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CHECKING THE WASTE

A STUDY IN CONSERVATION

By

MARY HUSTON GREGORY

What you would weave into the life of the nation, put into the public schools.

—Emperor William I.

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PREFACE

Much has been said and written on the subject of conservation and many excellent ideas have been advanced, but as yet too little has been accomplished in the way of practical results. Probably this is due largely to the fact that most people think of conservation as a problem for the federal and state governments, mine owners, great lumber companies, owners of vast tracts of land, and large corporations; and have not realized how much the responsibility for the care of our natural resources and the penalty for their waste rest with the whole people, that every one has a part in this work which has been called "the greatest question before the American people."

One cause of the failure to realize this personal responsibility is that while there have been college text-books and scientific treatises on various branches of the subject, such as Forestry, there has been no book treating of the entire problem of our natural resources, their extent, the amount and nature of their use, their waste, and what may be done to conserve them, prepared in a way that can be readily understood by the ordinary reader, and dealing with the practical, rather than the technical, side.

It is to supply the need for such general knowledge, and to show how such saving may be accomplished, that this book has been written. It is designed as a short but complete statement of the entire conservation question, and should be of service for study in teachers' reading circles, farmers' institutes, women's clubs, the advanced grades in schools, and for general library purposes.

Every statement of fact bears the weight of authority, for no facts or figures are given that have not been verified by government reports, reports of scientific societies, etc.

Information has been gathered from many sources, chief among them being the Report of the Conference of Governors at the White House, in May, 1908; the Report of the National Conservation Commission, the Report on National Vitality, the Report of the Inland Waterways Commission, of the Geological Survey, the Census Reports, and many government departmental pamphlets.

M. H. G.

Indianapolis, November 24, 1910.

CHECKING THE WASTE

CHAPTER I

WHAT IS CONSERVATION?

A Nation's Riches lie both in its people and in its natural resources. Neither can exist in its highest estate without the other. Goldsmith predicted the certain downfall of lands "where wealth accumulates and men decay," but, in the truest, broadest definition, there can be no national wealth unless the men and women of the nation are healthy, intelligent, educated and right-minded. On the other hand it is equally true that if the people of a country are to make the most of themselves in mind and

body; if they are to get the most comfort and happiness out of life and to become in the highest degree useful, they must develop its natural resources to the greatest possible degree.

The United States is particularly fortunate in its abundant riches of soil, forest and mine, and in the fact that from the beginning of the nation these have been the inheritance not of a people slowly learning the use of tools and materials, and [Pg 2] emerging from ignorance and savagery, but representing the most advanced and enlightened ideas and spiritual ideals of the time.

The result of these conditions has been inventions and discoveries that have developed a great nation at home and have done much to better the condition of the world. But the very magnitude of our natural wealth has made us careless, even prodigal, in its use, and thoughtful men are beginning to realize that with the natural increase of population which is to be expected, we shall, if the present rates of use and waste continue, find ourselves no longer rich, but facing poverty and even actual want. But it is not too late to save ourselves from the results of our past extravagance. We are only beginning to see the danger into which we have almost plunged, but we see enough to make us realize that every one must do his part in checking the waste. Before this can be intelligently accomplished we must understand something of the great national movement for the conservation of our national resources.

Let us go back for a moment to the beginning of our history as a nation, the days of Washington.

Invention at that time was little advanced over what it had been three hundred years before. The same type of slow-sailing vessels carried all the commerce. Wind and water were the only powers employed in running the few factories. Only a little iron [Pg 3] was used in this country, and in fact almost its only use anywhere at that time was for tools. There was little machinery, and that of the simplest description.

Anthracite coal was known in this country only as a hard black rock. Bituminous coal, gas, and oil were unknown.

The forests stretched away in unbroken miles of wilderness. The wood was used for the settlers' homes, their fuel, and their scanty furniture, but they needed so little that it grew much faster than it could be used. The man who cut down a tree was a public benefactor. The trees, though so necessary to life, were regarded as a serious hindrance to civilization, for they must be cleared away before crops could be planted.

To the pioneers as to us the soil was the most valuable of all resources. The rivers were necessary to every community for carrying their commerce, and turning the wheels of their saw and grist mills; while the fish, game, and birds made a necessary part of their living.

Under these conditions, with every resource to be found in such abundance that it seemed impossible it could ever be exhausted, and with a small scattered population to draw on all these riches, careless habits of using were sure to spring up. Our [Pg 4] forefathers took the best that the land offered, and that which was easiest to get, and gave no thought to caring for what remained. Their children, and the new immigrants who came in such numbers, all practised the same wasteful methods.

In the century and a quarter that has passed since then, a great change has come over the world. By the magic of the railroad, the telegraph, and the telephone, all the nations of the earth are bound more closely to one another now than were the scattered communities of a single county in those days, or than the states of the Union before the Civil War.

The forests have been cut away and in place of endless miles of wilderness there now stretch endless miles of fertile farms, yielding abundant harvests.

Slow-going sailing vessels have given place to steamboats which now carry the river and lake commerce. But men are no longer dependent on the rivers, for swift railway trains penetrate every part of the country. The stage-coach is replaced by the trolley-car, and the horseback rider, plodding over corduroy roads with his saddle-bags, is succeeded by the automobile rider speeding over the most improved highways.

Farm machinery of all descriptions has revolutionized the old methods of doing farm work. The fish, game, and birds are largely gone and in their place are the animal [Pg 5]

foods raised by man. Modern houses, filled with countless devices for labor-saving and comfort, have replaced the simple homes of colonial days.

What has brought about this change? The energy and industry of American men and women, aided for the most part by American inventions, and made possible by the wonderful natural resources of America.

No one could wish to have had our country's development checked in any way. These great results could be obtained only by using the materials that could be had easiest and cheapest, even if it meant great waste in the beginning. Labor was scarce and high in this country, abundant and cheap in Europe. In order to make goods that could be sold at prices even above those of European countries, it was absolutely necessary to have cheap lumber, coal and iron.

But the time has come when we can no longer continue this waste without interfering with future development. Some of the resources have been so exhausted that a few years will see the end of their use in large commercial quantities. Others, such as coal and iron, will last much longer, but when they are gone they can never be replaced; and so far as we can now foresee, the country will cease to prosper when they can no longer be had for use in manufacturing. The length of time they will last at [Pg 6] the present rate of use can be easily calculated. It is a long time for us to look forward, for it is longer than the lifetime of any man now living, or of his children, but it is within the life of his grandchildren, and that is a very short time in the history of a nation.

It may be said that while other nations have passed into decay, none has ever exhausted its resources so early in its history, and surely this great rich nation can not so soon face actual need. But we must remember that no other nation has ever used its resources as we have used ours. We are using in years what other nations have used in centuries.

It is not possible now, it probably never will be possible, to use every particle of a resource. This would be too expensive, would mean a labor cost far beyond the value of the thing saved.

In the beginning, as we have shown, the vast wastes were not wanton, but absolutely necessary, and we have not yet reached the point where we can afford to use the low-grade ores, to use all lumber waste and to practise many other economies that may sometime become necessary. But in the case of the forests we should provide enough trees for use in coming years, and in the case of all minerals, the refuse should be left [Pg 7] in such condition that it can easily be ready for possible future use.

If conservation meant leaving our resources untouched, and checking development in order that there might be an abundance for future generations, it would be both an unwise and unacceptable policy; but it must be thoroughly understood that this is not what is desired.

Conservation does not mean the locking up of our resources, nor a hindrance to real progress in any direction. *It means only wise, careful use.*

It does not mean that we shall cease to cut our timber, but it does mean that we shall not waste two-thirds of all that is cut, as we are doing at present. It means, too, that we shall take better care of articles manufactured from it, and most of all, it means that, when a tree is cut down another shall, whenever possible, be planted in its stead to provide for the needs of the future.

It means that we shall not allow the farms of our country to lose five hundred million dollars in value every year by letting the rich top-soil drain off into our rivers, because we have cut away the trees whose roots held the soil in place. It also means that we shall not steadily rob the land of the elements that would produce good crops, and put nothing back into the soil. [Pg 8]

It means that we shall not kill the birds that destroy harmful insects and thus invite the insects to destroy the crops that we have cultivated with such care.

It does not mean that we shall let our mines of coal and iron lie unused, as the miser does his gold, but that we shall, while taking what we need, leave as little waste in the mine as possible, and shall use what we take in the most economical way. This means a saving of money to the user, as well as a conservation of resources. It means, too,

that we shall not allow our water-power to remain unused, while we burn millions of tons of coal in doing the work that water-power would do better.

It means that we shall not allow enough natural gas to escape into the air every day to light all the large cities in the United States. It means that we shall take better care of the life and health of the people.

This is the true conservation.

In the following chapters we shall take up each of the great resources in turn, shall see what we have used, what we have wasted, what remains to us, how long it will continue at the present rate, how it may be used more wisely, and how it may be replaced, if that be possible, or what may be used instead of those which can not be renewed.

We shall study how we may make the most of all that nature has given us and develop our country to the highest possible point, how we may rise far above our present level in comfort, convenience, and abundance, and yet do all these things with much less waste than we now permit. [Pg 9] [Pg 10]

CHAPTER II

THE SOIL

The soil is the greatest of our natural resources. We may almost say that it is greater than all the others combined, for from it comes all of our food; a large part of it directly as plants which grow in the soil and which we eat in the form of roots, leaves, grains, berries, fruits, and nuts; and a part of it indirectly as animals, which have received their food supply from the plants.

But this is not all. The soil supplies almost every known need. We build our homes from the trees of the forest; combined with the iron that comes from the soil they furnish our fuel, our ships, our cars, our furniture, and countless other things. Our clothing is made from the cotton or flax which grows from the soil, the wool from the sheep that feed on the pastures, or from the silk-worms that feed on leaves.

So it is to the earth that we turn for every need, and Mother Nature supplies it. But it is of the soil as it gives us our food supply that we shall speak in this chapter, and we must first learn the nature of the soil, and the process of its making, in order to understand the need of extraordinary care in its management, and also how to use it so that it will not wear out, or become exhausted, but will increase in value for years and even centuries, as it will if properly cared for. [Pg 11]

The earth's surface is constantly being renewed. Although the great formative movements occurred ages ago, yet earthquakes, volcanic action, wind, frost and water are working continual changes. Hills and mountains have been thrown up, and nature has gone to work at once to shave down the mountains and fill up the valleys. The whole earth is as carefully adjusted and balanced as the wheels of a watch, but these adjustments take place in long periods of time. In a lifetime, or even a century, the changes of the earth's surface seem few and small, but they are none the less sure.

The soil or humus, that is, the upper layer of the earth's crust which is used in farming, has an average depth of about four feet, and has been formed by decay, first and most important of all by rock decay which is constantly going on under the surface of the earth and in exposed places everywhere, and is caused by the action of air and water. This process is very slow. In places where the rock is already partly ground up, or, disintegrated, as we sometimes say, it is more rapid, but the average growth of the soil from beneath by rock decay is scarcely more than a foot in ten thousand years. [Pg 12]

Some waste of this upper layer is constantly taking place from above, caused by wind and floods, and considerable additions are made to it by the decay of animal and vegetable matter, but in order to keep the soil at its best, the average soil waste should not amount to more than an inch every thousand years.

When this humus is once exhausted there is no way to repair the damage but to wait

for the slow rock-decay. In the river valleys there is no immediate danger of exhausting the entire body of the soil, but on the hills and in the higher regions the soil-depth is very much less than four feet, and the danger of waste much more serious. There are parts of the earth that were once almost as fertile as ours where great cities once stood, but where now nothing is left but the bare rock.

So we know that the end is sure, even for the life of man upon earth, unless we learn to conserve our soil.

The value of our farm crops can not be overestimated. In food value they are the life of the nation; in money value, our greatest national wealth. For the year 1909 the total value of farm products was the amazing sum of $8,760,000,000. It may give some idea of this vast amount to say that if we could have it in the form of twenty-dollar gold [Pg 13] pieces, stacked in one pile, the column would reach seven hundred miles high. If they were laid flat, edge to edge, they would extend from Alaska to the Panama Canal, with enough left over to reach from New York to San Francisco. If the money could be distributed, it would give us all, every man, woman and child in the United States, one hundred dollars apiece. The corn crop was worth $1,720,000,000; the cotton $850,000,000; wheat comes third with a value of $725,000,000; then come hay, oats, and other crops in vast amounts worth hundreds of millions of dollars. The cotton alone was worth more than the world's output of gold and silver combined. The corn would pay for the Panama Canal, for fifty battleships, and for the irrigation projects in the West, with a hundred million dollars left over.

And this is all new wealth. If we build a house, we have gained the house, but the trees of which we build it are gone. The same thing is true of every article we manufacture. Something is taken from our store in the making. But after we have taken these wonderful crops from our farms the land is still there, and the soil is just as ready to produce a good crop the next year, and the next, and the next, if we treat it properly.

