brought about a rebirth of iron making in the Chesapeake Bay region. Soon ironworks appeared north and south of the Potomac River. By the middle of the eighteenth century there were at least ten blast furnaces making an annual average of 500 tons of pig iron each.

Revitalization of the iron industry took place in New England as well. Building upon the ill-fated Saugus operations, Massachusetts attracted many persons skilled in producing iron. Bounties particularly encouraged the manufacture of ironware. Similar inducements led to the establishment of manufactories in Connecticut, Rhode Island, and the eastern end of Long Island. By 1733, New England had at least six furnaces and nineteen forges, and twenty-five years later, Massachusetts boasted fourteen furnaces and forty-one forges.

Discovery and development of the magnetite ores in eastern Pennsylvania did much to expand the colonial iron industry. Manufacturing commenced in 1716 and soon spread from the southeastern counties and the Schuylkill Valley to the Delaware River, adjacent to the Highlands. At least thirty-seven sites were in operation by the
mid-eighteenth century. Suffice it to say, Pennsylvania was the leading producer of iron in America—a position she maintained until this century.

A flourishing iron trade was one manifestation of increased manufactural activity. Quantities of pig iron had been shipped from Pennsylvania, Virginia, and Maryland to England since early in the eighteenth century (Table 3). Shortly, thereafter, axes and other implements were exported to the agricultural communities of the Carolinas. According to British ironmongers, ironmasters in New England, Maryland, and Virginia had taken over much of the colonial tool market by the 1730's. Furthermore, large quantities of American-made nails and anchors were competing successfully with the English product. Production costs were a primary reason for the progress of American iron. English ironmasters, their lands denuded of usable trees, were forced to pay tremendous prices for fuel. At many furnaces fuel represented over seventy percent of the cost of making iron. Colonial furnaces, with vast forests near at hand, never approached the figure. Labor and transportation expenditures also favored the colonial ironworker. In 1750, bar iron produced in England was selling for £17 per ton, whereas, American iron brought £14 to £16 per ton in Philadelphia. Transportation accounted for much of the price differential. English iron prices included £2.8 per ton for transport as compared with £1.5 per ton for American iron. Import duties prevented much competition in English markets, but could not check England's diminishing share of the business in the American colonies.
### TABLE 3

**IRON EXPORTED TO GREAT BRITAIN**  
**FROM 1730 to 1745**

<table>
<thead>
<tr>
<th>Year</th>
<th>Iron</th>
<th>Pennsylvania (Tons)</th>
<th>Virginia and Maryland (Tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1730</td>
<td>Pig</td>
<td>199</td>
<td>1,527</td>
</tr>
<tr>
<td>1730-1</td>
<td>Pig</td>
<td>169</td>
<td>2,081</td>
</tr>
<tr>
<td>1731-2</td>
<td>Pig</td>
<td>107</td>
<td>2,225</td>
</tr>
<tr>
<td>1732-3</td>
<td>Pig</td>
<td>95</td>
<td>2,310</td>
</tr>
<tr>
<td>1733-4</td>
<td>Pig</td>
<td>147</td>
<td>2,042</td>
</tr>
<tr>
<td>1734-5</td>
<td>Pig</td>
<td>243</td>
<td>2,412</td>
</tr>
<tr>
<td></td>
<td>Bar</td>
<td>20</td>
<td>---</td>
</tr>
<tr>
<td>1736-8</td>
<td>No data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1739</td>
<td>Pig</td>
<td>170</td>
<td>2,242</td>
</tr>
<tr>
<td></td>
<td>Bar</td>
<td>44</td>
<td>---</td>
</tr>
<tr>
<td>1740</td>
<td>Pig</td>
<td>159</td>
<td>2,020</td>
</tr>
<tr>
<td></td>
<td>Bar</td>
<td>---</td>
<td>5</td>
</tr>
<tr>
<td>1741</td>
<td>Pig</td>
<td>153</td>
<td>3,264</td>
</tr>
<tr>
<td></td>
<td>Bar</td>
<td>---</td>
<td>5</td>
</tr>
<tr>
<td>1742</td>
<td>Pig</td>
<td>143</td>
<td>1,926</td>
</tr>
<tr>
<td>1743</td>
<td>Pig</td>
<td>63</td>
<td>2,816</td>
</tr>
<tr>
<td></td>
<td>Bar</td>
<td>---</td>
<td>57</td>
</tr>
<tr>
<td>1744</td>
<td>Pig</td>
<td>88</td>
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</tr>
<tr>
<td></td>
<td>Bar</td>
<td>85</td>
<td>---</td>
</tr>
<tr>
<td>1745</td>
<td>Pig</td>
<td>97</td>
<td>2,131</td>
</tr>
<tr>
<td></td>
<td>Bar</td>
<td>---</td>
<td>5</td>
</tr>
</tbody>
</table>

The diverse problems and interests of colonial and English iron makers, merchants, and ironmongers resulted in the passage of the Iron Act of 1750. The act provided for duty-free importation of American bar iron into England, while prohibiting expansion of the manufacture of ironware in the colonies.\(^\text{16}\) It was hoped that England's chronic shortage of bar iron might be relieved and competition in the colonies checked. In spite of the expectations, the Iron Act did little to hamper the growth of colonial manufactories. The offer of a duty-free market actually resulted in further expansion (Table 4). Pennsylvania, Virginia, Maryland, and the Highlands of New York and New Jersey became the major producing areas. The combined efforts of coastal and mountain ironworks allowed the American colonies to become self-sufficient in all iron products just prior to the Revolutionary War.
### TABLE 4

**PIG AND BAR IRON EXPORTED BY THE AMERICAN COLONIES TO GREAT BRITAIN**

<table>
<thead>
<tr>
<th>Year</th>
<th>Pig Iron (Tons)</th>
<th>Bar Iron (Tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1750</td>
<td>2,924</td>
<td>---</td>
</tr>
<tr>
<td>1751</td>
<td>3,210</td>
<td>---</td>
</tr>
<tr>
<td>1752</td>
<td>2,979</td>
<td>82</td>
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<tr>
<td>1753</td>
<td>2,736</td>
<td>208</td>
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<tr>
<td>1754</td>
<td>3,245</td>
<td>171</td>
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<td>1755</td>
<td>3,439</td>
<td>390</td>
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<tr>
<td>1761</td>
<td>2,766</td>
<td>39</td>
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<tr>
<td>1762</td>
<td>1,763</td>
<td>123</td>
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<td>1763</td>
<td>2,566</td>
<td>310</td>
</tr>
<tr>
<td>1764</td>
<td>2,554</td>
<td>1,059</td>
</tr>
<tr>
<td>1765</td>
<td>3,264</td>
<td>1,079</td>
</tr>
<tr>
<td>1766</td>
<td>2,887</td>
<td>1,258</td>
</tr>
<tr>
<td>1767</td>
<td>3,323</td>
<td>1,326</td>
</tr>
<tr>
<td>1768</td>
<td>2,953</td>
<td>1,990</td>
</tr>
<tr>
<td>1769</td>
<td>3,402</td>
<td>1,780</td>
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<tr>
<td>1770</td>
<td>4,233</td>
<td>1,716</td>
</tr>
<tr>
<td>1771</td>
<td>5,303</td>
<td>2,222</td>
</tr>
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<td>1772</td>
<td>3,725</td>
<td>966</td>
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<td>1773</td>
<td>2,958</td>
<td>837</td>
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<tr>
<td>1774</td>
<td>3,452</td>
<td>639</td>
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<tr>
<td>1775</td>
<td>2,996</td>
<td>916</td>
</tr>
<tr>
<td>1776</td>
<td>316</td>
<td>28</td>
</tr>
</tbody>
</table>

*Source: French, *op. cit.*, pp.8-10.*
NOTES

1. It was estimated in 1738 that of a total of 35,000 tons of iron required for trade, at least 23,000 tons had to be secured from abroad. By 1775, the total amount of iron imported to Great Britain from Sweden, Russia, and other sources was between 45,000 and 50,000 tons a year. Lawrence H. Gipson, The British Empire Before the American Revolution (Revised edition, New York: Alfred A. Knopf, 1960), III, 211.


4. For a complete account of the Saugus Ironworks, see: Hartley, op. cit.

5. Arguments for and against expansion of the American iron industry and regulation of said industry can be found in "Papers relating to Iron, Peltries, Trade, etc., 1712-1817," Penn MSS, Historical Society of Pennsylvania.


8. Penn MSS, p. 81.


11. Penn MSS, p. 45.

13. All foreign monetary values cited in the text are given in British sterling currency. Throughout the eighteenth century colonial businessmen had to contend with "pounds," "shillings," and "pence" issued either by the British government (sterling money) or by the various colonies (lawful or proclamation money). It was customary to think of the widely circulated Spanish-milled dollar, forerunner of the American dollar, as the standard of value. Commonly, one Spanish dollar could be exchanged for four shillings sixpence sterling money or six shillings proclamation money. Nevertheless, the actual value of the lawful money varied from colony to colony. Gipson, op. cit., X, 160.


15. Ibid., p. 169; Gipson, op. cit., III, 214.

16. A clause prohibited erection after June 24, 1750, ". . . no mill, or other engine for slitting or rolling of Iron, or any plating forge to work with a tilt-hammer, or any furnace for making steel. . . ." A full discussion of the regulations and results thereof can be found in Penn MSS.
CHAPTER IV

CHARCOAL, IRON, AND HIGHLANDS SETTLEMENT

Establishment of the physical and technological environments must be accompanied by an attempt to show the changing geographic patterns which iron making carved on the Highlands landscape. Certainly the present Highlands reflect many alterations initiated during this period of industrial exploitation.

The original land offered tremendous advantages to the foundation of a successful iron industry. Magnetite ore was incorporated in the country rock of the ridges and mountain masses. Limestone constituted a portion of the base material of many interhighland valleys. Abundant woodlands covered not only the highlands, but also the most accessible lowlands. Streams were everywhere and their valleys offered countless sites suitable for the erection of iron manufactories.

In addition, the technological level of the Highlands settler cannot be overlooked. Many were well versed in the manufacture of iron. Techniques had been transported directly from Europe, or borrowed from Europeans. The methods had proven successful elsewhere on the eastern seaboard and in Europe. The Highlands iron industry was a deliberate extension of a colonial industry heretofore confined mainly to the coastal plain.
Indian Occupance and European Penetrations

The earliest inhabitants of the Highlands were Indians known as the Lenni Lenape, or Delaware. Records indicate that they were most numerous within the Musconetcong Valley and on the Highlands margins adjacent to the Hudson and Delaware rivers. Food was obtained by hunting, gathering, and agriculture. Game, roots, nuts, and berries were plentiful. Maize, beans, and squash occupied small clearings in the valleys. Rock ledges, caves, and wooden houses provided shelter. Trade was widespread, linking the Highlands dwellers with peoples to the east and west. Numerous trails were established, following the watercourses or the interhighlands valleys.

Although a good deal of information is available on the American Indian and his usage of iron ores, no evidence has been found to indicate that he was familiar with iron making prior to European contact. Mention was made of Indian discoveries of iron ore in the Hudson Highlands; however, there is no record of these deposits ever being exploited.

Initial contact with the European did little to alter Indian occupancy of the Highlands. Materially, Indians did adopt the rifle, cloth, and metal utensils. In turn, Europeans expressed interest in Indian crops, the location of good agricultural land, and Indian tales of plentiful supplies of iron ore. During the eighteenth century many of the Delaware were driven westward and their agricultural lands became occupied by Europeans. Formerly cultivated land reverted to patches of undergrowth known as "old fields" where settlement succession did not occur. The transition from Indian to European occupancy was most
noticeable in the Modna Creek, Ramapo River, and Musconetcong River valleys. By the 1730's the Indians who remained behind had retreated either to poor lands near the headwaters of the Musconetcong and Black rivers or to the recesses of the Hudson Highlands.

The role of the pioneer Highlands settler and his skills has long been misinterpreted. Early authorities, such as Coxe and Gordon, saw the colonists as manufacturers opening the way for agriculturalists. They deemed the forge uniformly as the precursor of the farm. After iron making had exhausted the land of its timber and iron, it was subdivided into farmsteads. The writer believes the actual settlement sequence was more complex than envisioned by nineteenth-century chroniclers.