This matter of soil conservation is of the greatest importance to every one of us. If [Pg 14] you are to own a farm, or rent a farm, or till a garden, or plant an orchard ten years from now, it will make a great difference to you whether the man who owns it from now until then knows how to care for it so as to make it produce well, or whether, by neglect, he allows it to become poorer each year. It will make a far greater difference if twenty years elapse.

It makes a difference to the farmer whether he gets twelve bushels of wheat to the acre, or whether he gets twenty, for the cost of producing the smaller amount is just as great as the cost of producing the larger, and the extra bushels are all profit. It makes a difference whether a garden furnishes all the fruit and vegetables needed by the family, or whether it does not even pay for cultivation, and the food must be bought at high prices. It makes even more difference to the dweller in the city, who must buy all that he eats, whether food is abundant or not. If food is abundant, prices are low, but when the yield is small the demand is so great that prices become high.

Not only the men, but the women and children as well, are affected by these food values, because it is from the extra money left over after the actual cost of living is taken out that the clothing, the house-furnishings, books, pictures, music, travel and [Pg 15] all the pleasures of life must come.

Great as are our harvests, we are not raising much more than enough for our present needs. Each year we are using more of our food at home, and have less to export to other countries. In a few years more the public lands will all be taken, and there will be comparatively little more land than we now cultivate to supply a population that will be many times as great as at present.

Men who watch the great movements of the world tell us that the time is coming before many years when there will not be food enough to supply all our people, when we shall be buying food from other countries instead of selling to them, when we shall have famine instead of plenty unless we realize the danger and at once set about to make the most of every acre of our land.

James J. Hill, the great railroad builder of the Northwest, and one of the best informed men of the country on food production and the increase of population, is doing a great work in pointing out these dangers to the people on every possible occasion.

Watching the great food-producing region of the country, he has noted that each year the yield per acre is growing less, and the population steadily more. He tells us that when our first census was taken only four per cent. of the people lived in cities, [Pg 16] that fifty years ago one-third of the people lived in cities, and two-thirds in the country, that is, two-thirds of the people were furnishing food to the remainder. Now conditions are almost exactly reversed. Only one-third remain in the country, and must supply the food, not only for themselves, but for all the two-thirds who are not food producers, so that the food supply is lagging far behind the demand. The price of corn has advanced from twenty-five cents to sixty-five cents a bushel in ten years, and this in turn raises the price of live stock. And so all along the line. Prices are growing higher all the time because not enough food is being produced to supply the demand.

So we can see that it is absolutely necessary that the soil be properly cared for if we are to continue to increase and prosper, for as Secretary Wilson has said, "Upon the fertility of the soil depends the whole business of agriculture."

The soil is exhausted in two ways: (1) By erosion, or the carrying away of the entire soil itself. (2) By so using the soil that one or more of its principal elements are worn out. We shall consider this form of soil exhaustion first, because it more directly concerns the work of every farmer.

By a fertile soil is meant one that has an abundance of plant food in the proper proportions. The soil contains all the elements that are needed to support life, but they [Pg 17] are in an inorganic form, that is, they are lifeless. Plants alone can take these inorganic substances from the soil, and change them into starch, sugar, fats, and protein. All animals, including man, must get these substances through plants, or through other animals that have already absorbed them from plants.

The soil contains ten elements that are absorbed or assimilated by plants. These are: (1) lime, (2) magnesia, (3) iron, (4) sulphur, all of which are found in most plants in very small proportions, and are present in most soils in quantities far beyond the needs of crops for ages to come; (5) carbon, which is obtained by plants through their leaves directly from the air and the sunshine; (6) hydrogen and (7) oxygen, which are taken from the water in the soil and carried to the leaves, where they also help to take the carbon from the atmosphere. With none of these elements, then, does the farmer need to concern himself in regions where the water supply is abundant, as they are, and will continue to be, plentifully supplied by nature. But the other three, (8) nitrogen, (9) potassium, and (10) phosphorus, are needed by plants in large quantities, and are taken from the soil far more rapidly than nature can replace them.

All these elements are necessary to plant life, but some plants require a large [Pg 18] amount of one element, others a small proportion of that, but a large amount of some of the others. No two varieties of plants require exactly the same proportions, so it is easy to see that the plant that takes out of the soil any one element makes the soil less capable each year of producing a good crop of the same kind.

In the early days of farming in this country, it was the custom to grow a single crop, which had been found to give good results, year after year in the same field. In Virginia and other near-by states nearly all the best land was given every year to the cultivation of tobacco, which exhausts the soil rapidly. In the states farther north other crops were planted in the same way. As a result, some of the most fertile soil in Virginia, the Carolinas, Massachusetts, and other eastern states has been so exhausted that it is no longer worth cultivating. Everywhere throughout the New England states are to be found these worn-out farms, and, while they were never so fertile as the lands of the Mississippi Valley, each one was rich enough to support a family in comfort, with something left to sell; but because they were required to produce the same crops, and so take the same element from the soil, year after year, they have become so lacking in one of the essential elements that they are unfit for cultivation, and have been abandoned. [Pg 19]

It is wisdom and good business policy for farmers to study carefully this question of plant food and to learn what each crop is taking from the soil, so that it may be replaced. It has been found by long and careful experiments, that when land has been "single cropped," as this abuse of the land is called, for a long time, the soil has been almost entirely deprived of its nitrogen. As you know, nitrogen is one of the elements of the air, so that there is a never-ending supply, but most plants are unable to take it from the air, and until the last few years the task of replacing nitrogen in the soil was

considered impossible. Recent discoveries, however, have shown that there are two ways in which it may be done. By means of electricity, nitrogen may be directly combined with the other elements of the soil. The other method is nature's own plan, and so is easier and cheaper. It has been found that while most plants exhaust the nitrogen from the soil, one class of plants, the legumes, of which beans, peas, clover, and alfalfa are the best known, have the power of drawing large stores of nitrogen from the air, and, by means of bacteria attached to their roots, restoring it to the ground.

So farmers have learned that if they plant corn one year, it is wiser not to plant corn in the same field the next year, but to sow wheat, which requires less nitrogen, and the following year to sow clover, so that the nitrogen which the corn and wheat have [Pg 20] taken from the soil, may be put back into it. If the land be naturally fertile, and has been well cared for, the soil is then ready to produce a good crop of corn again.

If the soil has become worn-out and the farmer is trying to improve its general condition, he can gain better results by keeping the field in clover a second year, when a profitable crop of clover seed may be had from the land. This system of changing each year, and alternating cereal crops, which take the nitrogen from the soil, with leguminous plants, which restore it to the soil again, is called "rotation of crops," and if regularly followed will preserve a proper balance of nitrogen in the soil.

In some parts of the West there is a lack of decaying vegetable matter in the soil, because the few plants which naturally grow there have small roots, and leave little vegetable material behind when they decay. For this condition one of the best crops to employ in rotation is sugar-beets, because they strike many small roots deep into the earth. As these decay, each leaves behind a tiny load of vegetable mold deep in the earth, and also makes the soil more porous. As the principal elements of the soil needed by sugar-beets are carbon and oxygen, which are absorbed from the air and sunshine, and as the beets can be sold at a good profit, it is an excellent crop to [Pg 21] employ in rotation. In the United States records in various states show that where sugar-beets are used in rotation, the wheat and corn yield is increased from two to four times, and in Germany they are largely used to restore the fertility of the land, even if the sugar-beets themselves are sold at a loss.

It is most important that farmers should understand the principle of rotation of crops, because nothing is taken from the soil so quickly or in such large quantities as nitrogen, and nothing is so easily put back; while, if it is not so replaced, the land becomes worthless.

A comparison of the results of single cropping and the rotation of crops has been clearly shown at the Experiment Station of the Agricultural College of the State of Minnesota, where for ten years they have planted corn on one plot of ground. For the first five years it averaged a little more than twenty bushels per acre, and for the last five years, eleven bushels.

On another plot, where corn was planted in rotation, the average yield was more than forty-eight bushels, the difference in average in the two plots being thirty-two bushels, or twice the value of the entire average yield on the exhausted ground. The corn grown at the end of the ten years was only about three feet high, the ears were small, and the grains light in weight. But it cost just as much to cultivate the land that [Pg 22] produced it as it did to cultivate the land that produced forty-eight bushels.

Of the other two elements, potassium is found abundantly in most soils. It is also found in a readily soluble form in various parts of the United States and is sold at a very low price. But even if these deposits were exhausted we could still use the rocks which are very rich in potassium, and are very abundant, in a pulverized form, or potash could be manufactured from them.

The only remaining element of the soil is phosphorus. This element was discovered in 1607, the year of the first English settlement at Jamestown and was first noticed because of its property of giving off light from itself. The name which was given it means light-bearer. It was at first thought to be the source of all power, to heal all diseases, and to turn the common minerals into gold. Although we have long ago learned that these ideas are absurd, yet we have also learned that its real value to man is far greater than was even dreamed of then.

It is the most important element in every living thing, for no cell, however small, in

either animal or vegetable organisms can grow or even live without phosphorus. It is found in the green of the leaves, and helps to make the starch. It enters largely into [Pg 23] the grain and seeds of plants, and is necessary for their germination, or sprouting, as well as their growth. Three-fourths of all the phosphorus in a crop of cereals is in the grains, giving them size and weight. It will thus be seen how necessary it is that the soil which feeds our plants, which in turn become the food of animals and of man, should contain a sufficient amount of phosphorus.

Phosphorus is taken from the soil in large quantities by every kind of crop. In parts of Wisconsin which have been farmed a little more than fifty years without fertilizing, it is found that about one-third of the phosphorus has been taken out of the soil, which would mean that in one hundred and fifty years, or a hundred years from now, the soil would be incapable of producing any living thing, and long before that time the crops would not pay for the labor of producing them. Almost every acre of land that has been farmed for ten years without fertilization is deficient in phosphorus, that is, so much has been used that the soil can no longer produce at its former rate.

It may be asked, if this be true, why the soil of America, which before it was cultivated had borne rich forests and fields of waving grass, has not become exhausted long ago. We must remember that nature always adjusts itself; that, in the wild state, [Pg 24] all plants decay where they grow, and the same elements are returned again to the soil. But when the entire product of vast areas is removed year after year, the soil has nothing except the slow rock-decay with which to renew itself.

In tropical regions it is not necessary to feed domestic animals at any season of the year, but in those countries where the natural food can be found only during a part of the year, the need of artificial feeding is seen at once, and it becomes a part of the regular expense of farming.

It would be considered the height of folly for a man to allow his valuable animals to starve to death because of the expense of feeding them, but few people recognize the fact, which is also true, that it is equally bad business policy to allow the valuable crops of wheat, oats, and corn to starve for want of plant food.

The phosphates (that is, phosphorus) are the only large items of expense, and in a large measure this may be lessened by raising live stock, for which high prices can be obtained either as meat or dairy products, and returning the manure, which contains a large amount of phosphate, to the soil. If all the waste animal products could be returned to the land, Professor Van Hise says, three-fourths of the phosphorus would be replaced. All animal products are rich in phosphates. The packing houses [Pg 25] manufacture large quantities from the bones and blood of animals.

The garbage of cities, when reduced to powder, yields large returns in phosphorus. It is said that if the sewage of cities, which in this country is often turned into rivers and streams, polluting them and causing disease, was reduced to commercial fertilizer, it would supply the equivalent of from six to nine pounds of rock phosphate per year for every acre of cultivated land in the United States. And this valuable product is now totally lost, and worse than lost, since it menaces the life and health of great numbers of our people.

There still remain to be considered the rock phosphates, the form in which phosphorus is found in separate deposits. The only large deposits that have been used are in Florida, South Carolina, and Tennessee, and from them about two and a quarter million tons were mined in 1907. Unfortunately, however, there is no law that prevents its export from this country, and almost half of this found its way to Europe, where it is eagerly sought at high prices.

Within a short time valuable phosphate beds, more extensive than any before known to exist in this country, have been discovered in Utah, Wyoming, and Idaho. Professor Van Hise, who is one of the highest authorities on the subject, says of these deposits [Pg 26] that with the exception of our coal and iron lands, they are our most precious mineral possession; that every ounce should be saved for the time which is coming when the population will have outgrown the capacity of the land, and means of increasing its fertility in order to prevent famine will be sought from every possible source.

The other great waste of the soil is by erosion, or the wearing away of the soil by stream-flow. We can all see this in a small way by wandering along the shore of any swift-running stream and noticing how the banks are worn away, and what deep

gullies and ravines are cut into them by the water running down from the fields above. Another way in which we can observe the effect of this waste is by noticing the muddy yellow color of streams during floods and after heavy rains, and comparing it with the clear blue of the same stream at ordinary times.

When we realize that this muddy color always means that the water is filled with soil, all that it will hold in solution, that it is carrying away the top soil, which is best for agriculture, and, finally, that every little streamlet and creek, as well as the mightiest river, is carrying this rich soil-deposit downward toward the sea in its flow, we begin to see how great a factor erosion is in the wasting of the land. [Pg 27]

The Missouri River, which drains a large area of wheat and corn land, is notable as a muddy, yellow river at almost all seasons. Do you understand what that means? It means that this great productive region is growing poorer each year, and that as the population increases, and the need of great harvests increases, the land is becoming less able to produce them. The Mississippi River is said to tear down from its banks more soil each year than is to be dredged from the Panama Canal. At the mouth of the river is a delta many miles in extent, formed wholly of land that has been carried down the river. The soil in lower Mississippi and Louisiana is almost black, and is in many places seventy feet in depth, and it has all been left there by the river, which took it from the higher lands.

It is estimated that our rivers carry out to sea one billion tons of our richest soil each year. The ancient Egyptians worshiped the Nile because each year the spring floods left behind the rich soil deposits that fertilized their fields and gave them an abundant harvest. Entire fields and even whole farms along the upper stretches of the Mississippi and Missouri have been carried away, not the top soil only, but the land itself, by the swift current of the springtime floods as they cut a new channel for the river. [Pg 28]

Canaan, the "land of promise" of the Bible, was once an abundant region, "flowing with milk and honey" in the language of Moses, with its grapes, its vast forests of cedar, fir, and oak, its treasures of wheat, olive-oil, and other rich agricultural products. Now all are gone. The entire country seen by the traveler in the Holy Land to-day is one of the most desolate regions on the globe, where the few inhabitants are scarcely able to obtain a scanty living.

We wonder what has brought about this change, and we have not far to seek in answer to our questioning. The preservation of the forests means the preservation of the soil, and the destruction of the forests means the destruction of the soil. This is the universal law. First the forests were cut down and the hillsides left bare. Then the streams wore great ravines down the unprotected hillsides. Steadily the work of destruction by erosion has gone on, until time beyond our possibility to comprehend must pass before the land can be made productive again. The hills and valleys of China have been devastated in the same way, and many of the older regions of the earth that were once the sites of great cities and extensive commerce are now marked only by the ruins of the civilization that has passed away. They have almost ceased to support life. [Pg 29]

In the days of Rome's greatness, Sicily was known as "the granary of Rome" because from this little island came the grains to supply her vast armies. 12,000,000 bushels of grain was the tribute that Rome claimed of Sicily each year, and yet Sicily had enough left to make her rich. She built splendid cities and became great. But the same story of destruction is to be read in the history of Sicily. Now the entire island does not raise a million and a half bushels of wheat altogether. The soil is barren. The cities have nearly all fallen into ruin. The people are scattered. Thousands have come to America, seeking a poor living at the lowest wages because at home there was no chance to earn even the little they require. They allowed the soil to become exhausted by lack of fertilization and by erosion and it long ago ceased to support the people. All the rest followed naturally.

In many parts of our own country this same danger is coming on us. It is only the beginning, but the end is as sure for us as for those far-off Eastern countries.

Millions of acres have already been destroyed in the East and South. The Appalachian mountain system lies not far from the coast, and the rivers on the eastern slopes are short and swift. It is necessary, then, to exercise the greatest care of the [Pg 30]

forests in order to prevent the floods in this region from carrying away the lands in their swift rush to the sea. North Carolina was one of the richest states in the Union in natural resources a hundred years ago. Now it is low on the list in agricultural products. The forests on its mountain tops were valuable for their lumber, their turpentine, pitch, and other products, and great lumber companies have almost denuded the hillsides, regardless of the fate of the lands they cut over. The people of the state are powerless to prevent this except by buying all of these lands and replanting the forests. They have been pleading with Congress for power to stop the destruction of their forests and the wasting of their lands, but so far have received no assistance and meanwhile the land grows poorer each year. The same conditions are to be found in many other states that now rank high agriculturally, but in North Carolina we are beginning to see results.

In order to understand exactly how the damage is done to the land, let us suppose a case which has actually occurred in hundreds of places. A farmer owned a farm on the mountain side. Much of it was good wheat land, but the top was covered with forests. At last he decided to cut and sell the timber, and use the land for raising more wheat. [Pg 31] He did so, but now there was no spreading foliage to check the dash of the heavy rains as they fell to the ground. As they sank below the surface there were no masses of tangled roots to hold the moisture in the soil and to carry it up into the air again through the trees.

As the water penetrated deeper, the soil became softened, and was carried away down the hillside. It was only a muddy little stream, but it took away some of the richest soil from the fields, and the next year's crop was not quite so good. Every rain that fell carried more of the fertile soil down the hillside, and the next year the farmer wondered that the yield was still less. After a few years he ceased to sow the field because it had never paid for its cultivation, and was constantly growing poorer. But it was too late then to repair the damage that had been done. There were no seeds of forest trees left in the ground and the farmer did not plant them, so the ground lay idle and desolate. The rain wore deep gullies down the hillside, which, as they grew larger, became more of a menace to the lands below them. The streams soon grew large enough to take the top-soil from the fields lower down, and in a few years more the whole farm had grown so unproductive that the farmer, tired of the struggle, left the farm and went to the city to make a living. [Pg 32]

In the meantime the land in the valley below had been growing more fertile, for each year the spring floods had left a rich soil deposit behind them. The farmer down there had been innocently stealing the land above him, but not all of it, for much had been carried out to sea.

It is not possible to prevent this entirely, but much of the loss might have been avoided by leaving the hilltops, which are never well fitted for cultivation, covered with forests. In this way the soil-wash from above is prevented and the streams run gently and with only a small amount of muddy deposit, forming proper drainage for the soil.

The preserving of the forests on the great mountain ranges of the country, where nature has placed them, will mean in the one matter of soil-wash, fruitful lands and bountiful harvests, instead of barren, wasted lands, desolated by floods and seamed by great ravines, carrying desolation to the lands below them.

But in many cases the trees are already cut away. Here replanting becomes necessary and should be done in every case where soil-wash is beginning on the mountain tops. It is almost equally desirable to plant small shrubs and bushes as an undergrowth, so that the roots may form a thick mat below the ground to hold the water in the soil, and permit it to filter through slowly. [Pg 33]

In Massachusetts, the tracks of the Boston and Albany Railroad are depressed so that trains may pass below the level of the highways. In order to protect the banks from erosion, the sloping sides of this roadway have been planted with trailing rose-bushes and other vines which have thickly matted roots. These serve a double purpose in preventing landslides and washouts on the tracks, and in adding greatly to the attractiveness of the scenery along the railway.

The poorest land of a farm is always found on the hilltops, because even with the greatest care there is always considerable waste of the top-soil. This land, then, should

never be used for field crops. It should constitute the woodland, or if this is not possible, the pasture-land of the farm, for the grass roots protect the soil and prevent it from washing away, and the profits on the hay are at least as great as any other crop which could be grown on hill land.

But when erosion has been checked and the top-soil preserved, when the soil is thoroughly fertilized, and a proper rotation of crops established, there are still other lessons to be learned in order to make our country as productive as it might be, as it will *need* to be to support the population that we shall have by the end of the century.

As a nation we undertake to farm too much land and do it carelessly. The invention [Pg 34] of labor-saving machinery has made it possible to farm hundreds and even thousands of acres together with little physical labor. This has made farmers heedless of small amounts of land wasted.

A man often only expects to make a comfortable living on one hundred and sixty acres of land, while in Europe he would expect to grow rich on two or three acres. It is often said that a French family would live off of an American farmer's neglected fence-corners. In France, in England, in Holland and Belgium every bit of land is tended and made useful. We have the best natural soil in the world, the most fertile river valleys, watered by abundant rains. The fertility of our lands is the envy of the civilized world, and has drawn thousands to our shores in the hope of finding comfort and plenty, and yet the total value of our farm products was only eleven dollars and thirty-eight cents per cultivated acre according to the last census, while in the little island of Jersey, just off the English coast, the average annual value of products is over two hundred and fifty dollars per acre.

Germany has been cultivated nearly eighteen hundred years, the soil is not naturally so productive nor the climate so favorable as ours, but the wheat yield there averages more than twice as much as in this country. [Pg 35]

When the most fertile land in the world produces so much less than poorer lands elsewhere it plainly shows that we are robbing the soil in order to get the largest cash returns in the shortest possible time and with the least possible labor.

The American farmer needs to cultivate a much smaller amount of land thoroughly, to have a soil analysis made of his land in order to know what crops are best suited to it and what elements are lacking to make it produce the best. In Illinois more than half a million acres had become unfit for cultivation. Analysis showed that the soil was too acid. By mixing limestone dust with the soil the trouble was corrected and the land reclaimed.

Often it is only necessary to find the cause of some deficiency, or lack, in the soil, and the remedy will be found to be simple and cheap, while the result of its use will be to double the crop. Nothing else so quickly and easily responds to proper treatment, no other resource is so easily conserved. All the soil needs is proper treatment.

Every bit of waste land should be cultivated for either use or beauty, or both. If all the lanes and neglected places could be planted with fruit and nut trees, berry vines, and bushes, herbs or flowers which need little cultivation after they are planted, our food, in variety and quantity, would be greatly increased. "The hedge-rows of Old England" are famous for their beauty and the air of comfort and prosperity they give. [Pg 36] They take the place of the weeds that grow by the country roadsides in America and which constitute one of the greatest nuisances of the farmer.

Another thing that should be considered is the marketing of farm products. Near a city or near a canning factory the soil can be most profitably used for the raising of vegetables, for which the cost of cultivation is great, but which yield far larger profits than farm crops.

Within the last few years a new system of farming has been developed in the West, which is of great interest to all of us, both because it is opening up for production a large part of our country that has seemed valueless, and because the lessons that have been learned there are of the greatest advantage in every part of the country.

West of the one-hundredth meridian, which crosses North and South Dakota, the western part of Nebraska, Kansas, Oklahoma, and Texas, and including the states west of them, lies a vast region that used to be known as the "great American desert." It comprises almost half of the United States. Here the noble forests of the eastern

states and the prairie grasses of the plains were replaced by sage-brush and cactus. The soil was light in color and weight, and the rainfall very scanty. [Pg 37]

It seemed impossible that it could ever be fitted for agriculture. But there were a few great rivers, rich mining districts, and excellent grazing lands. These attracted settlers, and to them some cultivation of the soil became almost a necessity. The waste waters of the rivers were used for irrigation and the land when watered was found to produce remarkably fine fruits and agricultural products. Yet there were hundreds of thousands of acres that could not be irrigated for lack of water, and the problem of finding a use for these barren, semi-arid lands remained unsolved for many years.

But here and there in different states and under varying conditions, after many experiments and failures, men began without water to grow successful crops on these semi-arid lands, where the rainfall was scarcely more than ten inches per year. Others following this method found success, and it began to seem possible that all this territory might some day become a great farming region.

By comparing the methods employed in different states, the few general laws have been worked out which must be applied in order to farm successfully in this region, though the details differ with local differences in altitude, climate, soil, and rainfall. Here farming is being reduced to a science. In other parts of the country a man sows his seed and nature cares for it, and gives him his harvest; but here he must wring from nature all that he gets, so it is only the man who farms according to fixed laws who can hope to succeed. [Pg 38]

This system is usually called "dry farming," though "scientific farming" would perhaps be a better name, for the same principles that are absolutely necessary here will greatly increase the yield anywhere. The most important principle is to conserve every particle of moisture in the soil. It is necessary to go deep into the soil to find the underlying moisture. The seed-bed is made very deep. Plowing is from sixteen to nineteen inches deep, while in well-watered regions it is only about six inches. This deep seed-bed is thoroughly cultivated to make the soil porous, the soil being reduced to a fine powder. After sowing the seed, the ground is packed as solidly as possible. This is done by especially designed machines. The surface of the soil is kept broken all the time to prevent the escape of the moisture. This rule applies equally to all soils in dry weather, and will often save a crop of corn in any part of the country during a drought.

These are simple rules, but the practice of them is opening up the great semi-arid regions, not of the United States only, but of the whole earth. Western Canada, a large part of Australia, the Kalahari Desert of Africa, and many parts of Asia, which are all semi-arid, will in time become productive instead of barren. [Pg 39]

It must be remarked that the grains of the East could not withstand the severe winters in a large part of the Northwest, so the Department of Agriculture sent men all over the world to find drought-and-cold-resisting grains. They found a hard winter wheat, the most nutritious in existence, which is now growing all the way from the Dakotas to the Pacific Ocean, producing crops far above the yield of the eastern states. 50,000,000 bushels of this wheat was raised in 1907.