Settlers hesitantly approached the rugged, forested Highlands prior to 1700; moreover, they were confined to the most accessible sections along the periphery of the study area and to the tributary valleys of the Hudson and Delaware rivers. The first years of the eighteenth century saw Dutch settlers from Ulster County, New York, move southward into the Wallkill Valley on the edge of the Western Highlands. Germans from Pennsylvania took up lands in the unglaciated valleys of the southern Highlands. Captain John Evans... expended great sums of money in clearing several places for Farms, and planted several Families of Scots and Irish..." on a large tract of land along Murderer's (Modna) Creek in the Hudson Highlands. The sale of well-timbered land, plentiful meadows, and wheat acreage on the Rockaway River attracted settlers from Newark, Elizabeth, and New York. In addition, surveys were conducted to determine the character of the interior
segments of the Highlands. Charles Clinton, surveyor of a goodly portion of the Hudson Highlands between 1735 and 1749, often evaluated the agricultural potential of the lots he had laid out. Land was described as being "... Scarcily Sufficient for a Settlement ...," "... pretty well timber'd with Oak but Generally Stoney ...," or having "... Some very Good dry Swamp or Rather Lowland that may be plowed and Good Swamp for meadow. ...".

To other prospective settlers the Highlands looked rather inhospitable and were thought to be incapable of improvement and wholly without transport facilities. Valuable only for firewood, "... no man [would] accept any part of it ... unless it be what is contiguous to the River, where he may with ease transport the wood.")

In spite of the great expenditures of money and labor, agriculture met with only mixed success and the pace of Highlands settlement was exceedingly slow. It should be kept in mind, however, that the adjacent Triassic Lowland and Kittatinny Valley continually offered greater rewards to the agriculturally minded settlers. By 1710, probably fewer than three thousand persons were residing within the confines of the study area.

Establishment of the Iron Industry

Interest was now directed to reports of iron ore found throughout the Highlands"... in great quantities ... but at a great distance from the British and amongst the Indian Settlements." The change in attitude is also evident in Clinton who, in the last years, remarked of the "... Attraction of Iron Oar [sic] and Loadstone [sic] which is in
Every hill here in this part of the Mountain . . . " or that " . . . there would be a good fall had here for an Ironworks or mill . . . . "10

Soon land advertisements promoted those attributes of the landscape which led to the manufacture of iron:

To be Sold, or Leased

Several Tracts of Land in the Province of New-York and New-Jersey, viz. New-York. In Orange County About 2000 Acres, in Cheescock's Patent, Part thereof adjoining Haverstraw, on Hudson's River, about 40 Miles from New-York, and Part in the Clove, which is very fine Land; the Rest is Mountain Land, extending from Haverstraw to the Clove: This Tract will be sold, or leased in Lots of 100 Acres and upwards; it affords the best conveniences for Iron Works, of any Tract in North-America, having plenty of Iron Oar [sic] and Wood, and a very fine Stream, sufficient for several Furnaces or Forges, within seven Miles of a good Landing on Hudson's River. . . .11

So thoroughly were the conveniences publicized and so widespread was the response, that by the Revolution, practically every ore body known today in the Highlands had been opened.

A bloomery, the first ironworks associated with the Highlands, was erected at Whippany soon after that community's founding by a number of settlers from Newark and environs (Plate IV).12 The necessary ores came from magnetite outcrops like those at Succasunna,13 and from limonite found along the Whippany River. Limestone was obtained from small, isolated exposures in the Whippany Valley or gathered from the abundant glacial till. Production was consumed locally--mostly as various and sundry utensils--or shipped as bars to Newark and Elizabeth via horseback over almost nonexistent trails.
New York-New Jersey
HIGHLANDS

Charcoal Iron Manufactories (ca. 1750)
- Bloomery or Forge
- Furnace
- Plantation

Compiled from numerous sources
Adjacent to one of the largest plains areas within the High-
lands, Whippany became the focus of regional settlement until the mid-
eighteenth century. The Whippany River and its tributaries furnished
access to lands within the Passaic Range and to portions of the High
Bridge Valley. Crude roads led across the drift-covered Morris plains.
Enticed by the prospect of open lands, additional settlers journeyed
from New England, New York, and Burlington, to join those from Newark
and Elizabeth. Land was touted for its ability to sustain iron making
and agriculture. Several forges were erected primarily to rid the
area of surplus wood and to provide local farmers with implements.
Shortly thereafter, agriculture surpassed iron making as the region's
principal occupation. The landscape had undergone extensive trans-
formation. Houses and barns were of English style; meadows were in
English grass; and flax, corn, and orchards occupied the fields.

Other pioneers began to descend on the Highlands--north and
south. Welsh and Scotch-Irish folk from East Jersey journeyed along
the Wanaque and Pequannock valleys to reach tracts of land purchased
expressly for the purpose of developing ironworks, and were followed
by a few settlers intent on clearing land for agriculture.

The hills of the Eastern Highlands amply furnished raw materials
for iron making; nevertheless, rugged terrain isolated the small groups
of pioneers. Often, provisions and iron products had to be carried by
men because it was "... Impossible for a horse to follow Over the
vast hills." From the outset, manufactories encountered difficulties in
that the sparse population provided little or no local market for iron.
Roads had to be constructed in order to facilitate the transport of iron to regions outside the Highlands. Old Indian pathways were converted into roads by cutting back the trees to allow passage of horses, mules, or wagons (Fig. 19). Traffic moved northward through the Ramapo Valley and southward to Aquackanonk Landing (Passaic), via Pompton and Wanaque (Plate V).

The southern invasions came from Europe and Pennsylvania by way of the Delaware River and its tributaries, chiefly the Musconetcong River. Lying south of the terminal moraine, the landscape presented an environment conducive to iron manufacturing, while also being regarded as "... exceeding fertile for Grain or any Thing else that may or will be sown or planted therein."19

Commencing with the founding of Oxford Furnace in 1742,20 men of diverse skills were attracted to lands near the newly established ironworks. Colliers, lumbermen, farmers, and tradesmen of English, Welsh, German, and Scotch-Irish heritage found places in communities springing up around the manufactories.21 Primarily due to the introduction of the iron industry, population in the southern Highlands almost doubled between 1738 and 1745.22

So familiar did these iron communities become that land advertisements often mentioned them, although they usually had little to do with the place being described:

The first Tract lies about two Miles from Oxford Furnace . . . containing near 300 Acres of Land, being noted for the best place to raise Stock of any in that County, having upwards of 100 Acres of drained Meadow already made on the Premises, and great Part thereof fine Timothy and Clover Grass, besides other improvements, and sundry Advantages which are natural to that Place. . . .23
New York - New Jersey
HIGHLANDS

Transportation Patterns
- Roads (1776)
- Additional Roads (1800)
- Turnpikes (1828)
- Railroads (1860)

Compiled from numerous sources
The natural affinity of furnace and forge led to the founding of a cluster of small fineries and chaferies around some prominent furnace. For example, Oxford was instrumental in establishing forges at Changewater, Greenwich, and Chelsea (Plate IV).

A flourishing trade arose as the furnace supplied pig iron necessary for operation of the forge. Additional trading activity was generated between manufactory and local inhabitants as well as between manufactory and peripheral market cities.

Farmers found settlement near ironworks advantageous "... on Account [of] the great Numer [sic] of People employ'd at the Iron Works ... there is generally as good a Market for Grain, and other Produce, as at New-York." In exchange, the manufactories provided utensils, chimney backs, nails, and sundry other products. An advertisement in the New Jersey Journal offered for sale:

Scythes, nails, pots, kettles, griddles, and-irons, smoothing-irons, morters [sic], cart and wagon boxes, six and ten plate stoves, weights, etc.²⁵

Iron and iron products not consumed locally were transported overland to the Delaware River for shipment to Philadelphia and to markets in England. At Oxford, Jonathan Robeson also claimed some trade with New York, citing "... the price and carriage of iron ... being about the same."²⁶ Lewis Evans gave a rate of twenty shillings per ton for pig iron shipped down the Delaware River to Philadelphia in 1755.²⁷ Pig iron then brought about £4 per ton at the marketplace.

The extent of the annual tonnage and categorizing of the trade cannot be ascertained with any degree of finality. Few Jersey ports handled Highlands iron. Moreover, the principal cities of New York and Philadelphia seldom specified the origin of the iron shipments.
By the mid-eighteenth century, the Highlands manufactories began to grow and spread rapidly. Impetus was furnished by the newly opened duty-free English market, the needs of a growing local population, demands for iron in other colonies, and by the Revolutionary War. Soon the charcoal iron industry would reach into every sector of the study area.

As the most accessible forests were cleared for towns and farmsteads or converted into charcoal for the iron manufactories, ironmasters were forced to seek additional woodlands for the maintenance of their trade. The settlements and transportation networks, developed in conjunction with earlier ironworks, became springboards for the penetration of the Highlands interior valleys and ridges. In evidence throughout the industrial expansion was the concentration of major producing facilities in the headwaters regions of the larger streams and their tributaries (Plate VI).

A newly kindled interest was taken in the iron potentials of the remote Western Highlands and in the Hudson Highlands. Early seventeenth-century movements of Dutch, English, and Germans had brought settlement only to the limestone Kittatinny Valley. The rugged, forested slopes and sterile soils of the neighboring ridges discouraged the advances of agriculturalists.28

Discovery of iron ore on unexploited lands encouraged the founding of an iron community at Andover by English interests from Philadelphia. The plantation consisted of "... an elegant Stone Dwelling-house, Stables, Smith's Shop, Springhouse, and a Number of Outhouses for Workmen;
Charcoal Iron Manufactories (1760-1800)

- Bloomery or Forge
- Furnace
- Plantation

Compiled from numerous sources
a large Coalhouse . . . also 5000 acres of well timbered Land to accommodate [sic] the Furnace . . . .  

Following a pattern established in the southern Highlands, operation of the Andover manufactory was instrumental in attracting men to operate the forges which were erected to refine Andover pig metal. Merchants from the nearby Kittatinny Valley were eager to market iron products and supply manufactories with necessary articles. Farmers occupied and cultivated the Vernon and Wallkill valleys. Grist- and sawmills were built to serve ironworker and farmer alike.

Under certain circumstances iron maker and agriculturalist were one and the same. In a marshy valley, a dam might be erected and waterwheels constructed for a small ironworks. Within a few years, formerly useless land was drained and cleared. Fields and meadows replaced the manufactory and the forests which had previously clothed the lower mountain slopes (Fig. 1).

Interest in the Hudson Highlands was exemplified by the growth and distribution of the population. Heretofore confined to Modna Creek Valley and the lowland about Haverstraw and Goshen, the iron industry provided a means of livelihood for settlers who wished to occupy the bouldery, infertile valleys and steep-sided ridges. Over a span of three decades, the numbers of inhabitants increased fourfold in Orange County (Table 5). Roads were built to furnish access to the markets of New York and to serve the local populace. Much of the former traffic utilized the Ramapo Valley or a road crossing the Highlands to Haverstraw on the Hudson River (Plate V).
<table>
<thead>
<tr>
<th>Year</th>
<th>Hunterdon</th>
<th>Morris</th>
<th>Bergen*</th>
<th>Sussex**</th>
<th>Orange***</th>
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<tr>
<td>1745</td>
<td>9,151</td>
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<td>3,006</td>
<td>----#</td>
<td>----</td>
</tr>
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<td>3,268</td>
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<td>600</td>
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<td>----</td>
<td>4,886</td>
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<td>----</td>
<td>----</td>
<td>14,062</td>
</tr>
<tr>
<td>1784</td>
<td>18,363</td>
<td>13,416</td>
<td>9,356</td>
<td>14,187</td>
<td>----</td>
</tr>
<tr>
<td>1790</td>
<td>20,153</td>
<td>16,216</td>
<td>12,601</td>
<td>19,500</td>
<td>18,478</td>
</tr>
</tbody>
</table>

* Included Bergen and Passaic counties.
** Included Warren and Sussex counties.
*** Included Orange and Rockland counties.
# Indicates an absence of data for the year cited.

An accurate determination of the number of ironworks active during the latter half of the eighteenth century is difficult. However, often forges and furnaces were so numerous that travelers thought it impossible to journey across the Highlands without meeting some little manufactory.\textsuperscript{30}

A survey taken in 1784 credited New Jersey with eight furnaces and seventy-nine forges engaged in iron manufacture, a majority of which were in the Highlands.\textsuperscript{31} No figures were given for the Hudson Highlands, although this writer's investigations show six furnaces and seven forges active during the concluding decades of the eighteenth century. Jedidiah Morse in 1795 attributed to Morris County "... no less than seven rich iron mines, from which might be taken ore sufficient to supply the United States; and to work it into iron are two furnaces, two rolling and slitting mills, and about thirty forges, containing from two to four fires each."\textsuperscript{32}

The Highlands Landscape c. 1790

Almost a century of European exploitation and settlement had profoundly altered the appearance of the study region. Bountiful natural attributes—streams, iron ore, and timber—had attracted iron making even to the most remote segment of the area. The Highlands had become, with eastern Pennsylvania and Virginia, one of the leading regions of iron manufacture in North America.