The soil is the natural disintegrated rock, rich in the mineral elements, but lacking in decayed vegetable matter. The crops soon exhaust the nitrogen, and as clover and the common alfalfas can not grow there, the problem of finding legumes has been the most serious one facing this new region; but in Siberia the Agricultural Department has recently found a new clover and three varieties of alfalfa that will stand the cold, and Secretary Wilson believes that these will solve the problem.

Every acre brought under cultivation adds to the world's food supply. Can we even dream of what it will mean when 200,000,000 acres are added to the farm lands of this continent? It means prosperity for the farmers themselves, homes for those who are now crowded in cities, work for the idle, and food for the hungry. It means wealth and happiness for thousands now living and millions yet to come. [Pg 40]

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CHAPTER III

FORESTS

Aside from the soil itself, which supports all life, there is no other resource so important to man as the forests, with their many uses covering so wide a range.

The beauty and restfulness of a forest, the grace and dignity of single trees, the shade for man and animals, the shelter from storms—all these things appeal to our love for the beautiful, and touch our higher nature. The person who loves trees is a better person than the one who does not. As the poet expresses it:

> "Ah, bare must be the shadeless ways, and bleak the path must be,
> Of him, who, having open eyes, has never learned do see,
> And so has never learned to love the beauty of a tree.
>
> "Who loves a tree, he loves the life that springs in star and clod,
> He loves the love that gilds the clouds, and greens the April sod,
> He loves the wide Beneficence; his soul takes hold on God."

[Pg 43]

Trees have played an important part in the history of our country: The "Charter Oak," in the hollow of which the original charter of Connecticut remained hidden from the agents of the king; "Eliot's Oak," under which the gospel was first preached to the Indians; the wide-spreading elm under which William Penn signed his treaty of peace with the Indians.

But no tree has held so dear a place in the hearts of the people, or been so watchfully cared for as the old "Washington Elm" still standing in Cambridge, Massachusetts. Under it Washington took command of the continental army. It is visited every year by hundreds of persons, who stand with uncovered heads beneath its spreading branches. Many years ago it was struck by lightning and the upper part torn off, but all the broken edges have been sealed with pitch to stop decay. It has been covered with fine wire netting to prevent the bark being chipped off by relic hunters. It is carefully guarded from damage by insects, and the boughs are stayed by strong wires.

And so we might name many instances of trees that are loved and cared for on account of their beauty, stateliness or some event connected with them, but it is the [Pg 44]

usefulness of trees that we shall mention in this chapter.

In the larger use of forests is included their effect on climate and rainfall. It is generally believed that clouds, passing over the damp, cool air that rises from a forest, are more likely to be condensed into rain, and so we can establish the general rule that the country which is well wooded will probably have a larger rainfall than the one which has few trees.

Twenty-five years ago Kansas was a prairie state with few trees, and the semi-arid plains extended half-way across the state, but thousands of acres of trees have been planted, and crops have been cultivated, and the more forests and crops the farmer plants the more rain comes to water them. The great droughts which used to ruin their crops year after year no longer disturb them. The hot winds which could undo a whole season's hard work in a day are seldom heard of now. Kansas is no longer in the semi-arid region. It is one of the most productive states in the Union, and this has come, not by dry-farming, but by the cultivation of the soil and by the planting of trees.

Though rainfall increases, destructive floods become fewer, for the humus and the leaves on the ground in the forests hold the water as in a vast sponge, and, as we have [Pg 45] seen in the preceding chapter, they keep the waters in check and distribute the rainfall gently and evenly on the lands below. They thus prevent erosion of the hillsides and balance the water supply of rivers.

Trees supply us with food and medicine, and greatest of all their direct uses, they furnish lumber for all kinds of manufacturing.

We can not think of life without the comforts and conveniences that we get from wood; but interior China affords a striking example of what it means for a nation to have a very small supply. There is no wood for manufacturing and the natives search the hillsides for even the tiniest shrubs to burn and even for grass scratched from the soil. Once this part of China was a great forest region, but century by century the forests have been used, not rapidly, as in this country, for China is not a great industrial nation, but surely, until there is hardly a twig left.

China is not the only nation that has suffered in this way. Many of the ancient peoples have entirely passed away; and the destruction of their forests, as we have seen in the previous chapter, was the first cause leading to their extinction.

Denmark was originally almost covered with forests. These were cut down for fuel, for lumber, and to make way for agriculture. For a long time there was no attempt to [Pg 46] restore them, and now a large area, once productive, has become a sandy desert. In the same way, large parts of Austria and Italy have become valueless because the growing forests were cut down.

In France the forests at the head-waters of the Rhone and the Seine were cut down and fierce floods began to pour down the valleys each year, bringing destruction to property and crops all along their way. But France has long ago learned the lesson of forestry, and as soon as the danger was seen, the mountain sides were replanted with trees, and since then conditions have been gradually changing for the better.

France has had another experience in forestry that has taught her what can be done to save her waste lands. Near the coast were great sand-dunes. The winds drove them each year farther inland, and the sand was gradually driving out the vineyards and farm crops. In 1793 the planting of forests on these dunes was begun. Of 350,000 acres, 275,000 have been planted in valuable pine forests. More than half of these belong to private owners and there is no record of their value, but the portion belonging to the government has yielded a large income above all expenses, and is worth $10,000,000 as land; and this was not only valueless but was a menace to the [Pg 47] surrounding country. In the interior of France a sandy marsh covering 2,000,000 acres has been changed into a profitable forest valued at $100,000,000.

A hundred years ago all the eastern part of the United States and the Rocky Mountains and the Pacific coast region were covered with thick forests hundreds and hundreds of miles in extent. Evergreens—the pines, hemlocks, cedars and spruces—grew near the coast in great abundance, while farther inland were found the most magnificent hardwood forests in the world.

Unfortunately, the first needs of the early settlers required them to cut down these mighty forests. The soil, which was very fertile, could not, of course, be used for

farming purposes until the land was cleared, and so this was the first necessity.

The wood was used to build the cabins, to make the rude furniture, the wagons and ox-carts, and for fuel, but this disposed of only a small amount of the wood that came from the clearing of a farm. No man could give it to his neighbor when all had more than they could use, and there was no market for its sale. The trees were burned in large quantities to clear the land for the planting of crops.

Wood was of the greatest value to the first settlers, but it was also the greatest hindrance to their making homes, so they took no care whatever of what they could not use. It was burned or left on the ground to decay. As towns sprang up, there began to be a demand for lumber for houses, for furniture, for vehicles and for fuel from those who had no trees of their own. This made a market for the best grades of lumber at a low price, but almost every farmer would give away trees of the best hardwood to any person who would cut and haul them away. [Pg 48]

Conditions have changed very slowly, but very surely. In every state, in every county and in every township there has been a steady clearing of the land as it fills with new home-makers. At the same time the demand has grown enormously each year from the dwellers in cities.

The opening up of railroads and telegraph lines in the middle and latter part of the century made a great demand for wood. The building of ships and steamboats, the opening of mines, the establishing of telephone and trolley systems, the building of great cities, all these have called steadily and increasingly for wood.

The time has long passed when wood was a hindrance to progress. For a long time there has been a ready market at high prices and it is rapidly reaching the point where we shall face an actual shortage of timber. This is not true of all parts of the country, of course. Maine, Washington, and parts of Oregon, Alabama, Arkansas, and Mississippi, Wisconsin and some other states, still have vast quantities of lumber, but trains and ships carry it to all parts of the world so there is no lack of a market. [Pg 49]

The change from plenty, even great excess, to need, has come so gradually that few persons, even those living in the forest regions, have realized until within a very few years how general is their destruction. Those who, riding about a small portion of the country familiar to them, have been struck with the disappearance of the woods and the cultivation of the lands, have looked upon it wholly as a sign of progress, and have not realized that the same thing is going on in every part of the country.

The wholesale destruction of the forests, without replanting, has come mostly from ignorance. We have had all our resources in such great abundance that we have not hitherto needed to learn the lessons that the Old World has learned, sometimes at the cost of whole nations, but the time has come when we *do* need to learn them.

The first lesson is to study the various uses of the forests, to find how they are being affected by present use, their wastes, and the best means of preserving them. When all the people have learned these lessons, they will, undoubtedly, gladly set about righting the wrongs that have been done in the past. [Pg 50]

The original forests of this country covered an area of about 850,000,000 acres, with nearly five and a half trillion board feet of "merchantable," that is, salable, timber according to present standards. (A board foot is one foot long, one foot wide and one inch in thickness.) Considerably more than half the original number of acres are still forested, but most of the land has been cut or burned over, some of it several times, and the amount remaining of salable timber, which includes only the best part of the trunk, is from two to two and a half trillion, that is from 1,400 to 2,000 billion, feet. The yearly cut for all purposes, including waste, is now over two hundred billion board feet;—some authorities place the amount as high as two hundred and seventy-five billion feet. This, however, probably includes firewood, one of the largest uses of wood, but taken very largely from worm-eaten wood that could not be cut into lumber. It also probably includes boughs, and other unsalable parts of the tree.

The timber cut doubled from 1880 to 1905, is still increasing at almost the same rate, and, if we had the timber, it would doubtless double again by 1930. But even at the present rate, the forests now standing, without allowance for growth, would be exhausted in from ten to sixteen years. The yearly growth of timber in our present forests is estimated at from forty-two to sixty billion feet, and the yearly cut at from [Pg 51]

three to three and a half times the amount added for growth.

That is, we are using in four months at least as much wood as will naturally grow in a year. The other eight months we shall be using our forest reserves, and each year there will be less forest land to produce new growth, as well as less old wood to cut.

Mr. R. A. Long, an expert lumberman who spoke before the first Conservation Congress, estimated then that the forests, making allowance for growth, would not last over thirty-five years. The government figures indicate that they will last about thirty-three years, at the present rate, but as the rate has been doubling every twenty-five years, many persons who have studied the situation believe that the supply will not continue in commercial quantities for manufacturing more than twenty-five years.

We must understand, must think, what the destruction of our forests would mean to us. It would mean fierce droughts and fiercer floods. It would mean the gradual drying up of our streams, a scarcity of water to drink, as in China to-day. It would mean that the manufacture of wooden articles would practically cease. The thousand [Pg 52] conveniences that we enjoy as a matter of course would become rare and costly. It would mean that only the rich could build houses of wood, and this would force the masses of people into crowded quarters, not only the poor, but the well-to-do also. These are only a few of the many disasters that would follow the loss of our forests, and all these things might come to pass before we ourselves are old!

If we knew that at a certain time a tidal wave would engulf our homes, how we should work to save all that we could before the calamity overtook us! And we should set about the saving of our forests with equal care, for their destruction means distress for every one of us.

Fortunately, this is only the dark possibility. The methods of prevention are well known to those who have studied the history of the nations that have fallen, and the nations that have risen to power. It is only necessary that all the people should know these things and realize their importance, in order to keep conditions as they are at present or even to better them.

The methods of prevention are five. They are:

(1) To use the trees in the most careful and conservative way without the great wastes now common. [Pg 53]

(2) To save the vast areas of forests that are now burned each year.

(3) To prevent loss from insects.

(4) To use substitutes: that is, to use other and cheaper materials to take the place of wood whenever possible.

(5) To plant trees and to replant where old ones have been cut, until all land that is not fitted for agriculture is covered with forests.

These are only the rules that good sense and good business would teach us to follow, but we have not followed any of them in the past, and now it will be necessary to do all these things if we are to continue to have enough wood to use to keep pace with our progress in other directions.

As an example of the rapid rate at which we are consuming our forests, we use nine times as much lumber for every man, woman and child as the people of Germany use, and twenty-five times as much as the people of England use. This is due to several causes, many of which we would not wish changed.

To begin with, this was a new and undeveloped country, a large part of which had never been inhabited, and all the land, as fast as it was occupied, must be built up with entirely new homes; and because wood is the cheapest building material it is the one generally used. [Pg 54]

The growth of all European countries is mostly by the increase of their own people, while this is only a small percentage of our growth, which comes largely from immigration from other countries, so the increase of population is much greater here and the proportion of new homes needed is far greater. Improvements of all kinds, public buildings, churches and bridges were built in almost every European community long ago, while in this country these things are being done each year in

thousands of places.

Wages are higher in this country, and more people are able to afford the luxuries of life, vehicles, musical instruments, and the large variety of small conveniences to be found in almost every American home but seen in few homes of the poorer class in Europe.

These are a few of the reasons why we use such a large amount of lumber each year. They are all conditions that mean a larger, better nation than we could otherwise have, with a higher standard of living, and while in some particulars, as we shall show, there should be changes that would conserve our forests, the great wastes do not lie in the *use*, but in the *abuse* of the forests.