Ironmasters of diverse origins settled within the area. English, Germans, and Scotch-Irish direct from Europe joined like groups from New England, West Jersey, and Pennsylvania. These folk, their trade,
and their cultural heritage played a significant role in the evolution of the Highlands landscape.

Large tracts of land were taken up by iron makers to supply charcoal and iron ore for the manufactories, to furnish food for men and their families, and to provide pasturage for animals. Requirements for good charcoal-making land were summed up in the following statement "... about 2000 Acres of Woodland, the farthest not more than two Miles and an Half distant... most of it well timbered...". The bulkiness of charcoal and its transportation over difficult terrain influenced the distance from the ironworks as cited above. Conifers and broadleaf deciduous trees were used in making charcoal. The sprout hardwoods were preferred for the consistent quality of the charcoal produced and because the trees rejuvenated quickly--only fifteen or twenty years' growth furnished another usable tree.

One or more iron mines were usually found on lands adjacent to the ironworks. Sustaining a furnace with a capacity of twenty tons of pig iron per week (500 tons per annum) necessitated the production of at least twice that amount of iron ore. Few mines could furnish the required ores singlehandedly. Hibernia Furnace, surrounded by several good iron mines, was obliged to cart ore from mines many miles away to meet the demands of the blast furnace. Seldom, if ever, were all mines associated with a particular manufactory operated simultaneously. Closing of old mines and opening of new ones was merely a migration of holes along a number of ore pods in a continuous ore deposit.

Small patches of meadow were cleared and drained as pasturage for livestock. Cultivated plots, or cabbage gardens, furnished food for the ironworkers and their families.
In view of the above land requirements, most iron communities covered expanses encompassing 1500 to 5,000 acres or more.

Numerous opportunities for employment were afforded by the ironworks to skilled and unskilled laborers alike. Size and composition of the work force varied considerably with the type of manufactory. A four-fire forge might employ as few as forty men; whereas, 183 were needed to operate the Sterling plantation—including fifty-five wood-cutters, thirty-five furnace and forge workers, and eighteen ore and charcoal haulers. Poor pay and poorer living conditions resulted in a high desertion rate and a perpetual shortage of laborers. Slaves had been tried in a few smaller ironworks during the early years, but were eliminated in favor of employing European indentured servants. Often neighboring farmers and their animal teams were contracted for hauling in the winter months.

The situation was somewhat better for the skilled worker. Faced with a demand greater than the supply, ironmasters offered inducements such as better pay and more substantial housing to attract the required furnaceman, founders, blacksmiths, carpenters, and the like. A manager and a clerk were needed to oversee and account for the operation of each forge and furnace.

Advertisements for all of the aforementioned positions appeared regularly in local newspapers as well as those from New York and Philadelphia. During the Revolutionary War, the Mount Hope and Hibernia enterprises sought service exemptions for between fifteen and thirty "... Men such as are used to Wood cutting, Coaling and Laborer Suitable for Iron Works."
The constant depletion of natural resources gave a somewhat transitory nature to the iron industry. An ever-increasing penetration of the interior valleys of the study area resulted from the abandonment of earlier sites. Those, primarily on the periphery of the Highlands and in the more fertile and readily accessible valleys, were replaced by general agriculture, milling, lumbering, and town developments (Fig. 20). As early as 1779, advertisements like the following in the Pennsylvania Packet appeared:

One lot of about one hundred and thirty acres. . . . It includes a good stream, Pine Brook, with a very fine mill dam, the remains of a bloomery forge and saw-mill, some good buildings and improved meadows and plowlands. . . . 37

By the turn of the century, the only active ironworks in the lower Musconetcong Valley, Greenwich and Changewater, were operating intermittently. Much the same was occurring along the upper courses of the Raritan and the lower reaches of the Rockaway, Passaic, and Pequannock rivers and their tributaries (Plate VI).

The iron industry was also responsible for several other extant cultural manifestations. Dwellings associated with forges, furnaces, and plantations differed widely with regard to mode of construction and materials used. The diversity of national origins represented by ironworker and ironmaster resulted in houses which expressed not only cultural heritage, but also local expediency or individual fancy. Rather crudely constructed homes of log, stone, or half-timber were erected for the various and sundry laborers. More opulent dwellings of similar materials or frame construction were occupied by the iron-master or manager.
Perusal of contemporary materials, especially newspaper advertisements, netted few worthwhile descriptions of houses associated with ironworks. An advertisement for the sale of Chelsea Forge, staffed and operated primarily by English and Scotch-Irish folk, noted:

... three convenient dwelling-houses, one of which is stone, two stories high, with fireplaces at each end ... the other two of frame and square logs well finished with convenient fireplaces ... and a number of log-houses sufficient for accommodating the hands necessary for carrying on the works. ...

A drawing of an old dwelling at Hibernia depicts a one and one-half story log house with a projecting roof and a gable-end chimney. Although the basic plan is German in origin, Wacker believes English influence brought about the substitution of a gable-end chimney for the central one preferred by the Germans. Culture heritage might explain the presence of the house type in northern Morris County, for German and English folk worked several iron manufactories in the vicinity of Hibernia. At Andover, with plenty of good limestone to be had for building, the tenant houses were constructed substantially of stone.

The overseer's house was well constructed, commodious, and furnished with items purchased in New York, Philadelphia, or Europe. Other than bigness, each manor house was unique and did not represent a specific heritage. Rather, plan and construction were dictated by contemporary fashion.

As ironworks and appurtenant settlement pushed into the Highlands interior, they were followed by a marked increase in the number and density of roads (Plate V). The nature of iron making often separated
manufactories from the markets and each other. Furnaces were isolated by the thousands of acres of woodland needed for charcoal. Operators of fineries and chaferies, in an attempt to offset high manufacturing costs with low distribution expenses, chose riverine sites near either market or transport, not near the furnace. Old Indian trails gave way to many miles of ungraded, stump-filled tracks traveled by pack-horses and carts. Good wagon roads were found exclusively near the older and most populous settlements. Cheap water transportation was furnished by the Delaware, Hudson, Passaic, and Raritan rivers, but only after an arduous overland journey. Elizabeth, Newark, Aquackanonk, New Brunswick, Trenton, and Morristown emerged as trading centers for the iron communities. New York and Philadelphia continued to represent Highlands iron in foreign commerce.

Early settlement of the Highlands had established a pattern for the entire eighteenth century. The fertile soils and moderate relief of the southern Highlands were more conducive to settlement than the rugged, glaciated northern portion. Agriculture, lumbering, and milling amply met the needs of the greater population density. Often these occupations offered employment to persons displaced by the failure or removal of ironworks. Forgemen, miners, and colliers were encouraged to cultivate the land until conditions permitted restoration of the manufactories.

A comparison of the growing Highlands population from 1745 to 1790 can be found in Table 5. The growth of Morris, Sussex, and Orange counties paralleled the rise of iron working in those regions. Nevertheless, only Morris County lay predominantly within the study region; thus, most figures include population growth in areas adjacent to the Highlands.
Early maps by Evans, Faden, Sotzmann, and an unknown author, available at the New Jersey Historical Society and the New York Historical Society, confirm the uneven cultural development within the Highlands. Numerous roads and a rather large number of settlements appeared south of the terminal moraine. Many of the communities were directly attributable to the iron industry. Others were trading centers or agricultural villages ancillary to the industry. Consequently, it was the unglaciated, fertile, and easily accessible areas of the southern Highlands that conformed most strikingly to the settlement succession described by Coxe and Gordon (see page 54).

In contrast to all the activity in the southern Highlands, many northern regions continued to resist habitation. The demise of iron manufactories did not result in agricultural settlement. More often than not, abandonment of an ironworks led to a general depopulation of the surrounding lands. Poor soils of glacial origin, rugged terrain, and inadequate transport combined to inhibit the area's growth. The Ramapos, especially, witnessed a smaller population increase and less movement into the region than did any other segment of the Highlands. The only appreciable clusters of people were situated in certain favored valleys or near the scattered ironworks. Chastellux observed that, as he proceeded into the mountains north of Ringwood, he was to "... plunge into the woods by a road with which nobody was too well acquainted. The country I was to pass through, called 'the Clove,' is extremely wild, and was scarcely [sic] known before the war. ..."42

Maps also provide evidence of the rich heritage of place names attributable to the iron industry. Succasunna and Irondale were prominent
mine sites. Mount Hope, Ringwood, Andover, and Hibernia were among the several iron plantations. Oxford, Franklin, Changewater, and Greenwich denoted forge and furnace establishments which endured. After the disappearance of the iron industry, the aforementioned settlements and many more continued to dot the Highlands landscape.

Perhaps the greatest change wrought by the charcoal iron industry was in relation to the extent and condition of the forest cover. In Europe, the use of charcoal for making iron had led to a large-scale devastation of forests. Leading industrial nations, such as England, restricted the use of woodlands for smelting. Upon coming to the Highlands, the ironmaster was struck by the expanse of timber which seemed, for a time, a limitless supply of fuel for maintenance of a manufactory. Taking title to all accessible forest lands, the ironworker usually

"... rendered [them] almost useless to anybody else. . . ."43

The practice of cutting off the forest cover was fraught with danger and some travelers expressed doubt as to the permanence of the Highlands iron industry. One such description:

The business of the mines and foundries, in New Jersey as well as throughout America, cannot be said to be on as firm a basis as in most parts of Europe, because nobody is concerned about forest preservation, and without an uninterrupted supply of fuel and timber, many works must go to ruin, as indeed has already been the case here and there. Not the least economy is observed [in] regard to forests. The owners of furnaces and foundries possess for the most part great tracts of appurtenant woods, which are cut-off however, without system or order . . . the Union, a high furnace in New Jersey exhausted a forest of nearly 20,000 acres in about twelve or fifteen years, and the works had to be abandoned for lack of wood.44

It had been widely held that 20,000 acres of woodland was required to keep a furnace operating indefinitely. However, improper
management, increased manufactory production, and a variable growth rate among forest species contributed to the unreliability of this estimate.

The immense quantities of charcoal needed by the never-satiated ironworks contributed much to the elimination of the more desirable hardwoods or permanently altered the natural forest composition through repeated cuttings. Persistent use of the same sites for charcoal making permanently damaged soil fertility and resulted in numerous sterile spots which supported little or no plant life for several decades.

Iron making also provided several secondary agents of change: fires originating from sparks emitted by furnaces and forges or from smoldering charcoal pits; drainage of wet lands; creation of meadows; browsing activities of domestic animals; and logging of pine and red cedar to meet the needs of local construction.

By the dawn of the nineteenth century, much of the forest cover had been all but obliterated in several areas. Wallkill Valley, Modna Creek Valley, and the limestone sectors of the southern Highlands were prime examples. Somewhat less denuded were the gentle slopes and plains areas from Mendham to Dover. Extent of the vegetation cover on the ridges changed little from precolonial times; nevertheless, the ecological composition had been disturbed. The contrast between settled and unsettled regions was quite marked, and described thusly:

Behind these rocks [the Hudson shoreline] are ranges of enormous mountains which extend far into the country, and are covered with trackless forests. In other places . . . form beautiful little valleys . . . which terminate at the base of lofty mountains. The country thus gently undulated is covered with rich farms, plantations, orchards, and gardens, and studded with neat and handsome dwelling-houses.45
NOTES


9. Representation of the Lords Commissioners for Trade and Plantations to the King upon the State of His Majesties Colonies and Plantations on the Continent of North America, September 8, 1721, quoted in Ibid., V, 601.


12. Several secondary sources give a date of 1710 for this event. The published journal of John Reading, a surveyor, indicates the presence of numerous agricultural settlements; nevertheless, he saw no ironworks and had not heard of any in operation during the early summer of 1715. "Copy of Journal of . . . Reading While Surveying Lands in the Northern Part of New Jersey, April 17th to June 10th, 1715," Proceedings of the New Jersey Historical Society, 3rd Series, X (1915), 35ff.

14. Typical of the advertisements were the following:

    ... hath on it a very good Iron Mine, and is well accommodated with Streams of Water, one of which is near the said Mine, fit to set a Furnace on, and the other Streams are suitable for Finories [sic]. The Pennsylvania Gazette, February 23 - March 4, 1730, quoted in William Nelson, ed., *New Jersey Archives*, First Series, XI (1704-1739), 237.

    A Tract of Good Land, divided by Whipple River, containing Twelve Hundred and Eleven Acres. ... it is a square Tract, and good Gripper on both sides the River for Meadow, and lies within half a Mile of the Iron-Works. The New-York Gazette, August 26, 1734, quoted in William Nelson, ed., *New Jersey Archives*, First Series, XI (1704-1739), 353-354.

15. Ed Thompson, personal communication.


17. Mr. James Norman of Newfoundland, New Jersey, mentions a map made prior to 1740 which shows a furnace near Bloomingdale, a few miles upstream from Pompton, on the Pequannock River. Personal interview. However, this writer could find no other evidence of its existence or operation.


28. Lewis Evans' 1755 map of the Middle Colonies showed several settlements between what is now Newton, New Jersey, and Goshen, New York, but none in the adjacent Highlands. Gipson, Lewis Evans, Plate VI.

29. Pennsylvania Gazette, October 4, 1770, quoted in Boyer, op. cit., p. 27. The use of stone as a building material was characteristic of this segment of the Highlands.


31. Ibid., I, 550.

32. The American Universal Geography (Boston: J.T. Buckingham, 1805), I, 519.


34. Letter dated March 9, 1786, from Captain George Ross to John Jacob Paesch. Ford Collection, Box 1, MSS, National Park Service, Morristown National Historical Park. It mentioned that Col. Samuel Ogden supplied Hibernia Furnace with 700 tons of ore from the Ogden Mine in Sussex County, about twelve miles from the furnace.

35. For a complete roster of the positions at Sterling, see: Calendar of Historical Manuscripts Relating to the War of the Revolution (New York: State of New York, 1868), II, 69.


41. Gipson, Lewis Evans, Plates II and III; William Faden, The Province of New Jersey, Divided into East and West, Commonly called The Jerseys (Charing Cross: Wm. Faden, 1777); D. F. Sotzmann, Map of New Jersey (Hamburg: Carl Ernst Bohn, 1797); D. F. Sotzmann, Map of New York (Hamburg: Carl Ernst Bohn, 1799); Pennsylvania, Nova Jersey et Nova York cum regionibus ad Fluvium Delaware in America sitis (Vienna: Conrad Lotter, 1748).


 CHAPTER V

RINGWOOD: AN IRON PLANTATION

Perhaps the most important contribution of the era of charcoal iron was development of the iron plantation or iron manor. Seemingly of English origin, these large and often financially able enterprises had been part of American iron making since the seventeenth-century founding of Saugus. Dispersal of iron manufacture along the eastern seaboard introduced the manor to southern New Jersey, Maryland, and Virginia. Later and more permanent plantations were established in Pennsylvania, northern New Jersey, and New York.

Several iron communities were found scattered throughout the Highlands during the eighteenth century (Plate VI). All were similar in morphology and function; however, each was unique in time and place. The regional contributions of Andover and Sterling have been alluded to in a previous chapter. Ringwood has been chosen for a more detailed investigation because of the scope of its commercial enterprise, the changes it wrought on the land, and the role it played in settling a segment of the northern Highlands. It exerted an influence on the cultural and physical landscape which remained long after technological evolution brought a halt to iron manufacture in the Highlands.
Physical Setting

Situated within the meager valley of Ringwood Creek, a tributary of Wanaque River, Ringwood plantation occupied a large portion of the Ramapo Mountain region along the New York-New Jersey border (Plate I). Dominated by broad, forest-covered masses of gneiss, whose dissected summits attain elevations of 800 to 1000 feet, the land contributes much to a feeling of remoteness and isolation.

A characteristic of the Passaic Range, of which Ramapo Mountain is a part, is a decided southwesterly slope. Drainage is oriented toward a rather narrow longitudinal valley occupied by the Wanaque River.

A predominantly broadleaf deciduous forest covers much of the hillsides and summits about Ringwood, as well as the less favored sections of the tributary valleys. Interspersed among the various species of hardwoods are small stands of coniferous types such as pine, red cedar, and hemlock. The forest floor consists of litter, flowers, ferns, and grasses. Ferns, mosses, woody shrubs, and mountain laurel cover the steeper slopes. Patches of bare country rock are also visible.

Scattered throughout are swamps and natural wet meadows. These result from inadequate or disrupted drainage due to the differential resistance of local rocks to Pleistocene glaciation or to accumulations of glacial debris.

Soils are characteristically acid, rocky, exhibit shallow profiles, and have been adversely affected by drainage conditions. Glaciation produced stony conditions almost equal to those found in New England. Drift is not too deep, except in the valleys. The steeper
slopes are covered with thin layers of soil or none at all. The region has little potential for the agriculturalist. Those who have tried never stayed too long.

Historical Background

Ill-suited to even the most rudimentary type of cultivation, the sterile soils and rugged terrain offered few inducements to settlement. Shunned by Indians, except for infrequent hunting and fishing expeditions, and circumvented by early European invaders, the region could claim no permanent residents until Cornelius Board established an ironworks about 1735. Shortly thereafter, several forges were founded on Ringwood Creek below Sterling Lake, and a furnace was erected by the Ogden family of Newark. A few agriculturalists took up the natural meadows and swamplands adjacent to the manufactories. The early settlers, mainly from the British Isles, numbered only about two dozen families.

Primitive conditions proved too difficult for a small manufactory to overcome. The diminutive market provided by the local populace was unable to sustain even a few ironworks. The situation was only somewhat relieved by periodic shipments of iron over almost nonexistent roads to Aquackanonk Landing for sale to merchants in Newark, Elizabeth, and New York. Although numerous mines were opened, forests claimed for timber and charcoal, and several permanent dwellings erected, the Ogdens and their neighbors soon abandoned the lands or offered them for sale.

The response of Peter Hasenclever, a German living in England, to the Ogden's advertisement heralded the advent of one of the most
outstanding developments in the industrial utilization of the Highlands. Spearheaded by Hasenclever and several wealthy acquaintances, the American Company was formed in order to "... exploit land in the American Colonies for the production of pig iron, hemp, potash and other useful items." In addition to the Ogden tract and surrounding lands, title was secured to areas elsewhere in New Jersey and New York.

Plantation Components

As viewed by Peter Hasenclever in 1765, the Ringwood area was "... a new, wild and thinly-inhabited country ...," and was described by representatives of the East Jersey proprietors thusly:

We find the land exceedingly rocky and mountainous. The mountains appear to be almost inaccessible along the river, some of them bare of timber, others well timbered. In the whole tract we viewed we saw but two small pieces of swamp which were both taken up, and in the whole there did not appear to be fifty acres of plow land. ... From the place we entered upon this view for near three miles we could not travel along the edge of the river, the mountains on both sides being so rocky and steep that it was impossible to climb them. ... In our opinion the land is entirely unfit for any purpose but that Mr. H. proposed to employ it in. ... Development of the Ringwood plantation rested on refurbishing its most pivotal feature--the Ogden furnace. Hasenclever introduced several changes which aided in its operating efficiency. The exterior country rock and the furnace capacity of 700 tons of pig iron per annum were not altered. However, slate was substituted for country rock as the refractory lining, prolonging the blast period, and a roof was built over the furnace, shielding men and equipment from wind and water.
Four forges with eleven fires (chafery and finery) and six hammers were erected within three miles of the furnace (Fig. 21). The forges processed pigs into bars by the usual method. Housed in a building eighty by forty-five feet, four fires could produce 250 to 350 tons of bar iron annually.

Hasenclever also installed a stamping mill which reprocessed furnace and forge cinders, separating usable metal from the slag. No data are available on the amount of iron recovered in this manner; nevertheless, since the mill was common in conjunction with later furnaces, savings must have been considerable.

Several ore bodies were opened to augment those worked in previous years. By the Revolutionary War, at least eight mines were operative, yielding ores of sixty to seventy percent iron. Additional pits were abandoned because they "... abounded in sulphur or copper, or had qualities which rendered the goodness of the ore dubious."

Power necessary for the operation of the furnace, forges, stamping mill, and other plantation activities was furnished by water from the nearby Ringwood Creek. Dependence on this energy source proved to be a nuisance at several times in the year. Winter ice choked the waterwheels, virtually halting all activities; spring floods were responsible for damage to equipment every year; and summer drought drastically reduced the supply of water just when demand was at its peak.

To alleviate the threat of flood, a small raceway diverted water from the river to the furnace area, providing some measure of protection for the ironworks. The low summer water level was corrected
by the creation of a large reservoir and canal described thusly:

This Reservoir is a pond called Toxito [Tuxedo] pond, is about three miles long, and near one mile broad; it formerly emptied itself into Ramopough [Ramapo] River, but by an immense dam of 860 feet long, and from 12 to 22 feet high, the natural outlet is stopped up, and the water raised to such a height, as to take its course with a head of ten feet high, into a long canal, which conducts into the Ringwood River.12

Houses, outbuildings, and stores were in ample supply on the plantation (Plate VII). Such buildings were usually constructed simply and economically by the manor overseer. Native materials were always used. Colliers were housed in small tent-like structures of sticks and clay or one-room log cabins (Fig. 22). The latter consisted of logs notched and caulked with clay, earth and brush piled around the outside of the foundation, and an earthen floor inside. Roofing materials often were tree bark or shingles split from oaks and pines. Doors were hung without hinges and windows were unglazed.

The miners, forge- and furnacemen, and other personnel lived in more permanent structures. The earliest dwellings were probably of log; although cottages of stone, squared logs, and frame filled in with brick and clay later gave permanence to the iron manor (Fig. 23).13 A small garden of one to five acres adjoined each house.

The most imposing house was that of the ironmaster. Situated on a small rise overlooking the plantation, and constructed of timber, stone, and plaster, it presented a unique sight to travelers in the area (Fig. 24). The house was commodious, with large rooms, wide hallways, and open fireplaces. Furnishings contrasted sharply with those in neighboring dwellings, often having been imported from Europe. Well-
cared-for gardens surrounded the house and completed the scene. It was a fitting setting for the social life of the manor.

Barns, stables, and a small blacksmith's forge were provided for the horses, cows, oxen, and other animals. Storehouses, a smokehouse, a gristmill, and a sawmill furnished goods consumed by the plantation personnel. A combination general store and inn, run by the ironmaster, schoolhouse and/or church, and a not-too-distant tavern were also part of the isolated community (Figs. 25 and 26).

The lands surrounding the manor were used by farmers and woodsmen who were employed by the ironmaster or who rented their lands from him. Individual farms contained twenty-five to thirty acres. Grains, primarily buckwheat and corn, were the major crops. Ancillary to the farmlands and equally important was the acreage in meadows. Improved pastures were derived from swamps and bogs cleared and drained at no small expense (Plate VII). However, the need for extensive charcoal-producing woodlands confined cultivated and improved land to three or four percent of the estate's 10,000 acres.

The lack of substantial European or Indian settlement on the surrounding lands forced the American Company to rely heavily on imported, indentured labor. In order to operate the furnace, forges, mines, and mills as well as make charcoal and cart ore, Hasenclever attracted many Germans, English, and Scotch-Irish. A check of surnames in 1780 revealed a sixty-forty balance in favor of workers from the British Isles. Primitive surroundings and the rather harsh nature of the work soon drove many to desert and almost every issue of the newspapers carried
notices asking for the return of runaway laborers and advertisements for new workers, frequently with this appended: "Those who are Germans, or who can work in the German way, shall be preferred." Although schooled in basically the same methods of iron manufacture, German forge-and-furnace employed techniques "... different from that of England, and [which seemed] to be attended with greater dispatch and saving of fewel [sic]."^17

Hostilities of the Revolutionary War greatly diminished the potential labor supply. Negroes and captured Hessian soldiers were employed to perform the most unpleasant and unskilled tasks.^18

Industrial activity stimulated the building of roads. A few poorly constructed roads had been used in conjunction with earlier ironworks; however, such roads proved incapable of carrying the commerce of the much larger Ringwood enterprise. Glacial debris and the rugged topography made road building tiresome, laborious, and expensive. Numerous wetlands and small creeks had to be bridged with timber. After extensive rains or during spring floods, most roads were impassable. Dust frequently made travel unpleasant in the summer months.