Now let us see what use is made of all the wood that is cut every year. The greatest use of all is for firewood, but this is largely the decaying or faulty trees from farmers' [Pg 55] wood-lots, or the waste product of a lumber region, so this does not constitute so heavy a drain on the forests as the fact that 100,000,000 cords a year are used, would indicate.

Twenty times as much of the salable timber is sawed into lumber as is used in any other way. Nearly 40,000,000,000 board feet are thus used, but lumber is used in a variety of ways, while the other cuts are confined to a single use.

The first and greatest use of lumber is for building purposes, for houses, barns, sheds, out-buildings, fences, and for window-sashes, doors and inside finishings of all buildings, even those made of other materials.

Next comes furniture of all kinds,—chairs, tables, beds, and all other house, office, and school furniture; musical instruments, pianos, etc., vehicles of all kinds,—farm wagons, delivery wagons, carriages and other pleasure vehicles, including parts of automobile bodies, agricultural implements, plows, harrows, harvesters, threshing machines and other farm implements. Though these are built largely of iron, yet one-fourth of the implement factories report a use of 215,000,000 feet of lumber a year, so the entire output of these factories calls for a large amount of wood from our forests.

Car building is the other really great use for lumber. Freight cars, passenger cars, [Pg 56] and trolley cars use each year an increasingly large proportion of the product of our saw-mills.

After these come the various smaller articles, which, though themselves small, are used in every home and are turned out in such vast quantities as to require a very large amount of lumber each year.

An empty spool seems a trifle, but the making of all the spools requires the cutting of hundreds of acres of New England's best birch woods. Butter dishes, fruit crates, baskets, wooden boxes of all kinds, tools and handles, kitchen utensils, toys and sporting goods, picture molding and frames, grille and fretwork, excelsior, clothes-pins, matches, tooth-picks,—all these are mowing down our forests by the thousands of acres.

The lumber cut includes all kinds of both hard and soft woods. A very large percentage of this is of yellow or southern hard pine, of which several billion feet a year are used.

An almost equal amount is used for hewn cross-ties for railroads and trolley lines. Many sawed cross-ties are included in the item of lumber. The hewed cross-ties are made from young oak-trees, or from hard-pine, cedar and chestnut. Without them no more railroad or trolley lines could be built, and the present systems could not be kept in repair. Many other materials have been tried, but wood is the only one that has ever [Pg 57] proved satisfactory and safe for this purpose.

The next largest use of lumber is the grinding of it into pulp to be used in making paper for our books, magazines and newspapers, wrapping papers, etc. The woods used for this purpose are mostly spruce and hemlock. The great sources of supply of pulp-wood are Maine and Wisconsin, and large amounts are imported from Canada, which greatly lessens the drain on our own forests.

Next in importance comes cooperage stock for the making of barrels. When we consider the many uses of barrels,—that vinegar, oil, and liquors are all shipped in

tight barrels, which are mostly made of the best white oak, and that flour, starch, sugar, crackers, fruits and vegetables, glassware, chemicals, and cement are shipped in what are called slack barrels, made of various hardwoods, the hoops being always of soft elm, a wood which is rapidly disappearing, we can see the size and necessity of this industry.

Round mine timbers, largely made of young hardwood trees, are used to support the mines underground. Mining engineers say that on an average three feet of lumber are used in mining every ton of coal taken out. Assuming that 450,000,000 tons of coal are mined each year, this would mean that almost a billion and a half feet a year are used in the coal mines, and this is about the amount shown by the government report. [Pg 58]

After this comes wood for lath used in building. This product is usually taken from lower class wood or logging camp waste. Then comes the wood for distillation into wood-alcohol for use in manufacture and to furnish power in engines.

Next in quantity used comes veneer, which has two entirely different uses. The highest grade woods are cut to about one-twentieth of an inch and glued to cheaper woods as an outside finish in the making of furniture. The other use is for veneer used alone, when a very thin wood is desired. This is employed for butter dishes, berry baskets, crates, boxes and barrels.

Next on the list come poles—electric railway, electric light, telegraph, and telephone poles. Every pole that is erected for any of these purposes, every extension of the service, and all replacing caused by wind or decay, means the cutting of a tall, straight, perfect tree, usually cedar or chestnut. If we think of each pole of the network that covers the entire continent, as a tree, we shall better realize what our forests have done in binding the nation together.

Leather is stained by soaking the hides in a solution containing the bark of oak or hemlock. Sometimes an extract is made from chestnut wood. This has caused one of the most criminal wastes of trees, for a great deal of timber was cut down solely for the bark, and the wood left to decay in the forest. But now, as the price of lumber advances, more of it is used each year and less left to waste. [Pg 59]

The bark and extract of the quebracho, a South American tree, are being imported for use in tanning, and are still further reducing the drain on our own forests.

Turpentine and rosin do not in themselves destroy the forests any more than does tapping the maple trees for their sap, but in the making of turpentine trees that are too small are often "boxed" and the trees are easily blown down by heavy winds or are attacked by insects and fungi. Many destructive fires also follow turpentining, so that on the whole the turpentine industry is responsible for the destruction each year of large areas of the southern pine forests. The methods of turpentining introduced by the government result in the saving of thirty per cent. more turpentine, and also protect the trees so that they may be used fifteen or twenty years and still be almost as valuable as ever for timber.

Twenty millions of posts are cut each year in the Lake States alone, and the entire number used is probably two or three times as great. [Pg 60]

These constitute the greater uses of wood, not a full and detailed list; but it plainly shows that all the uses are not only desirable, but necessary for our comfort and happiness, and that we would not willingly sacrifice one of them, and in order that this shall not become necessary, let us see what abuses we can find in the management of our forests. And here we find the most startling figures of all.

Great and important as is our list of products made from wood, we are surprised to learn that of all wood cut fully two-thirds is wasted in the forests, left to decay or burned. The largest forests are now all located far from the great manufacturing regions, and that means far from the lumber market. The cost of transportation must be added to every car of lumber sold. The freight on a car-load of lumber from the South to Chicago or other points in the middle West is not less than a hundred dollars, and from the Pacific coast it is very much higher.

It does not pay to send low-grade lumber when the cost is so great, and as there is no local market a large part of each tree is burned. All the upper end of the trunk and all branches are thus destroyed, although much valuable timber is contained in them.

At one mill in Alabama a pile of waste wood and branches as high as a two-story house burns night and day throughout the year, and that is probably true of all the larger mills. [Pg 61]

If the timber could be conservatively managed as are live-stock products, so that all the waste could be utilized, all the small articles, shingles, lath, posts, tan-bark and extract, pulp-wood, wood for distillation and small manufactured articles would be made by-products of the larger cuts.

Much has been said of the greed of large lumber companies in causing wholesale and reckless destruction of the forests, and much of it is doubtless true, but the lumber companies cite the fact that no farmer will gather a crop of corn which will not pay for the labor cost of gathering, and say that at the present prices of lumber they can not pay the present freight rates to the factories. It seems therefore that a certain amount of waste is unavoidable unless wood-working plants are established near the forest regions.

The first great step in conserving our forests is to stop the unnecessary wastes in use. The next step is to take measures to prevent the great destruction of our forests by fire.

Those who have never lived in a great forest region can have little idea of the extent of the damage caused by these great forest fires. The loss of life of both man and animals, the sweeping away of houses and crops, the homelessness and misery of those who have lost everything they had saved, are not to be taken into account here, but only the loss of the forests themselves. [Pg 62]

It is estimated that the loss by fire is as great as the entire amount cut for use in the entire United States. The National Conservation Committee reports that 50,000,000 acres of woodland are burned over yearly. This probably includes all burned-over lands, in much of which the standing timber is not destroyed, but the saplings and seedlings are killed as well as the grass for grazing and for the protection of the roots. Much land is burned over in this way year after year until hope of future growth is gone, though the damage to the large trees has not been great. In one way this loss is even more serious, as it shuts off the hope of future forests, but the loss of our full-grown standing forests is grave.

In 1891 this loss amounted to 15,000,000 acres, or nearly forty thousand acres every day in the year. Since then the work of the Forest Service in fighting fires and the great clearing of the forests, has reduced this somewhat, but it still amounts to no less than 30,000 acres of our best salable timber a day. This is the really great and serious loss of the forests.

All the wood that is used goes to make our country a better place to live in, to make its people more comfortable and happy, but all that is lost by fire is a loss to all the nation in comforts for the future, and in the present it means high prices for lumber because our forests are disappearing so rapidly. [Pg 63]

And we are letting them burn at the rate of thirty thousand acres every day! More than enough to supply all our needs. If any one could gather together in one vast pile our houses and barns, our furniture, our wagons and carriages, our farm implements, all our home conveniences, our railroad cross-ties, our trolley and telephone poles, our papers and magazines, and burn them all, the whole world would be roused by the fearfulness of the loss. But we sit idly by and see the materials of which all these things are made and must be made in the future, and with them our shade, our water-sheds, the soil of the forest-lands itself destroyed, with never a word of protest.

In a paper prepared for the National Conservation Congress, it was stated that in some years government survey parties were unable to work in the Rocky Mountains for whole seasons on account of the dense smoke, and the fires were allowed to burn till the snows of winter put them out. The writer further stated that he believed from observation that the Forest Service, by checking fires in their beginning, has in the last few years saved more timber than has been used for commercial purposes. [Pg 64]

Private owners of large tracts should be compelled to use the same care in preventing fires that is exercised by the government. This care, and the breaking up of the forests into smaller tracts by clearing the land in alternate sections would soon reduce the fire loss so greatly as almost to save us from anxiety for the future of our

timber lands.

The next great loss to the forests is from insects. When insects have bored into wood it becomes honey-combed by the canals cut by the little insects and is utterly valueless. The loss to fruit and forest trees will be taken up more fully in the chapter on insects. At present it is only necessary, in order to show how much our forests suffer in this way, to state that the yearly loss from this cause is placed at no less than $100,000,000 a year, and the loss to fruits is counted at one-fifth of the entire crop. Some slight idea of the danger to our forests will be seen by the simple statement that forty-one different species of insects infest the locust tree, eighty the elm, one hundred and five the birch, one hundred and sixty-five the pine, one hundred and seventy the hickory, one hundred and eighty-six the willow, while oak trees are attacked by over five hundred! [Pg 65]

This is exceedingly difficult to control and can perhaps never be entirely checked. Some remedies will be suggested later, and by having smaller forests, more carefully watched, some personal care can be given to the trees. In Germany the trees are as closely watched as are other crops, and the saving in value well repays this extra care and expense.

A much smaller loss comes from the winds that sometimes level all the trees over many square miles. This can not, of course, be prevented, except possibly in the turpentine forests, but care should be taken to use all the wood, never allowing it to decay where it fell, and also to replant the land with trees, unless it is fitted for agriculture.

A great saving of the forests may be effected by what is called preservative treatment, which consists of treating railroad ties, piling, mine timbers, poles, and posts with creosote or zinc chlorid to prevent decay from the moisture of the ground or from injury by salt-water borers. The use of creosote is almost double the cost of zinc chlorid, but it is much more effective and durable. A fence post can be treated with creosote for about ten cents, a railroad tie for twenty cents, and a telephone pole for from seventy-five cents to a dollar. In every case the timber treated will last twice as long as it would without such treatment and in view of the present high prices it is [Pg 66] bad business policy to use timber in such a way that it will need replacing soon. It is estimated that if all timbers which could be profitably treated were so cared for, it would mean a money saving to the owners of $47,000,000, and an annual saving in wood equal to 4,000,000,000 board feet of lumber.

The next point in the conservation of the forests is to seek substitutes to take the place of wood. There are many uses of wood which nothing else will satisfactorily supply. For example, no railroad cross-tie has ever been designed of other material that does not increase the danger of railway accidents, though over two hundred kinds have been patented.

There is nothing that will take the place of wood in furniture, and in many small articles. Some articles might be replaced in metal, but it makes them too heavy or too expensive. But in certain lines there is an excellent opportunity to use other materials to great advantage.

Cars are now being built of steel, and of combinations of metal with asbestos. These are not yet entirely satisfactory, but it is hoped that they can be perfected soon. Cement and concrete are taking the place of wood to a great extent in building, and their use will doubtless increase rapidly.

When veneer is used for barrels and boxes it affords a saving of nearly two-thirds in [Pg 67] the amount of wood required. This is a line of use where cheaper substitutes should always be used if possible, because a package is usually used only once, never more than twice, and then discarded, so that the wood is put to little real service compared with other wooden articles.

When possible, small articles of wood should be made only in a forest region or near saw-mills to use the scraps and save an unnecessary drain on the more valuable grades of lumber.

One of the most important lines in which substitutes are practicable is in the making of paper and box-board or pasteboard. The latter is sometimes called strawboard, because it is made from wheat straw, and where it is manufactured, uses a large

amount of straw that would otherwise be wasted, but the great wheat fields of the West still have immense quantities of unused straw, which, if made into strawboard, would not only bring more prosperity to that region but would lessen the drain on the forests.

A box bound with wire and made of corrugated paper now takes the place for many light articles of the wooden packing-case. The strawboard also takes the place of wood-pulp for smaller paper boxes. Rice-straw, hemp, flax-straw, cotton fiber and peat have all been tested in a small way and found to make excellent paper, and it is [Pg 68] thought corn-stalks can also be used, but none of these is now manufactured in the United States on a large scale. This is largely because the price of pulp-wood is low, and the cost of experimenting with new materials is great with the results uncertain.

This brings us to the last one of our preventive measures for the decline of our forests, the one which needs the most careful attention of all—the replanting of the lands that are not fitted for agriculture, and planting trees about houses and unoccupied spaces.

Many farmers have planted orchards on a part of their farm-lands and many trees have been planted in town and country, but until a few years ago there was no organized effort to plant trees.

Now many states have set apart a day which is called Arbor Day, for this purpose, but in no state does it hold so important a place as it should. It is observed by the schools but not by the general public.

In Germany there are regular tree-planting days in which all the people take part. Every one who is not too poor—and he must be poor indeed—plants a tree in his own garden, or in front of his home, in the forest or in the highway; for himself or for the general good.

Each child plants a tree on his or her birthday every year, and watches and cares for [Pg 69] it as it grows. The roadsides are lined with fruit or nut or flowering trees which have been planted in neat, orderly rows. These things are in striking contrast to the observance of Arbor Day in this country, where one tree suffices for an entire school, or at best each class has a tree of its own. It is all a matter of enthusiasm and education.

In considering the best trees for planting we come to the last great use of trees of which we have not spoken. Fruit and nut trees supply us with large quantities of the most wholesome and delicious food. The apple, pear, peach, plum, and cherry grow in the central part of the United States, and oranges, lemons, figs, olives and apricots in the warmer parts.

By planting these trees in suitable places one may have a rich harvest for many years to come. If a small fraction of the seeds of fruit trees which are wasted each year were planted, the general food supply would be greatly increased, and many benefits would be derived from the trees themselves.

Have you ever heard the story of "Apple-seed John," the man who, according to tradition, went through what is now western Pennsylvania, Ohio and Indiana while the country was still a wilderness and planted orchards for the settlers who, he was sure, would come later? [Pg 70]

So many stories have been told of him that it is hard to discover how much of the tale is really true. At least one poem has been written about him, and the Reverend Newell Dwight Hillis has woven the facts and fancies of his career into a charming book, *The Quest of John Chapman*.

The story is that he spent his winters in the settlements near the Atlantic coast teaching the children or working at small tasks about the farms, and taking his pay always in the seeds of apples, peaches, pears, plums, and grapes. The farmers and their families saved all their seeds for him and when spring came he filled his boat with seeds and started down the Ohio River. When he reached a suitable landing-place he took his bags of seeds on his back and trudged through the forest.

Whenever he came to an open space he planted an orchard, built a fence of boughs about it, and started on again. And so he traveled on and on, through all the spring and summer months, year after year, planting his seeds for those who would come

after him, until he grew too old to work.

The first settlers in those states found the orchards and vineyards awaiting them, and a few trees are still standing that are said to have been planted by Apple-Seed John. The story of this man who in his humble way devoted his life to others is one that may well be told and imitated, for while none of us can do the work he did, it may [Pg 71] inspire us with a wish to make some spot on earth better by planting our few seeds or plants.

In carrying on this work in the schools as well as by the general public, a regular plan should be followed. Much can be accomplished with no expense at all, even in cities. In all cases the expense will be very small compared to the good accomplished.

Seeds may be planted and later transplanted. This will require no expense and little labor. Every child, large and small, in city and country, can learn to do this work and can thus perform a real service. Small saplings which are growing close together, where they can never develop, may each be planted in a place where it will have a chance to grow into a thrifty tree. Most farmers would be entirely willing to allow the pupils to take such saplings from their wood-lots if the work were properly done. This is an excellent work for country schools to undertake, both for the good it will accomplish and for the training of the pupils themselves in practical work.

Fruit trees of suitable size for planting may be had for about twenty cents each. Most American children could easily save that amount from money spent on candy, sweetmeats or toys so as to have a tree ready for planting on Arbor Day which would [Pg 72] yield them fruit as they grow older, and be a source of pride and pleasure. Such trees will of course usually be planted at the children's own homes, but it would be an excellent idea to follow the German plan of planting public orchards just outside the town. When the trees are old enough to bear, the children are allowed on certain days to go and gather and eat the fruit and carry it home in baskets.

The older boys in every school, whether city or country, should be taught to plant and transplant trees in the best way. The following directions for the work are sent out by the Department of Agriculture at Washington:

"The proper season for planting is not everywhere the same. When the planting is done in the spring, the right time is when the frost is out of the ground and before budding begins.

"The day to plant is almost as important as the season. Sunny, windy weather is to be avoided. Cool, damp days are the best. Trees can not be thrust carelessly into a rough soil and then be expected to flourish. They should be planted in properly worked soil, well enriched. If they can not be planted immediately after they are taken up the first step is to prevent their roots drying out in the air. This may be done by piling fresh dirt deep about the roots or setting the roots in mud. [Pg 73]

"In planting they should be placed from two to three inches deeper than they stood originally. Fine soil should always be pressed firmly—not made hard—about the roots, and two inches of dry soil at the top should be left very loose to retain the moisture."

The reading of such poems as Lucy Larcom's "He who plants a tree plants a hope," or William Cullen Bryant's, "Come, let us plant the apple tree," and suitable talks or papers on trees, dealing with their kinds and uses, on the benefits of forests, and on practical forestry, should be a part of the Arbor Day exercises.

In many communities a tract of land which is not well suited for general agriculture may be obtained for the benefit of the school, and some simple work in forestry may be undertaken by the pupils. Sometimes a farmer may be induced to give a small bit of waste land where the experiment may be tried. Sometimes such land can be bought by the school in one of the following ways:

A series of entertainments may be given by the pupils, the proceeds to be applied to the buying of the land, and the pupils may also obtain money in other outside ways to bring to the general fund. If only one acre can be bought and cleared by the pupils, and properly planted, a little at a time, a tree for each child's birthday, or by obtaining [Pg 74] small seedlings and saplings from the forest, it will be a source of keen interest, and will give an added pleasure to the school work. Watching the growth of the trees and caring for them will keep this interest alive year after year, and in time it will become a valuable property belonging to the school. Sometimes the school officials will set

aside a sum from the public money to purchase the land. In one High School, one acre is thus bought each year, and every pupil in the senior year gives and plants a tree. Sometimes the farmers or the merchants of a community may unite in buying the land, which will, of course, become public property, and set it aside for improvement after the manner of a city park.

Sometimes women's clubs become interested in such a movement and will raise the funds necessary for beginning it. It then becomes the duty of the school, year after year, to plant and care for the land. After a time the school will have a valuable property to sell, or can have a yearly income from the sale of timber.

Such plans may be carried out in many schools. Every school can and should do something to forward this great work. All school yards should be well planted and care taken that the boy with a new knife does not try it on the bark or that the bark is not rubbed from the trees in careless play. Many trees planted in school yards have been destroyed in this way. [Pg 75]

But we shall not be safe if only the schools plant trees. Farmers and lot owners should take up the work in earnest, adding as many trees as possible each year. In this way they could insure an abundant supply of fruit, nuts and timber for the future, could increase the value of their property, and provide a steady income besides.

Farmers' institutes would find this a most important work to undertake, arranging for a common plan to be carried out in an entire neighborhood, and setting aside days in which all the members may work together to set out trees by the roadsides. This brings us to the question of what kinds of trees are best to plant.

For town or city lots, fruit trees should always be chosen, because they bear in a short time and will add to the family food supply, and so lessen the cost of living and increase the variety of food. Every farm should have a good assortment of fruit. Any nurseryman's catalogue will furnish lists of kinds so that a wise choice may be made. In selecting fruit trees, great care should be taken to choose the best varieties.

For streets and roadsides, nut or wild fruit trees are best, for the trees are generally graceful in appearance and will yield some return, as the more popular maples and poplars will not. The chestnut is one of the best trees for such planting, though it is of a rather slow growth. English or American walnuts, pecans, mulberry and persimmon trees can be grown in most parts of the United States. [Pg 76]

One town in Kansas is planting fruit trees on all its streets, so that in a few years there will be an abundance of fruit free to every passer-by. This is a most excellent plan, but individuals would be likely to find the fruit molested if only a few trees are planted in a community.

Barn-lots and lanes should be planted with wild cherry, haws, elder, dogwood, mountain-ash, and other wild fruits to serve as food for birds, poultry, and hogs.

Where the banks of streams need to be protected from erosion, probably the best tree for planting is the basket willow, which thrives well near the water, has a heavy network of roots, and is valuable for weaving into baskets and furniture.

For all hillsides and rocky places, as well as wood-lots, the hardwoods which sell best for timber should be planted in the North and West, and the evergreens near the sea-coasts and in the South. Forests of oak, hickory, walnut, maple (especially the sugar maple, which yields a steady return during the lifetime of the tree), elm, chestnut, and locust will sell for a good price, and are always salable. It requires many years to grow large timber, but by proper management several years can be gained in its growth, and it is always a valuable investment for a farmer to make for his children. [Pg 77]

Not individuals only, but states and the national government as well, should provide forests for the future, and this is the greatest duty of all, for much of the most important work can only be done by a power that can control the entire watershed at the head-waters of a river-system.

For example, the Appalachian Mountains are the source of hundreds of streams which flow east, west and south, and pass through many states. These mountains were originally covered with a heavy forest growth, but they belong largely to private companies who are cutting the forests at a rapid rate.

The effect of this is seen in bare hillsides, washed by mountain torrents which are causing disastrous floods on the lowlands, filling up the streams, and carrying away much of the most fertile soil of some of the southeastern states, and in the drying up of the small tributaries.

This can not be remedied by single companies nor by the states that suffer most. The only remedy is for the government to buy the land at the head-waters of the rivers and reforest it. The same conditions on a smaller scale are to be found in every [Pg 78] mountainous region where the forests are cut away.

The United States owns a large amount of forest but not nearly enough to insure a supply of wood for the future. The public forest lands are nearly all in the West. They consist of national forests, national parks, Indian and military reservations and land open to entry as timber claims. In all they contain nearly 100,000,000 acres, or about half as much as is contained in farmers' wood-lots and about one-fourth as much as the amount owned by large lumber companies.

The United States, on its public domain, is setting about a careful system of cutting and replanting. This system is known as forestry. It has been worked out by some of the more advanced nations of Europe who saw that destruction was coming on them through the cutting away of their forests. Now forestry is practised by every nation except Turkey and China. The principles have been well proved and the results of scientific care of the forests are known to be even more sure than in farming or live-stock raising.

The Department of Agriculture will send complete directions for planting trees in rows at proper distances, will tell what kinds are best suited to each region and condition, how to make them grow rapidly, and when to cut. All these things should be [Pg 79] thoroughly understood by every land owner, large or small, but at present forestry is practised on only one per cent. of all land in this country, owned by private persons or companies, though it is practised on seventy per cent. of all public lands.

The countries that show the best results in forestry are some of the German states, particularly Prussia and Saxony, and France. In Prussia the rate of production is three times as great as it was seventy-five years ago. There is three times as much saw timber in a tree as there was at that time, and the money returns from an average acre of forest are now nearly ten times what they were sixty years ago. In Saxony the state forests are receiving two dollars and thirty cents per acre a year above all expenses from forests on land not fitted for agriculture, and the profit is increasing every year.

France and Germany together spend $11,000,000 a year on their public forests and receive from them an income of $30,000,000, or nearly three times as much, while the United States spends for its public forests more than ten times as much as it receives.

Many of our states are taking an active interest in forestry and are buying tracts of land of low value for state forests. New York is taking the lead in the work of planting forests, but even here the amount done is much less than it should be. The state [Pg 80] forester says that one million trees are planted each year while twenty millions should be planted.

The National Conservation Commission reported that the entire United States should plant an area larger than the states of Pennsylvania, Ohio, and West Virginia, in order to supply our future needs, but that we have actually planted an area less than the state of Rhode Island.

This, then, is the lesson we should learn in regard to our forests: To guard against waste in cutting and use, fire, and insects, and to plant trees until our future supply of timber is assured, till the head-waters of our streams are protected and our waste lands made into valuable forest tracts; till every farm has its wood-lot, and every community its fruit and shade. It is a work in which every one of us may take some part and from which good results are certain to come.

ORCHARDS

Another phase of tree-culture that does not, strictly speaking, come under the head of forestry, but which should be considered here, is the cultivation of orchards, either for home use or for commercial purposes.