Within ten years of its founding, Ringwood was connected via land carriage to American Company properties at Charlotteburg and Long Pond, as well as to ship landings at Haverstraw, Aquackanonk, and Hackensack. From the latter points, goods were then sent by water to New York, Newark, and Elizabeth. Over this network moved the trade for which Ringwood--indeed all iron manufactories--was the focus: beef, pork, flour, grain, and hay from neighboring farms; clothing, utensils, liquor--especially rum and brandy--and sundry items from England and
the West Indies; and iron products from the manor. Within the plantation itself, additional roads of three to eight miles in length were necessary for transporting provisions, charcoal, iron ore, and pig iron (Plate VII). The bulk of the traffic consisted of oxcarts, horse-drawn wagons and carriages, and riders on horseback.

Iron Making at Ringwood

The manufacture of iron was the sole function of Ringwood Manor from its establishment by Hasenclever in 1765, until the mid-nineteenth century. Ringwood's forges and furnace worked only as charcoal manufactories.

All raw materials for making iron were available on the plantation lands. Iron ore came from several mines, notably the Good Hope, Peter, Hard, and Keeler (Caler) pits (Plate VII). Loosened by black powder and hand tools, the ore was loaded into carts and wagons for the short journey over cleared pathways to the furnace (Fig. 27). Charcoal burning was performed at several locations in the surrounding woodlands. Limestone was supplied by numerous outcroppings or gathered as boulders from the glacial till.

Once assembled at the furnace, successive layers of fuel, iron ore, and flux were taken across the charging bridge of the furnace. Based on an average production of twenty-five tons of pig metal per week, each ton required approximately 250 bushels of charcoal, two to three tons of ore, and 500 pounds of limestone. Total cost of the materials prior to the Revolution was about £3. Labor, transportation, and incidental expenses accounted for another £3 or £4. Between 1774
and 1776, pig iron brought £8.7 per ton at the market. Cast-iron articles of almost every description were made available for sale in markets as distant as South Carolina.

Pig iron not offered for sale was converted into bar iron by Ringwood forges for shipment to England and the West Indies. The refining process resulted in a loss of thirty percent or more of pig metal and increased charcoal requirements by fifty percent. Labor and transport charges—from furnace to finery, finery to chafery, and chafery to market—were also substantially raised. Thus, Ringwood bar iron sold for £28 to £30 per ton, a price which compared favorably with offerings elsewhere in the colonies. In 1776, the last full year of production before the Revolutionary War, almost 400 tons of bar iron were sold in New York for £11,206. From these sales the American Company realized a profit of £360, hardly worth a capital expenditure of almost £50,000 and the labor of 500 to 600 men.

The Demise of the Plantation

Following the end of hostilities between England and America, Ringwood and other colonial iron centers underwent a general decline. Independence resulted in the loss of America’s major foreign iron market. Forests became scarce and the price of charcoal rose to three cents per pound. Labor became harder to find and higher priced. A ton of ore, raised and carted to the furnace for about $1.50 in 1775, now cost $2.00. Antiquated transportation networks increased charges to $5.00 per ton on pig iron and more on bars. Finished bar iron cost about $110 per ton (1810), versus a price of $80 per ton in 1790. More-
over, the new American nation neglected to impose adequate duties on foreign iron, bringing a deluge of products from a resurgent English iron industry to the eastern seaboard.23

After several years of intermittent and unprofitable operation, Ringwood passed into the hands of Martin Ryerson of Pompton. The plantation's manufactories, mines, and forests were consolidated with ironworks at Wanaque, Pompton, and the newly erected charcoal furnace at nearby Long Pond (Fig. 28). Even though the arrangement brought financial success, Ringwood Manor was never to sustain itself again. The lands were finally sold to Peter Cooper and Abram S. Hewitt of the Trenton Iron Company which operated furnaces at Phillipsburg and a rolling mill at Trenton.

Approximately one hundred years of iron manufacture had greatly altered the landscape of Ringwood and its environs. The focal point of the manor--the furnace--was in ruins and had to be dismantled. Many of the forges still operated, but charcoal technology was obsolete by the 1850's. Iron mines, which had produced almost 500,000 tons of ore, were converted from pits to shafts. Most mines were in good condition and had large reserves of ore which could be exploited.

The old manor house had been torn down, as well as a great many of the workmen's cottages and log structures around the old furnace area. Many of the farms and pasture lands on the estate had been abandoned. Old fields of weeds, woody shrubs, and red cedar dotted the land.

Human habitation, cultivation, and demands of the charcoal iron industry resulted in extensive removal of the Ringwood forests.
Streamsides and other lowlands were largely denuded, trees having been replaced by grasses or crops. Repeated cutting over of the vegetation stripped ridges of large-sized trees and induced locally heavy growths of underbrush. Natural recovery had begun; however, by no means was the extensive original forest cover to return.

The nineteenth century also brought a change in population composition. As iron making fell upon hard times, many of the white laborers sought other employment within the Wanaque Valley or moved to growing cities peripheral to the Highlands. Their places were taken by Negroes or Jackson Whites. Descendants of the latter still inhabit much of the land about the iron mines and nearby Hilburn, New York.

Iron Mining--The Final Stage

A large-scale rejuvenation of the Ringwood property was undertaken by the Trenton Iron Company. The old manor complex adjacent to the ironworks on Ringwood Creek was abandoned and later dismantled. Increased mining activity accompanied the opening of several reconditioned shafts. A company village was erected in close proximity to the mines. General stores, church, tavern, and new clapboarded multistory or multi-family dwellings clustered about the area, evoking memories of the defunct plantation era (Plate VIII). Several new roads, and later a railroad, were built to facilitate the movement of iron ore from the Ringwood mines to market.

Development of the mining region was hampered by two chronic problems—a lack of cheap transportation and foreign competition. Due to the somewhat remote location in the northern Highlands, the Ringwood properties had benefited little from turnpikes or the Morris Canal.
PLATE VIII

RINGWOOD MANOR
(c. 1900)

- Dwelling
- Railroad
- Building
- Mine
- Meadow
- Road
- Swamp
- Unpaved Road
Consequently, iron products and ore were still shipped to market in horse- and ox-drawn wagons via eighteenth-century roads.

Upon taking over the Ringwood mines, Hewitt proposed that a railroad be built to Pompton from where iron ore could be freighted on the Morris Canal to company furnaces at Phillipsburg. For an unspecified reduction in canal tolls (then seventy-five cents freight and fifty cents toll per ton for the journey), ore shipments of 25,000 tons annually were to be guaranteed by Hewitt. The alternative involved erecting manufactories at Ringwood and shipping finished iron products, the cost of which would be prohibitive.

Unable to get a favorable rate on the canal and not having the capital to construct a railroad, the Trenton Iron Company was forced to curtail mine operations. Subsequent efforts to find an outlet for transporting Ringwood ore ended in failure. Eventually a railroad was built adjacent to the old roadway along the Wanaque River and did carry iron ore to the canal. Nevertheless, in 1875, this development came too late to keep most mines open. The Peter mine was worked sporadically into the twentieth century before it ceased operations completely (Fig. 29).

The only twentieth-century vestiges of Ringwood's former iron enterprises are dilapidated company homes, some occupied by descendants of miners (Fig. 30), mine shafts filled with water and overgrown with brush, rusting mine machinery, cinder roads and the abandoned railroad over which ore was carted, and a rejuvenated forest cover largely undisturbed for a century.
NOTES

1. Map showing property owners in the vicinity of Long Pond lying between the old Bergen and Orange Counties (now Sussex) and southwest toward the Pahkahqualling (now Kittatinny) Mountain Range (n.p., n. pub., n.d.).


5. Iron plantations were established at Charlotteburg, about thirteen miles southwest of Ringwood on the Pequannock River, and at Long Pond, about three miles west of Ringwood, on the Wanaque River. Although each was planned as part of a single economic unit—the American Company—they operated as self-contained manors. A plantation was also established at Cortland on the east side of the Hudson River, but was not successful because of poor quality iron ore. A pot- and pearl-ash manufactory on the Mohawk River completed the works erected and overseen by Hasenclever.


8. Hasenclever insisted that he erected a new one, (Op. cit., pp. 7, 78) although Ogden advertised "... a new well-built furnace. ..." in 1764. The New York Mercury, March 5, 1764, quoted in William Nelson, ed., New Jersey Archives, First Series, XXIV (1762-1765), 328. It is difficult to believe this furnace could not have been salvaged one year later.

10. The less intense heat generated in charcoal furnaces was insufficient to completely separate the molten iron from the slag. The metaliferous cinders were subjected to pulverizing by heavy, water-powered iron hammers. The resulting iron particles were gathered and reintroduced into the blast furnace.


12. Ibid., pp. 248-249.


14. Hasenclever had brought over 535 persons, including women and children, from Germany alone to run American Company properties in 1765.


18. An outgrowth of this heterogeneous work force was a group of people known locally as the "Jackson Whites." Products of a Negro-English-Hessian-Indian admixture, the Jackson Whites became the dominant element in Ringwood's nineteenth-century labor pool.


20. An advertisement appeared in the New York Gazette and Weekly Mercury, June 10, 1776:

Orders for Iron drawn to any Size, from three Quarters to three Inches square, and from one and an Half to five inches flat, executed with Punctuality and Dispatch. Mill Irons, Rudder Irons, etc. drawn to Patterns. Quoted in William S. Stryker, ed., New Jersey Archives, Second Series, I (1776-1777), 114.


22. Ibid.
23. Technological changes, such as the introduction of bituminous coal, adaptation of the steam engine to increase blast furnace efficiency, and improvements in refining, made English products cheaper and superior. U.S. Bureau of the Census, Tenth Census of the United States: 1880, op. cit., p. 876.

CHAPTER VI

ANTHRACITE AND THE MORRIS CANAL

Except for a rather brief revival after the Revolutionary War, the iron industry of the newly independent United States entered upon hard times during the first years of the nineteenth century. The regions of iron production underwent significant changes. Abundant, verdant forests which had sustained the old iron-making techniques had been severely depleted and a lack of charcoal was instrumental in closing many ironworks. Old techniques now proved costly and ineffective. Roads and turnpikes were wholly inadequate and incapable of furnishing cheap, efficient transport of raw materials and of marketing finished articles. Finally, loss of the British and other foreign markets was keenly felt.

Few forges and furnaces escaped the hazards of the times (Plate IX). Small enterprises possessing little capital were subjected to foreclosures, continual changes in ownership, or were operated by several leaseholders. Even the owners of large plantations found conditions too difficult for successful operation. The census returns for 1820 reported iron sales dull, prices reduced by twenty-five or thirty-five percent, decaying ironworks, and the inability of blast furnace operators to pay rents.
New York-New Jersey
HIGHLANDS

Charcoal Iron Manufactories
(1825-1860)

- Bloomery or Forge
- Furnace

Compiled from numerous sources
Development of the Morris Canal

The decade of the 1820's would have brought oblivion to the Highlands iron industry, had not canal fever come to the rescue. It was reasoned that a canal, crossing the Highlands through northern New Jersey, would reestablish cheap, direct transportation to major iron markets, make available the Lehigh Valley coalfields and new iron technology, and induce the formation of new ironworks and new settlements within the general area of the Highlands.

An act of the New Jersey Legislature authorized the Morris Canal and Banking Company in 1824, and construction of the canal from Phillipsburg to Newark was completed by 1831, with an extension to Jersey City finished five years later (Plate X). As initially built the canal was twenty feet wide at the bottom, thirty-two feet wide at the top, and had a water depth of four feet. Later enlargement to twenty-five feet at the bottom, forty feet at the top, and a five-foot depth resulted from insufficient traffic estimates during the early stages of planning. ³

As had been anticipated, the canal accomplished a renaissance of the iron industry and brought industrialization to outlying towns and villages. ⁴ However, the enlarged population, burgeoning settlements (Plate X), improved agriculture, and anthracite coal heralded the end of charcoal iron.

Although several furnaces and a handful of forges continued to operate during the mid-nineteenth century, the age of the charcoal manufactory had come to an end. ⁵
NEW JERSEY Settlements

MORRIS CANAL

Settlements
- Founded before 1830
- Founded after 1830

Lake Hopatcong
Dover
Hackettstown
Boonton
Dover
Rooster R.
Boonton R.
Newark City
Jersey City
Phillipsburg
Masconetcong
South Bn.
Raritan River
Passaic River
Raritan River
Advent of Anthracite Technology

The transition from charcoal to anthracite coal gave fresh impetus to a troubled industry. Facilities for manufacturing iron increased; districts which had been handicapped by a lack of timber were revived; and prices declined as a result of increased production, providing stiff competition for foreign ironmasters.

Experiments using coal in iron making were carried on almost simultaneously in England and eastern Pennsylvania in the 1830's. Operation of the first furnaces differed little from the charcoal counterparts, with the single exception of the hot-air blast. Use of the hot blast and anthracite enabled furnace production to increase from twenty-five tons per week to thirty-six tons.

Within five years after the initial American successes, only six furnaces—all in Pennsylvania—utilized anthracite to reduce iron ore. A decade later, the list contained forty-two furnaces in Pennsylvania and New Jersey, and by 1856, 121 ironworks—including several in the Highlands (Plate XI)—had adopted the new techniques.

The technological evolution was the harbinger of a changing role for the ore resources of the Highlands. The Morris Canal had not only opened Pennsylvania coalfields to Highlands manufactories, but also provided new markets for iron ore from the latter region. In subsequent years, the largest quantity of ore went into the blast furnaces of the Delaware and Lehigh valleys, not to those of the Highlands.

This development had actually been envisioned prior to the opening of the canal. There were no forges or furnaces in New Jersey equipped to use anthracite in 1830, and it seemed far easier to haul two
New York-New Jersey
HIGHLANDS

Anthracite Blast Furnaces

△ Established before 1850
▼ Established after 1850

Compiled from numerous sources
tons of Highlands iron ore to the Delaware River than to transport seven and a half tons of coal to the Highlands (referring to the tonnage necessary for one ton of pig iron). The situation delayed the advent of anthracite furnaces in the region; nevertheless, improved transportation and market conditions furnished the stimuli for erecting new manufactories.

Anthracite Manufactories

The first Highlands anthracite blast furnaces were constructed at Stanhope near the Morris Canal. Selection of such a site for an ironworks in 1841 was not accidental. Copious woodlands and several neighboring iron mines, notably at Irondale, had sustained iron manufactories for almost a century. Impurities in the ores and elimination of forests by charcoal manufacture had resulted in an early cessation of activity.

Iron ore from nearby mines, limestone from the German Valley, coal from the Lehigh Valley, and a labor pool of men skilled in iron manufacture combined all the necessary ingredients for a successful venture. Three furnaces, with a total capacity of 200 tons weekly, were erected and operated by the Sussex Iron Company. The ironworks measurably increased the importance of Stanhope and revitalized the countryside, agriculturally and industrially.

In all likelihood, no other sector of the Highlands had as many large, producing mines in such close proximity. Pits were reconditioned and expanded into shafts. New mines were opened and ores were tested. By 1865, a dozen or so mines were shipping ore to Stanhope, Wharton, and, via the canal, to manufacturing districts from Boonton, New Jersey, to Allentown, Pennsylvania.
Miners and ironworkers were attracted by the new industrial complex. A few were immigrants—mostly Cornishmen and a sprinkling of Irish. Many were workers who had remained in the area after the demise of the charcoal manufactories. The latter had eked out a bare living from agriculture or tried to relocate near any forge or furnace in blast, usually without success. Relatively few, investigation shows, had deserted the Highlands for the growing peripheral towns.

The increased population aided farmers living in the neighboring German Valley. Heretofore, the markets for agriculturalists had been limited to Dover, Hackettstown, and the settlements at either end of the Morris Canal.

Subsequent to initial operations at Stanhope, similar anthracite manufactories sprang up at Boonton, Port Oram (Wharton), High Bridge, Chester, and elsewhere in New Jersey, as well as at Greenwood, New York—also the site of an operational charcoal furnace (Plate XI). At Oxford, conversion of the original charcoal furnace was completed by 1846. Adoption of steam power, the hot blast, and a new fuel increased production threefold, frequently making more iron in a single day than was made in a week during the colonial period.

The industrial facilities were a far cry from the old iron plantation. No great tracts of land were purchased, few new communities were built, raw materials were brought from distant points, finished products were usually made in plants many miles from the Highlands furnace, and foreign markets were virtually nonexistent. Furthermore, most of the aforementioned furnaces operated only a short time and were of scant import outside their respective localities.
Efficient and accessible transportation was a chief locative factor at several sites. Without a doubt, the Morris Canal must be given the greatest credit for any resurrection of the Highlands iron industry. Proximity to the canal was responsible for the rebirth of iron making at Boonton and the establishment of ironworks at Port Oram and Stanhope. The Trenton Iron Company used the canal for transporting ore to their manufactories at Phillipsburg.

Railroads furnished mid-century competition for the canal. Paralleling much of the latter's route, the trailblazing Morris and Essex Railroad pushed through the study area to Phillipsburg by 1861. It brought speed, efficiency, and year-round operation—not provided by the canal as it was closed in the winter months by ice—to Highlands transportation. Soon, much of the coal traffic from the Lehigh Valley had been captured by the railroads. Industrial development at Chester, High Bridge, and Greenwood can be traced directly to other trans-Highlands railroads. In addition, feeder lines such as the Mount Hope Mineral Railroad, the Ogden Mine Railroad, and others stimulated iron mining in many long-dormant districts. Later, many of these same railroads, or larger systems into which they were incorporated, would be agents for the transporting of products from many Highlands settlements and farms which owed their presence, at least in part, to the iron industry.

Better transportation and technological advances combined to lower substantially the cost of iron making. During the 1850's the actual cost of pig iron manufactured with charcoal was from $25 to $28
per ton, while the cost of making it with anthracite was from $15 to $17 per ton. At the market, anthracite iron sold for less than the cost of charcoal iron and compared favorably with the price of iron imported from England. This favorable price structure brought growth and prosperity to the Highlands iron industry (Table 6). However, the region was unable to regain its ranking as one of the three leading areas, held during the charcoal era.

Events later in the nineteenth century culminated in the final decline of the iron manufactories. Invention of the Bessemer process made previous iron-making techniques obsolete. Coupled with the use of coke, a by-product of bituminous coal, the furnace reduced the cost of making iron to $12 or $13 per ton—an impossible figure to attain with the anthracite technology. Moreover, the discoveries of bituminous coal in western Pennsylvania were followed by the unearthing of high-quality hematite ore in the ranges near Lake Superior. The center of the American iron industry shifted westward. The decline of New Jersey, Virginia, and other seaboard centers coincided with the rise of Ohio, Illinois, and Indiana. Pennsylvania and New York recorded shifts from east to west and from Highlands to Adirondack Mountains, respectively. In terms of distance, geographic relocation from the eastern seaboard to the interior was slight; however, it was large when viewed as heralding the termination of iron manufacture in the Highlands.

A New Role: Iron Mining

With the demise or intermittent operation of the Highlands anthracite furnaces, extractive exploitation became a dominant trend in the study area's geography.
<table>
<thead>
<tr>
<th>Year</th>
<th>Tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>1874</td>
<td>90,150</td>
</tr>
<tr>
<td>1875</td>
<td>64,069</td>
</tr>
<tr>
<td>1876</td>
<td>25,349</td>
</tr>
<tr>
<td>1877</td>
<td>52,909</td>
</tr>
<tr>
<td>1878</td>
<td>78,455</td>
</tr>
<tr>
<td>1879</td>
<td>78,143</td>
</tr>
<tr>
<td>1880</td>
<td>170,049</td>
</tr>
<tr>
<td>1881</td>
<td>171,672</td>
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<td>1882</td>
<td>176,805</td>
</tr>
<tr>
<td>1883</td>
<td>138,773</td>
</tr>
<tr>
<td>1884</td>
<td>82,935</td>
</tr>
<tr>
<td>1885</td>
<td>54,427</td>
</tr>
</tbody>
</table>

The initial drift toward this new position had become evident soon after the early years of Morris Canal operations. The importance of iron ore and anthracite coal to the canal was demonstrated by assigning the lowest tolls to these commodities.\textsuperscript{12} Forge cinders and bar and pig iron, among other items, also contributed heavily to canal traffic. The rising demand for iron ore and coal, within and without the Highlands, was accompanied by a general increase in canal commerce from 59,259 tons (1845) to 889,220 (1866).\textsuperscript{13} The last date became the highwater mark, for thereafter the newly extended railroads captured much of the coal shipments. Highlands iron-ore production and manufactured iron never attained the former combined coal-iron ore figure.

In 1880, Morris County's 568,420 tons made her the third ranking iron-ore producer in the nation, with Orange, Sussex, and Warren counties also producing over 50,000 tons each in that year.\textsuperscript{14} A portion of the ore was used locally by the few remaining furnaces. An overwhelming part was sent by canal, railroad, and riverboat to furnaces from Poughkeepsie, New York, to eastern Pennsylvania. Iron mining had become one of the area's most important industries and employed the services of several thousand Highlanders. Heavy demands over the next few years made possible the establishment of new production records as almost every workable ore deposit was made to yield some iron (Table 7). "Boom" conditions furnished the capital for mine improvements, such as better pumps, improved equipment, and a more general use of high explosives.
### TABLE 7

**NEW JERSEY IRON MINING**

<table>
<thead>
<tr>
<th>Year</th>
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</thead>
<tbody>
<tr>
<td>1790</td>
<td>10,000*</td>
</tr>
<tr>
<td>1830</td>
<td>20,000*</td>
</tr>
<tr>
<td>1855</td>
<td>100,000*</td>
</tr>
<tr>
<td>1860</td>
<td>164,900</td>
</tr>
<tr>
<td>1864</td>
<td>226,000</td>
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<td>1867</td>
<td>275,067</td>
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<td>1870</td>
<td>362,636</td>
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<tr>
<td>1871</td>
<td>450,000</td>
</tr>
<tr>
<td>1872</td>
<td>600,000</td>
</tr>
<tr>
<td>1873</td>
<td>665,000</td>
</tr>
<tr>
<td>1874</td>
<td>525,000</td>
</tr>
<tr>
<td>1875</td>
<td>390,000</td>
</tr>
<tr>
<td>1876</td>
<td>285,000</td>
</tr>
<tr>
<td>1877</td>
<td>315,000</td>
</tr>
<tr>
<td>1878</td>
<td>409,674</td>
</tr>
<tr>
<td>1879</td>
<td>488,028</td>
</tr>
<tr>
<td>1880</td>
<td>745,000</td>
</tr>
<tr>
<td>1881</td>
<td>737,052</td>
</tr>
<tr>
<td>1882</td>
<td>932,762</td>
</tr>
<tr>
<td>1883</td>
<td>521,416</td>
</tr>
<tr>
<td>1884</td>
<td>393,710</td>
</tr>
<tr>
<td>1885</td>
<td>330,000</td>
</tr>
</tbody>
</table>

*estimate

All activity came to naught with the events--economic and geographic--of the late nineteenth century. Most Highlands mines were too limited in reserves and the ores too high in phosphorus to supply the needs of a new era. Some sites, capable of producing good quality ore, were closed because of heavy expenditures for timbering and drainage in the ever-deepening mines. An anonymous visitor described circumstances at Succasunna: "... a pile of ore containing four thousand five hundred tons, every pound of which had been brought from the mouth of the shaft to the place where it lay--waiting a market--on a railroad track which was laid with English iron." Few mines, if any, ever "bottomed out" and reserves are still considerable in quantity, if not in quality.

The decline in Highlands ore production evident in Table 7 cannot be attributed solely to a geographic expansion of the American economy. A rising demand for Bessemer ore in the old eastern seaboard manufactories induced the importation of foreign ores, primarily from Spain and French West Africa. Destined for ironworks in eastern Pennsylvania, New York, and New Jersey, foreign ores succeeded in driving Highlands ore even from its oldest markets.

Vestiges of Anthracite, Iron, and Canal

The Highlands as a prominent factor in the American industrial picture had all but vanished by the last years of the nineteenth century. The heady promise of a substantial iron resurgence, fueled by anthracite coal and transported by the Morris Canal, had been greatly deflated by the discovery of new coal and iron deposits west of the Appalachians and
by the development of new and cheaper methods of iron production using bituminous coal. But the period of anthracite and the Morris Canal did not close without leaving its imprint on the land.