In a few sections, fruit is the most valuable of all crops. Oranges in Florida and California, peaches in some of the southern states, and apples in the northwest, are more profitable than any field crops, and their cultivation is made the subject of careful scientific study. But there are many other states where the raising of fruit in commercial quantities is almost altogether neglected, and to which almost all fruit is shipped from other sections. This is particularly true in the rich corn and wheat producing states of the Mississippi Valley. [Pg 81]

The early settlers each planted an orchard for home use, and these produced the finest quality of fruit in abundance; but usually, after being planted, the trees were left to take care of themselves, while the farmer's time and attention were given to his fields of grain.

As time passed, plant diseases and insect pests increased, winds broke down many of the unpruned trees, frosts often blighted the entire crop of fruit, and the uncultivated, sod-choked trees produced fruit that was less in quantity and poorer in quality each year.

In recent years the highest grade of apples have all been shipped from the West. These are grown on irrigated land; a high price being paid both for the land itself and for the water-privilege, and the orchards are seldom more than ten acres in extent. Wind and frost may cause as much damage here as in the eastern states and plant diseases and insect enemies are equally liable to injure the crop. [Pg 82]

But here orcharding is carried on in a scientific manner. The small size of the orchard makes it possible for the owner properly to care for every tree, and each one must be made a source of profit. Every condition that tends to affect the crop is carefully studied, and the remedy found and applied.

There is no reason why the same care and labor should not produce equally good results with far less expense in the well-watered regions of the eastern and central part of the United States. The neglected orchard will prove a failure anywhere, as surely as will a neglected garden, and success will come only by giving to fruit the same intelligent care that would be bestowed upon any other crop.

The cultivation of apples should receive particular attention in the north central states, because they have great food value, are not perishable, can be shipped long distances, and the demand, both at home and abroad, is always greater than the supply. The home orchard, however, should contain many kinds of fruit, and the same general rules in regard to the care of the orchard apply to all of them.

First, the orchard should not be located on land that is fitted to produce the best farm crops, but it must not be too steep and hilly to be cultivated. A sunny sloping hillside is best suited to orchard crops. [Pg 83]

In most cases little fertilization is needed except the planting of clover or some other leguminous crop. If corn be planted in young orchards, as is often the case, potash should be used as a fertilizer after the crop is gathered, since both corn and fruit trees draw very heavily on the potash in the soil.

Old orchards sometimes need a single application of a general fertilizer containing all the principal soil elements. All fertilizers should be applied not merely around the base of the trunk, but as far from it as the tree spreads its branches in all directions.

The trees should be carefully pruned and special attention paid to trimming the tops low to prevent damage from winds, and also to make spraying easy.

The soil should be deeply cultivated the first few years in order to make the roots strike deep into the ground, and afterward the soil should receive some surface cultivation every year.

When there is danger of frost after the trees have bloomed, brushwood fires are lighted and a dense smoke is raised over the orchard by burning pots of crude oil. This smoke is helpful in preventing the formation of frost, and will often be the means of saving the crop. [Pg 84]

The other great causes of failure to grow large quantities of perfect fruit, if the varieties are well chosen, are plant diseases and damage by insects. The methods of their control are given in the chapter on Insects, and include principally the disposal

of all decayed fruit, the raking up and burning of all leaves in infected orchards, arsenical and lime sprays, and, above all, such attention to pruning and cultivation as will keep the trees in good condition.

Lastly, the keeping of bees in the orchard will pay well, not only for the honey they produce, but because they assist greatly in carrying the pollen from flower to flower, and so increasing the crop of fruit.

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CHAPTER IV

WATER

Water is an absolute necessity to man, as much as the air he breathes or the food he eats. Water comes to us in the form of rain or snow. We usually think of it as unlimited, but we must come to think of it as a resource that can be abused and wasted or made useful and profitable as is the soil itself.

The amount of water is fixed and passes in an endless round from cloud to river or land and back to the clouds again. The average yearly rainfall of the United States is estimated at thirty inches, about forty inches in the eastern half, an average of eighteen inches in the western part, and in many places not more than ten or twelve inches. One inch of rain would amount to nearly one hundred and one tons per acre, or on a roof twenty feet long by twenty feet wide, one inch of rain would be two hundred and fifty gallons. With a rainfall of forty inches, this would amount to 10,000 gallons in a year, or an average, over every bit of land twenty feet square, of twenty-seven gallons for every day in the year. This is about the quantity that falls in the eastern
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part of the United States.

It varies slightly from year to year, but there is no more—there is no possible way of adding to it, though we may lessen it by allowing it to rush out to sea, giving no service to the land. As the land waters diminish the rainfall also grows less.

This two hundred trillions cubic feet of water which falls on our land every year constitutes our entire water resource, is the source of all our rivers and streams, of the moisture in the air, of our rains and snows, and our water for plant and animal growth.

To understand how much this is, we may say that it is about equal to ten times the amount of water that flows through the Mississippi River system. The water of the Mississippi and its branches is nearly half of all the water in the United States that flows through waterways to the sea. This water that flows through our streams is sometimes called the run-off. The run-off is increasing every year as we cut our forests and cultivate our land. It is used for navigation, irrigation and power, but the increase is not an advantage for these purposes as might be supposed, because it comes in disastrous floods, tearing away dams, ruining power sites, and not only preventing navigation during the flood season, but by filling up the rivers and changing the channels, making navigation difficult and dangerous throughout the year. The run-off is controlled to some extent and may be brought under almost as complete control as may be desired. [Pg 88]

As much as the water of five or six Mississippis, or a little more than half of our supply, is evaporated to moisten and temper the air, to fall as rain or snow, or to form dews. This is sometimes called the fly-off, and except for some changes caused by management of the land, is entirely beyond control.

A part of the remainder sinks into the soil below the surface. A large portion of this helps to cause the slow rock-decay that forms the soil, and which is known as ground water. It is estimated that within the first hundred feet below the surface of the earth there is a quantity of water that has seeped down; and that would form, if it were collected, a vast reservoir sixteen or seventeen feet in depth spreading over all the 3,000,000 square miles of the area of our country. This is equal to about seven years' rainfall and is a very important part of our water resources. In many places it forms into underground streams or lakes. It feeds all the springs and many of the lakes. Our wells are dug or drilled into this underground water system. It carries away the excess of salts and mineral matter from the soil, the trees strike their roots deep into the earth and draw from it, and last and most important of all, that which sinks immediately below the surface supplies all our plant growth. So that it is this last portion, that which sinks below the ground, and which is sometimes termed the cut-off, amounting to about one-tenth of all our water resource, or about the quantity that flows through the Mississippi River system, that forms the really important part. [Pg 89]

On this depends all that makes a land habitable, the water for drinking purposes and for plant and animal growth. On it depends the rate of production of every acre of farm and forest land and the life of every animal. Every full-grown man of one hundred and fifty pounds takes into his system not less than a ton of water each year, and every bushel of corn requires for its making fifteen or twenty tons of water.

Of the importance of this Professor Chamberlain says: "The key to the problem of soil conservation lies in due control of the water that falls on every acre. This water is an asset of great value. It should be counted by every land owner as a possible value, saved if turned where it will do good, lost if permitted to run away, doubly lost if it also carries away the soil and does destructive work below." [Pg 90]

The uses of rainfall are given thus:

A due portion should go through the soil to its bottom to promote rock decay. Some of it should go into the underdrainage to carry away harmful matter, another portion goes up to the surface carrying solutions needed by the plants. A portion goes into the plants to nourish them, and still another part runs off the surface, carrying away the worn-out parts of the soil.

Crops can use to advantage all the rain that falls during the growing season; and in most cases crops are all the better for all the water that can be carried over from the winter. There are many local exceptions, but in general crops are best when the soil

can be made to absorb as much of the rainfall and snowfall as possible. This also causes the least possible amount of wash from the land.

Doctor N. J. McGee says: "Scarcely anywhere in the United States is the rainfall excessive, that is, greater than is needed by growing plants, living animals and men. Nearly everywhere it falls below this standard. In the western part the average rainfall is only about eighteen inches; in the extreme eastern part the fall averages forty-eight inches. In the western part much of the land is unable to produce crops at all except when artificially watered. The eastern part might produce more abundant crops, [Pg 91] develop greater industries and support a larger population with a rainfall of sixty inches than it is able to do with a rainfall of forty-eight inches." As may readily be seen, the fly-off can be controlled only in a very small degree, by conserving the moisture that is in the soil, and so preventing it from evaporating too rapidly.

The cut-off can be controlled to a considerable extent through forestry and scientific farming and it is very important that the supply should be as carefully conserved as possible.

But it is in the run-off that the great waste of water occurs, and also that great saving is possible. It has been found by careful estimate that from eighty-five per cent. to ninety-five per cent. of the water that flows to the sea is wasted in freshets or destructive floods.

We are not accustomed to think of the water as wasted, since it seems beyond our control, but as we are taking a careful account of stock, and seeing how our forests, our fuels and our minerals are disappearing, and our soil being carried out to sea by the rushing waters, it is well to consider, also, whether this great resource may not be so used as to benefit mankind in many ways and at the same time lessen the drain on other resources.

The water of streams may be divided as to use into four great classes. The most [Pg 92] important is that used by cities for general supply, for household and drinking purposes; next, that which is used for navigation and the running of boats to carry commerce; third, that which is used for artificial watering or irrigation, and lastly, that which is used for power in manufacturing.

In the past, when water has been used it has seldom been employed for more than one of these purposes, but as we come to understand more the nature, value and possibilities of this great resource, we shall learn to make the money spent for one of these lines of activity supply several other needs.

As we study each of these separately we shall see this interrelation among them.

The cities of the United States have expended $250,000,000 in waterworks and nearly as much more in land for reservoirs, and for canals for conveying the water from these reservoirs to the cities. The better managed systems protect the drained lands from erosion by planting forests or grass and the water is completely controlled, so that all the water, even the storm overflow, is saved. There is very little waste in these city water systems until it comes to the consumer, where, except when it is sold through meters, the waste is often great.

The failure to provide the greatest good lies in the fact that the water systems have [Pg 93] been used for water supply only and have not been made profitable in other ways. The drainage basins should be heavily planted with trees, which will in time yield a large return, or with hay, which can be marketed each year. Whenever possible, the canals carrying the water supply should also be used to furnish power.

The city of Los Angeles, when it had a population of only 150,000, undertook to provide pure water from a point two hundred and fifty miles distant. To do so it must take on itself a debt of $23,000,000, a large sum for a city ten times its size. Yet the people were ready to assume this great burden to insure an unending supply of pure water, for they realized that without it their city could not continue to grow. It was not until the plans for piping water to the city were almost completed that the value of the water-power along the route was realized. It has been disposed of at a rate that pays ten per cent. interest on the debt each year, and has made what seemed a dangerous risk, a profitable business arrangement. All these other uses of water which are profitable, help to lower the price of water to the users.

The matter of supreme importance in the water supply, however, is not whether the

water is cheap, but whether it is pure. If refuse from factories is allowed to drain into a stream, the water becomes loaded with poisonous chemicals, acids, or minerals. If city sewage or barn-yards are allowed to drain into it, the germs of typhoid and other fevers enter the water supply. To insure the purity of water supply from a stream, no factory waste, city sewage or country refuse should be allowed to enter any part of the stream. In addition to this it should be carefully filtered. [Pg 94]

The disposal of waste is a serious problem, and the easiest way is to divert it into the nearest water course and trust to the old maxim, "Running water purifies itself."

This, while true as a general fact, has so many exceptions that it is not safe to trust to it. The Sanitary District Canal of Chicago has proved positively that even the most heavily germ-laden water becomes pure by running many miles at a regulated speed through the open country, but the conditions are altogether different from those of an ordinary river. First, in a river, sewage may enter at any point down-stream to add to the germs already present in the water, while nothing is allowed to enter the Drainage Canal after it leaves the city. Second, some germs live for several days and may be carried many miles. Only a microscopic test can prove whether water contains such germs. Usually such tests are not made and water is used without people knowing whether it is pure or not, but the water of the Sanitary Canal is tested at many points to determine its purity. Each hour and each mile of its journey it grows purer. This proves that although running water does purify itself, a stream that is drained into all along its course is not a fit source of water supply. [Pg 95]

Factory refuse, instead of being allowed to pollute the waters, should be turned to good use by extracting the chemicals, which form valuable by-products. All farm waste should be taken to a remote part of the farm, placed in an open shed or vat with cement floor and screened from flies to form a compost heap for fertilizers for the farm. This will amply repay the extra trouble and expense by increasing the farm crops. The sooner such refuse, especially manure, is returned to the land, the more valuable it is as a fertilizer.