Most visible relics of the period are extant along the former route of the canal and subsequent transportation arteries (Figs. 31 and 32). When, by 1850, the area was injected with a new technology and new peoples, many Highlands cities on the verge of decay were revived. Anthracite iron manufacture aided such old iron centers as Morristown, Boonton, Dover, and Stanhope. Iron became the economic basis for continued growth in the twentieth century. Port Oram, Port Murray, Port Colden, and the like sprang from ore landings or agricultural produce stops to locally important iron manufacturing and market towns (Figs. 22 and 34). Phillipsburg, nonexistent prior to the Morris Canal, parlayed its position as the western terminus of the waterway into the largest iron manufacturing center associated with the Highlands.

The impact of anthracite coal and iron technology was readily transferred to the surrounding land. Additional iron mines were explored and, if found promising, opened for exploitation. Population increase was substantial, especially in the towns which possessed the ingredients for iron manufacture. Negroes and East European immigrants replaced the older generation of English, Scotch-Irish, Welsh, and German workers. The latter groups forsook the heavy labor of the mines and furnaces for other ventures in the burgeoning commercial sections of the Highlands towns. Company-owned residential areas appeared adjacent to mine and furnace. Some consisted of multifamily units of stone or
frame (Fig. 35). More often single- or double-family dwellings of clapboards fronted by a small patch of lawn lined the single unpaved street leading to a mine (Fig. 36).

The advantages offered by the canal and railroads stimulated agriculture as well. With the closing of most iron manufactories by 1890, farming became the main pursuit of Highlands inhabitants. The trend was evident in the southern region late in the eighteenth century. One hundred years later, mixed farming dominated the landscape (Fig. 37). The latter half of the nineteenth century brought profound changes in the northern tier of counties. Nestled among the lakes, valleys, and ridges presently undergoing tremendous recreational development, small farms, which once supplied only the needs of local folk, expanded their shipments of flour and grain to new markets tapped by trains and canal. The drastically reduced travel time to urban centers led to the establishment of commercial dairying even on the most infertile, bouldery soils. Before the turn of the twentieth century, dairying had become the primary industry of Sussex and Orange counties (Fig. 38). Nevertheless, much land occupied during the iron era now lay abandoned (Fig. 39).

The introduction of anthracite as a substitute for charcoal almost brought a complete halt to the devastation of the Highlands forests. Certainly it would appear that much of the present vegetational cover dates from about 1850, when charcoal manufactories had all but ceased operations. Reforestation by natural means was quite vigorous, so much so that Vermuele's notation "... throughout [the] western
portion of the Highlands... very little evidence of bad effects from
deforestation... ,"19 might have been applied to the entire northern
Highlands.

Iron mining continued as a Highlands occupation until just a
few years ago. The remaining works--at Mount Hope, Wharton, and
Oxford--were widely scattered and no longer held a commanding position
in the regional economy (Fig. 40). The drab, look-alike company
dwellings, abandoned mine pits and shafts, and that vital link--the
mine road--remain. However, the casual Highlands traveler is scarcely
aware of their existence.
NOTES

1. Split Rock Forge, in Morris County, operated continually from 1801-1829; nevertheless, it was leased, wholly or in part, to several persons in that span. Cobb Collection, Box 10, MSS, National Park Service, Morristown National Historical Park.


4. Many of the Highlands towns which had been losing population suddenly began to grow with the influx of new industry. Boonton was a typical case in point. The East Jersey Manufacturing Company chose it as the site for a new blast furnace, forges, and a rolling mill and over two hundred people were brought in to operate the complex.


10. French, op. cit., p. 150.

11. For a complete discussion of the economics of iron manufacturing, see: Peter Temin, Iron and Steel in Nineteenth-Century America: An Economic Inquiry.

12. The tolls were set at 1.5 cents per ton mile in 1831 and reduced to one cent per ton mile after 1835. Lane, op. cit., p. 234.


17. Temin, op. cit., p. 199. Highlands iron ore could not be used successfully in the Bessemer process for the ore was too rich in phosphorus and sulphur.

18. Port Oram (Wharton) grew from nearly four hundred persons in 1865 to slightly less than one thousand in 1900. James Tregenza, personal communication.

CHAPTER VII

SUMMARY AND CONCLUSIONS

The study presented in the preceding chapters attempted to demonstrate the extent of landscape change attributable to two centuries of iron manufacture in the Highlands of New York and New Jersey. In order to pursue the thesis adequately, reconstruction of the original, pre-European environment was necessary. The impact of technology and economic factors on the iron industry and, in turn, on the Highlands was a central theme in the examination. Also presented was a sequential development of the region's iron industry, the actual environmental changes associated with the industry, the reasons for the eventual decline of iron, and a study of the cultural manifestations of the industry extant on the present landscape.

The study covered a time span which blanketed much of American industrial growth--from early European occupancy of the eastern seaboard to the expansion west of the Appalachians during the late nineteenth century.

While a good deal of information was available on the American Indian and the usage of iron ores, no evidence has been found to show that the Indian was familiar with working ores into finished products prior to European contact. Thus, the iron industry which blossomed in
the American colonies of the seventeenth and eighteenth centuries was the product of European antecedents. Techniques of construction and operation of forges, blast furnaces, tilt hammers, and rolling and slitting mills were brought by English and German settlers.

Due to its proximity to the earliest settlements, limonite, or bog ore, deposits first attracted the attention of colonists. Virginia soon became the undisputed leader in iron manufacture; nevertheless, the Pine Barrens of southern New Jersey and the bay area of Massachusetts attained a measure of importance. One-half century after the initial ironworks were established, magnetite deposits in New York, New Jersey, and eastern Pennsylvania were discovered. Production from manufactories in the Schuylkill Valley of Pennsylvania and the Highlands of New York and New Jersey began to outstrip iron making on the coast. By the outbreak of hostilities with England, the American colonies had become self-sufficient in iron products despite numerous English attempts at regulation of the industry. Colonial iron was also exported to England and the West Indies.

The study definitely shows that the role of the pioneer Highlands settler and his skills was misinterpreted by early authorities such as Coxe and Gordon. The hypothesis which Coxe and Gordon supported—the forge was uniformly the precursor of the farm which came into existence only after the land had been exhausted of timber and iron—must be modified in the light of present knowledge.

Entries in Charles Clinton's early eighteenth-century journal indicate that the emphasis on land evaluation was placed on potential agricultural rather than industrial usage. The notes of Clinton and
John Reading, as well as investigations by Muntz, Wacker, and the writer, point to substantial agricultural occupancy in fertile valleys, not only independent of past industrial development, but also prior to any industrialization. In fact, European settlement in the Wallkill, Modna Creek, and Musconetcong valleys and along the more accessible sections of the Highlands periphery antedated erection of the first ironworks at Whippany by several years. Moreover, abandonment of Ringwood, Sterling, and other manufactories north of the Pleistocene terminal moraine during the nineteenth century did not lead to subdivision and occupation of the land by agriculturalists. Instead, the rugged terrain and thin, bouldery, infertile soils discouraged all but a few attempts at cultivation. Cessation of iron making was usually followed by a general abandonment of the land and the regeneration of an extensive forest cover. If, indeed, a forge-farmer settlement sequence did exist in the Highlands, it occurred only in scattered, nonglaciated portions of Hunterdon, Morris, and Warren counties.

As colonists descended upon the area in ever-increasing numbers, among the first lands to be occupied, especially north of the moraine, were those containing the essentials for iron manufacture—a nearby deposit of ore, a large tract of woodland for charcoal and timber, a constant supply of water to operate the bellows and tilt hammers, and an avenue to market, via road or river. Afterward, natural meadows and hill lands were utilized to provide hay for animals and cropland for the workers.

Seldom could one iron mine furnish enough raw material to sustain a blast furnace in full production. The situation necessitated the
development of several mines, often working the same ore body, for each established manufactory. However, due to the limited capabilities of open-pit mines, ironmasters were usually forced to purchase and transport ore from mines several miles away.

The charcoal demanded by iron production was manufactured at many woodland sites in close proximity to the consuming forge or furnace. The English method of production—utilizing a great pile of wood, covered with turf, which was allowed to smolder for eight to ten days—was almost universal within the Highlands. All manner of hard- and softwoods were burned, although sprout hardwoods were preferred for making quality charcoal.

The flux used in smelting iron ore was provided by limestone. Procured from numerous outcroppings, especially in the Musconetcong-Wallkill and the High Bridge-Greenwood Lake valleys, or gathered as boulders from the abundant glacial till, the material was readily available to any ironworks.

With similar environmental requirements, several forges often occupied lands within a short distance of a blast furnace. Due to the limited demand for pig iron at the marketplace, fineries and chaferies could rely on sufficient pig metal supplies to make refined bar iron and various and sundry tools and utensils. However, forging operations could not keep pace with furnace production and four to six forge fires were needed to accommodate each blast furnace.

Most manufactories were located on or near a waterway which, in conjunction with several waterwheels, supplied the air blast used
by furnace and forge and operated the tilt hammer. Reducing and refining iron ore with eighteenth-century technology were continuous processes. Thus, the ideal site was on a stream whose regime underwent little fluctuation during the blast period. Location of fineries and chaferies near water provided cheap transportation which helped to offset the high production costs of a thirty percent metal loss in refining pig iron and large charcoal requirements. Nevertheless, the often severe Highlands winter caused most streams to freeze over and ironworks usually had to be shut down for several months each year.

Many of the valleys within the study region provided the advantages for making iron and became cluttered with manufactories. Attaining greatest importance in the eighteenth century were the Ramapo, Wanaque, Pequannock, Rockaway, Wallkill, and Musconetcong river valleys. All of these concentrations were hard by the most productive mining districts near Andover, Dover, Franklin, Oxford, and Ringwood, New Jersey; and at Sterling Lake, New York.

Promotion of the Highlands' natural resources was responsible for much of the early growth experienced within the region. Ironworks offered employment to large numbers of unskilled and skilled workers. Woodcutters, colliers, miners, and ore and charcoal haulers were in demand at all times. Furnace- and forgemen were in short supply. The bulk of the labor force consisted of indentured servants from Germany and the British Isles. Poorly paid and subjected to difficult living conditions, workers frequently deserted the manufactories in search of other employment. Repeated newspaper advertisements exemplified the perpetual shortage of labor encountered by most ironworks.
Private entrepreneurs not only encouraged iron manufacture, but once forges and furnaces were founded, they advertised to entice settlers to lands in the neighborhood of these works. Often farmers, lumbermen, and tradesmen took up residence and towns were established. However, the rather sterile soils of the glaciated Highlands proved incapable of sustaining settlement and were abandoned after the manu- factories ceased production.

In contrast to the developments north of the terminal moraine, the southern Highlands had become predominantly agricultural before the nineteenth century. Only ironworks associated with Oxford Furnace continued to function. The widespread eradication of forest lands permitted tillage of the soils and the growing of wheat, corn, and a variety of other crops. Riverine locations once appropriate for an ironworks, instead were utilized as gristmill sites. Flour became an important trade item, supplanting iron at the markets of New York, Philadelphia, and elsewhere.

Manifestations of economic endeavor developing in various sectors of the Highlands became quite obvious on maps of the eighteenth century. Lack of considerable settlements in glaciated portions was indicative of a population which was small, widely scattered, and clustered near the iron manufactories. The paucity of major roads heightened the isolation associated with each ironworks. Trade was carried on only among the local folk, the furnace and forge, and the manufactory and a nearby market or landing. Regions south of the terminal moraine exhibited a more open appearance. A rather large
population was supported by the iron industry, extensive agricultural development, roads, townscapes, and the like.

The aftermath of the Revolutionary War wrought distinct changes to the iron industry of the Highlands. Although a few new manufactories had been established, the early decades of the nineteenth century found the entire industry under severe economic duress. The aforementioned war and technological advances in Great Britain combined to deprive the American iron industry of its major foreign market. Moreover, English products began to flood the eastern seaboard. As iron prices declined in the face of foreign competition, domestic manufacturing costs increased. Charcoal became scarce in some areas; labor was harder to find and higher priced; and the old means of transportation were wholly inadequate.

Few Highlands manufactories were able to weather the economic chaos, and more often than not, smaller ironworks were forced to close. Settlements founded and nurtured by the iron industry directed their attentions to other activities. The next several years saw little or no influx of people into the study area. However, few ironworkers deserted to the peripheral cities during the lean years. Most sought other ventures, notably agriculture and lumbering, until the forges and furnaces were restarted. Only the large, self-contained works, known as iron plantations, maintained a degree of order and stability.

During the last decades of the eighteenth century as many as ten plantations were in operation throughout the Highlands. Unimportant and isolated as these sites are today, the iron communities formed regional centers of population and of economic and social life during
much of the period under study. Little difference seems to have existed between the iron manor and the Southern plantation, except that whereas the planter regarded agriculture as supreme, the iron-master subordinated agriculture to manufacturing.

The iron plantation consisted of industrial, agricultural, and financial units dispersed over lands encompassing up to 10,000 acres. Several forges, mills, and iron mines were clustered about the blast furnace or furnaces which formed the nucleus of the manor. Good stands of timber were protected for use in making charcoal and as a source of building materials. Valleys were cleared and cultivated by farmers and their grain was ground at the community gristmill. Natural meadows and wetlands were exploited for their hay and pasturage. Roads were built over difficult terrain at great expenditure of capital and labor. A manor house, workmen's cottages, barns, sawmill, stores, and storage facilities generally completed the community. Men of many skills were encouraged to settle nearby because the iron plantation was judged to be a very good market for all kinds of products.

The unsound economic conditions and inadequate transportation networks would have led to the complete collapse of the Highlands iron industry had not steps been taken to remedy the situation. Advent of the hot blast and the introduction of anthracite coal as a smelting agent prior to 1840 brought about a substantial realignment of the locative factors governing iron manufacture. No longer was it necessary to isolate ironworks by several thousand acres of charcoal-producing woodlands. Furnaces were now placed on riverine sites convenient to
transportation and a plentiful supply of coal—usually furnished by Morris Canal "flickers" or by the subsequent railroads.

The union of Pennsylvania coal, Highlands iron ore, and a new, efficient technology brought about the revival of many districts which had been partially closed because of a scarcity of charcoal. Additional industrial, shipping, and market towns sprang up along the canal route. Prices were lowered to stimulate consumption and combat foreign competition. However, the canal and anthracite also supplied the coup de grace to the remaining charcoal manufactories.

The preeminence of the Morris Canal as an artery of trade was suddenly usurped during the mid-nineteenth century with the introduction of the railroad. The Morris and Essex Railroad penetrated the Highlands and extended to Phillipsburg on the Delaware River. Placed in direct competition with the canal, the former had the advantages of rapid transport and continuous operation. With the loss of its coal traffic, canal tonnage dwindled, supported as it was only by the products of Highlands mines, manufactories, and farms.

The railroad completed a transportation evolution which began with horses carrying leather bags of ore and bars of iron hung over the saddles, progressed to use of wagons on roads and turnpikes, and followed with the canal.

Few of the newly established anthracite iron manufactories enjoyed a prolonged period of prosperity. Nevertheless, the operations were instrumental in revitalizing the Highlands countryside. A new generation of miners—mostly Cornishmen, Irish, East Europeans, and
Negroes--replaced the older English, Scotch-Irish, and German settlers. Farms were expanded to meet the demands of an enlarged local population and to supply the markets opened by canal and railroad. Company towns were built and existing communities grew. But technological evolution which had doomed charcoal iron led to the final demise of the iron industry in the Highlands.

The use of coke had become increasingly popular as a smelter of iron ore during the late nineteenth century, luring industry to locations near the source of the raw material west of the Appalachians. New discoveries of iron ore in the Adirondack Mountains and in the Lake Superior ranges increasingly replaced Highlands ore which was unsuited to the Bessemer technique of iron manufacture. The decline was further accelerated by the importation of iron ore, forcing Highlands ore even from traditional markets.

While iron mining continued, and flourished briefly, throughout the final years of the last century, the Highlands manufactories all but vanished. Those which remained made little, if any, contribution to the economic stature of the region.

Although all operations of the industry have now been extinguished, the legacy of iron remains evident on the Highlands landscape. Introduction of anthracite coal was instrumental in the return of the forests within the study area. The sharply reduced need for charcoal allowed an almost complete restoration of woodlands on the ridges of the northern Highlands. Only in some valleys has man perpetuated pastures and meager farms. Nevertheless, changes occurred in forest composition as a result
of numerous cuttings, fires, and other alterations. Few large trees or relics of precolonial forests remain. The scope of human activity on the fertile lands of the southern portion achieved such intensity that woodlands have never recovered their former extent. The valleys have been devoted almost entirely to agriculture and commerce; only the high mountain elevations and steeper slopes remain forested today.

Many present Highlands settlements, especially those associated with past transportation patterns, owed their founding and/or growth to the iron industry. Ore landings, shipping points for iron products, and market towns attained a regional importance which carried over to the twentieth century. However, not all iron communities survived. Numerous small, scattered empty areas stand as mute evidence of iron sites not convertible to other economic functions.

Until the suburban sprawl of recent years encroached upon the Highlands, much of the population was rooted to the age of iron. Little or no evidence was found of substantial out-migration of ironworkers or their progeny. In several places descendants of miners and ironworkers still occupy the lands of former manufactories. Others may be found engaged in all forms of economic activity in the towns and villages or inhabit much of the farmland.

Several furnaces still stand and forges have been unearthed by amateur archeologists. Old dwellings built by iron companies are used as homes. Cinder roads, abandoned railroads, and an almost wholly obscured Morris Canal furnish clues of former transportation routes. Finally, place names often remain as the only testimony of the great role which the iron industry played in populating and settling the
Highlands. Industrialization contributed much, rewarded few, and greatly affected the landscape. However, much has been lost with the passage of time, which moves to obliterate the cultural scars.
SELECTED BIBLIOGRAPHY

Published and Printed Materials


Publications of the Pennsylvania Historical Commission, Vol. IV.
Harrisburg: Pennsylvania Historical Commission, 1938.

Bishop, John L. A History of American Manufactures from 1608 to 1860.


Cantlon, J.E. "Vegetation and Microclimates on the North and South Slopes of Cushetunk Mountain, New Jersey," Ecological Monographs, 23. (1953), 241-270.


Cook, George H. *Geology of New Jersey.* Newark: Board of Managers, 1868.


Gordon, Thomas P. Map of the state of New Jersey with parts of the adjoining states. Trenton: H.S. Tanner, 1828.

_______. A Gazetteer of the State of New Jersey. Trenton: Daniel Fenton, 1834.


Hasenclever, Peter. The Remarkable Case of Peter Hasenclever, Merchant. London: n. pub., 1773.


Homes, Henry A. "Notice of Peter Hasenclever, an Early Iron-Manufacturer," Transactions of the Albany Institute, VIII (1876), 199-206.

Honeyman, A. Van Doren (ed.). New Jersey Archives, First Series, XXXI (1775).


Map of a group of iron mines in Morris County. New York: John Bien, 1867.

Azoric and Paleozoic formations; including the iron-ore and limestone districts. Trenton: Geological Survey of New Jersey, 1868.


Jones, Carmita DeS. "Batsto and the Bloomeries," The Pennsylvania Magazine of History and Biography, 47 (1923), 185-195.


Lee, Francis Bazley (ed.). New Jersey Archives, Second Series, II (1778).


Map Showing property owners in the vicinity of Long Pond lying between the old Bergen and Orange Counties (now Sussex) and southwest toward the Pahhahqualling (now Kittatinny) Mountain Range. N.p., n. pub., n.d.


Mitchell, Samuel L. "The physical geography of the first range of mountains extending across New Jersey from the Hudson to the Delaware," American Mineralogy Journal, 1 (1814), 70-79.


*A New and Accurate Map of New Jersey from the Best Authorities.* N.p., n. pub., 1770.


Ricord, Frederick W. and Nelson, William (ed.). *New Jersey Archives, First Series*, IX (1757-1767), X (1767-1776).


Sotzmann, D.F. Map of New Jersey. Hamburg, Germany: Carl Ernst Bohn, 1797.


Whitehead, William (ed.). New Jersey Archives, First Series, IV (1709-1720), VI (1738-1747), VII (1746-1751), VIII (1751-1757).


**Manuscripts**


Act to exempt a number of Men employed at Mount Hope Furnace and Hibernia Furnace from military duty--1777. MSS. National Park Service, Morristown National Historical Park. Morristown, New Jersey.


Diary of Mahlon Dickerson--July 1, 1809 to December 31, 1819. MSS. Rutgers University. New Brunswick, New Jersey.


John P. Carey and Harry F. Swayzey Collection. MSS. Rutgers University. New Brunswick, New Jersey.

Lawrence, John. Surveyor's journal, September 24--October 31, 1743, while running the division line of the Province of New Jersey. MSS. Rutgers University. New Brunswick, New Jersey.

Letter from Jacob Ford to Garret Rapage, June 11, 1770. MS. National Park Service, Morristown National Historical Park. Morristown, New Jersey.


Ryerson Family Papers, 1733-1862. MSS. Rutgers University. New Brunswick, New Jersey.


Voorhees, Oscar M. Chronicles Ancient and Modern Respecting the People, Lands and Industries of the High Bridge Section. MSS. Rutgers University. New Brunswick, New Jersey.

Interviews and Communications


APPENDIX
Fig. 1. Western Highlands and Pequest Valley. Cleared and cultivated, the valley and lower slopes are contrasted with the forested upper slopes and summits.
Fig. 2. Eastern Highlands near Sterling, New York. Covered by a second-growth forest, few habitations are visible on the land.
Fig. 3. The wide, flat valley of the Musconetcong River has been occupied by whites for over two hundred years.
Fig. 4. Abandoned open-pit mine and spoil bank.
Fig. 5. Large mining pit and adit. Once operations ceased, the pit soon filled with water.
Fig. 6. Drawing of a forge and tilt hammer.
Fig. 7. Forge and bellows. Saugus Ironworks Restoration, Saugus, Massachusetts.
Fig. 8. Tilt hammer at Saugus Ironworks Restoration, Saugus, Massachusetts. Cam machinery attached to waterwheel can be seen in the background.
Fig. 9. Fragments of pig (bottom) and bar (top) iron.
Fig. 10. Drawing of a Stückofen.
Fig. 11. Drawing of a blast furnace.
Fig. 12. Charcoal furnace at Wawayanda, New Jersey. So oriented that it might be charged from the ridge, the casting arch was in the center and the waterwheel on the right.
Fig. 13. Tuyère opening of furnace. Hopewell Village National Historic Site, Pennsylvania.
Fig. 14. Casting arch, floor, and tools. Saugus Ironworks Restoration, Saugus, Massachusetts. Sand bed moulded the iron into the familiar "sow and piglet" form.
Fig. 15. Leather bellows and air blast. Saugus Ironworks Restoration, Saugus, Massachusetts. This device injected cold air directly into the furnace.
Fig. 16. Drawing of a tub bellows.
Fig. 17. Tub bellows and waterwheel. Hopewell Village National Historic Site, Pennsylvania.
Fig. 18. Preparation of a charcoal "pit."
Fig. 19. Old wagon road used to transport ore from the mines and goods to market.
Fig. 20. The Rockaway Valley served as a source of food and as an avenue of transport for the region's eighteenth-century ironworks.
Fig. 21. Recently excavated forge pit at Ringwood Manor State Park, New Jersey. It is believed to be part of the Hasenclever complex.
Fig. 22. Collier's hut. Hopewell Village National Historic Site, Pennsylvania.
Fig. 23. Dwellings such as these workmen's cottages were common on all iron plantations. Hopewell Village National Historic Site, Pennsylvania.
Fig. 24. Manor house at Ringwood Manor State Park, New Jersey. Building dates from the mid-nineteenth century.
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Fig. 26. Oldest remaining building at Ringwood Manor. It may have served as the schoolhouse.
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Fig. 28. Remains of the charcoal furnaces and waterwheels at Long Pond. Hewitt, New Jersey.
Fig. 29. Abandoned Peter Mine, Ringwood, New Jersey. With no hope for an early resumption of iron mining, the property was recently sold for residential development.
Fig. 30. Early nineteenth-century, company-built home for ironworkers. Ringwood, New Jersey. Now occupied by the descendants of the former workers.
Fig. 31. Morris Canal and towpath near Wharton, New Jersey. This is one of the few remaining sections of the old canal.
Fig. 32. Orientation of houses to Morris Canal. Wharton, New Jersey.
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Fig. 36. Clapboarded building of mining era. Wharton, New Jersey.
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Fig. 38. Farmstead in the northern Highlands. The rocky soils of the glaciated areas are useful only for dairying.
Fig. 39. Abandoned farmlands north of the terminal moraine. Near Newfoundland, New Jersey.
Fig. 40. Ore concentrator at the Scrub Oak Mine, Wharton, New Jersey. All work ceased in October, 1964.
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