In cities the sewage should be disposed of in such a way as to yield a profit to the city, and also promote the health of the people. The sewage of a city of 100,000 people is supposed to be worth, in Germany, about $900,000 a year for fertilizer on account of the phosphorus it contains. The city of Berlin operates large sewage farms, using as laborers men condemned to the workhouse. The expense for land and sewer system was $13,000,000, but it pays for the money invested, with $60,000 yearly profit over all expenses. [Pg 96]

On the other hand the cost of impure water to the city of Pittsburg was reckoned at $3,850,000, and in the city of Albany, New York, the annual loss was estimated at $475,000.

In the early settlement of our country all towns were built on streams, and the ones which grew and flourished were all on rivers large enough to carry commerce by boat. After the invention of steamboats, daily packet lines were run on all the principal rivers.

Albert Gallatin planned a complete system of improved waterways, including many canals, that was intended to establish a great commercial route. Many canals were built and put into actual operation and dozens of others had been planned, when the building of railways began. This new system of transportation at once became popular. Not only were no more canals dug and no more steamboat lines built, but many of those actually in operation were abandoned.

In order to encourage railroad building and develop new regions, the government has given land and money to the extent of hundreds of millions of dollars, until now the railroads form one-seventh of all our national wealth, having 228,000 miles of tracks and earning $2,500,000,000 each year, while the waterways owned by the government have fallen into disuse. [Pg 97]

Within the last four or five years another change has come about in the general attitude toward the waterways. At the time that the crops are moved in the fall, and when coal is needed for the winter supply, there are not nearly enough cars in the country to handle the volume of business, neither are there enough locomotives to move the necessary cars, nor tracks, nor stations. In short, the railways are entirely unable to handle the vast products of the country during the busiest seasons. Many

persons in the West have suffered for fuel, and commerce has been greatly checked by the shortage; and the situation is growing worse each year as production increases.

James J. Hill estimates that the cost of equipping the railroads to carry the commerce of the country would be from five to eight billion dollars. This means a heavy tax on iron and coal and timber as well as on the labor resources of the country, and it would then be only a question of time until still further extensions were needed.

With these facts in view, interest in the waterways of the country has been revived.

It is estimated that it will require five hundred million dollars, or fifty million dollars a year for ten years completely to improve the waterways of the country. This is not more than one-tenth of what would be needed to equip the railroads. The cost of carrying freight by rail is from four to five times that of carrying it by water. [Pg 98]

Much of the heavy freight of the country,—coal, iron, grain and lumber,—should be carried in this way, in order to reduce freight rates and so, indirectly, the cost to the people, and further to relieve the burden on the railways.

The railways, it might be added, would still have a large and increasing package-freight business, besides the handling of heavy freight in parts of the country where there are no navigable rivers.

For these reasons it would seem clearly the only wise policy to adopt a general plan for waterway improvement and carry it into effect at once. But there are many things to be considered.

Millions of dollars (in all about five hundred and fifty-two millions) have been spent for the improvement of waterways. Some of it has resulted in great gain, but a large part of it has been wasted through lack of an organized plan. Work has been begun and not enough money appropriated to finish it. In the course of a few years much of the value of the work is destroyed by the action of the current or by shifting sands, or if a stretch of river is finished in the most approved manner, often it is not used much, in some cases actually less after than before the work was begun, and these things have created a prejudice against waterway improvements. [Pg 99]

The other reason is that in spite of the overcrowding of the railroads, the traffic on many of our large rivers is steadily growing less. The Inland Waterways Commission finds as a reason for the decrease, the relations existing between the railways and the waterways. A railway, they consider, has two classes of advantages. First, those that come from natural conditions. A railroad line can be built in any direction to any part of the country except the extremely mountainous parts, while a river runs only in a single direction.

If a new region distant from a large water course is opened up, as is being done rapidly in the West through irrigation and dry farming, the people are entirely dependent on the railways to develop it, to bring them all the conveniences of the outside world, and to carry the products of their land to the market.

Branch lines and switches can be built to factories and warehouses, while boats can reach only those situated along the water-front.

Another advantage of the railroads is that they bill freight all the way through, and that freight is much more easily transferred from one road to another. It is much more difficult and expensive to load and reload freight from boats and barges on account of the high and low water stages of the river. This difference amounts to as much as sixty feet in the Ohio River at Cincinnati. Railways make faster time, and the distance between two points is usually shorter, though sometimes during the busy season of the railways the river freight reaches its destination much sooner. [Pg 100]

The other class of reasons relates to the railways themselves, which have always been in open competition with the waterways, and to gain traffic for themselves, usually charge lower rates to those points to which boats also carry freight. In many cases they have bought the steamboat lines so that rates might be kept up, and then, unable to operate the two lines as cheaply as one, have abandoned the steamboat lines.

Another method by which the railroads have driven out the water traffic, is by charging extremely heavy rates for freight hauled a short distance to or from boats,

making it quite as cheap as well as more convenient to send freight all the way by rail.

Lastly, railroad warehouses, terminals and machinery for handling freight are all much better than those of inland steamboat lines, except at some points on the Great Lakes where the traffic is very heavy.

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Some of these disadvantages might be overcome by law. In France, where the waterways are managed better than in any other country, the law requires that railroad rates be twenty per cent. higher on all heavy freight than the rates on the same freight if carried by water, and in several countries railroad companies are not permitted to own or manage a steamboat line.

These measures are suggestive of what may be done by law to correct abuses, but laws alone can not accomplish everything. The rivers belong to all the people, and every one who wishes may operate steamboat or barge lines, but before these can become profitable, and before first class warehouses and machinery are installed, there must appear on the part of the people a desire to patronize them. The best results are found in those cases where there is harmony between the railways and the steamboat lines; those in which the steamboat lines relieve the railways of much of the heavy freight which they are not able to handle without greatly increasing their present equipment.

There should be coöperation on the part of the people. The towns and cities along the banks of many European rivers provide suitable terminals, warehouses and wharves with free use of the service. In other cases this is done by private capital with a charge for use to shippers. Sometimes it is done by the steamboat companies themselves, but unless one or the other method is assured all along the river it is not wise for the government to undertake the improvement of a stream.

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Intelligent improvement of the waterways of the United States demands first that a careful survey of the needs of the whole country be made, then that a systematic plan be carried out providing for the improvement of important streams first.

The state and nation should work together, and any work that is begun should be completed as promptly as possible so that its full benefit may be realized.

Certain work, such as the improvement of the channel, should be done by the national government, since the waters belong to the nation; but the expense of constructing levees or dykes should be borne by the land owners along the banks, because the land thus protected is greatly increased in value; or by the state, which gets the return in increased taxes.

In many instances, the improvement of a stream would be a great benefit to one state or part of a state, but it would be impossible in many years to improve all the desirable streams, so that the larger ones of most general importance must be considered first.

In such cases the improvement is often undertaken by the state. Some navigable rivers have been thus improved and many canals are the property of states or of private companies.

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Only a few rivers have a steady flow throughout the year at a depth sufficient to carry large boats. On most streams destructive floods at certain seasons and low waters at others interfere with navigation during a considerable part of the year. Most rivers have sand-bars, sunken rocks or logs in the channel, making the passage of boats difficult and dangerous. Others are well suited for navigation, except at points where rapids and falls make it impossible for boats to pass. The Ohio, the Tennessee, the Missouri and the upper Mississippi abound in such dangerous places and these should be canalized. It is the improving of rivers in these ways, dredging harbors to make them safer, and digging canals to provide a short passage between two bodies of water, that constitute what is known as the Improvement of Inland Waters.

If you look at a map showing the navigable streams of the United States you will see that nearly all of them lie in the eastern part.

The Mississippi is like a great artery with branches extending in all directions, east and west. The Great Lakes, with their outlet, the St. Lawrence River, and the many important rivers emptying into the Atlantic Ocean and the Gulf of Mexico, such as the Merrimac, Hudson, Delaware, Susquehanna, Potomac and Rio Grande, form great

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highways for all the commerce of the eastern part of the country, while the Columbia, Sacramento and Colorado Rivers, with their branches, are the only navigable streams of any importance west of the Mississippi River system. [104]

In some places a small portion of land divides two important water areas, and canals dug through this neck of land change the commercial routes of the whole world. Such are the Isthmus of Suez, eighty-seven miles wide, through which a canal was cut that saves a sailing distance of 3,700 miles from England to India. Only the Isthmus of Panama, forty-nine miles in width, divides the Atlantic from the Pacific Ocean. When the canal across this narrow strip is completed, the sailing distance from New York to San Francisco will be shortened 8,000 miles, the entire distance around South America.

The Sault Ste. Marie Canal, connecting Lakes Superior and Huron, is only a little more than a mile and a half long, but it opens up the entire iron, copper, lumber and wheat resources of the Northwest to cheap water passage through the other lakes to the manufacturing region of the East.

The Erie Canal, by connecting Lake Erie with the Hudson River from Buffalo to Albany, New York, makes the only water passage from the Great Lakes to the ocean that lies within the borders of the United States. [Pg 105]

If you will turn to the map again, you will see still other places where a short canal may open up an entirely new and important water route. From Chicago to Lockport, Illinois, is only thirty-seven miles, but Chicago is on Lake Michigan, while Lockport is on the Illinois River, a branch of the Mississippi. This canal, a large part of which is now in operation, is a part of the Lakes to Gulf waterway. One plan is to broaden and deepen the channel so that large vessels may pass, without unloading, from the Lakes to the Gulf of Mexico.

Another proposed canal which would be undertaken largely by individual states and a part of which is already completed, would afford a safe inside passage connecting the many bays, channels and navigable rivers of the Atlantic coast.

Still another proposed measure is the cutting of a canal from the southern end of Lake Michigan to the western end of Lake Erie at Toledo, Ohio, to avoid the long haul up Lake Michigan and down Lake Huron again.

The United States now has 25,000 miles of navigable rivers and a nearly equal mileage of rivers not now navigable but which might be made commercially important; five great lakes that have a combined length of 1,410 miles, 2,120 miles of operated canals, and 2,500 miles of sounds, bays and bayous, that might be joined by tidewater canals easily constructed, less than 1,000 miles long altogether, and making a continuous passage from New England to the Gulf of Mexico. [Pg 106]

In all, our waterways at the present time are 55,000 to 60,000 miles long, the greatest system in the world, but almost unused.

The most important waterway improvement so far completed, is the Sault Ste. Marie, or the "Soo" canal which cost $96,000,000. A depth of eight feet was increased to twenty-one feet. The traffic has risen in sixteen years from a million and a quarter tons to forty-one and a quarter million tons.

A large proportion of the United States is not naturally fitted to be the home of man; at least, it is not fitted to produce his food, and except on the lofty mountains the reason for this will almost always be found to be either a lack or an excess of water.

In some parts of the country, there is, as we have seen, little rainfall. These arid or semi-arid lands must be provided with water for drinking purposes and for agriculture. The diverting of water courses into canals and ditches so that water can be carried to these waste lands is called irrigation.

In other parts of the country where rains are abundant, serious floods occur every year, often many times in a year. Thousands of acres of land thus subject to overflow are lost to use. The holding back of these flood waters in the upper part of the rivers, and so preventing these overflows, is termed storage of waters. [Pg 107]

In still other regions the rainfall is abundant, and the land low-lying. Large areas are always covered with water. Such lands are called swamps or bogs, and when drained,

they become the richest of agricultural lands. Irrigation, storage and drainage are the three methods employed to make waste lands valuable and useful. The land is saved or reclaimed, so all these methods of balancing and distributing the water supply are called reclamation.

In general it may be said that irrigation is more generally needed in the West, storage of flood waters in the central and eastern states, and drainage in the South.

By thus distributing the rainfall, hundreds of millions of acres have been or may be reclaimed, and large regions, formerly unfit to inhabit, have been turned into profitable farms. Three-fourths of one per cent. of our total rainfall, or two per cent. of all that falls in the West, is used for irrigating 13,000,000 acres.

There are several methods of irrigation which are adapted to different regions and different crops. The rice fields of South Carolina, Georgia, Louisiana and Texas are irrigated by allowing the land to remain continually flooded to a depth of several inches. When the irrigation season is over the levees are opened, and the water runs off rapidly, and the crop is soon ready to be harvested. Tidal rivers are used to supply water in most cases, but in Texas many flowing wells are employed for irrigation. [Pg 108]

In Florida, where irrigation is used largely for intensive farming, various means are employed, some of which are also used in the western and southwestern states. Mechanical pumps, operated by turbine wheels, pump the water from the rivers if a lift be required. Sometimes the water is pumped direct to the fields in iron pipes and applied by means of hydrants and hose, as in a city water system.

Overhead pipe lines are now recognized as the most perfect and satisfactory form of artificial watering. Two-inch pipes are run over frames several feet in height. These are arranged in parallel lines all over the fields about forty feet apart. At intervals of forty feet, a small iron pipe, ending with a fine spraying attachment, extends upward. The water is turned on in the evening and comes out of the sprayer in a fine mist and falls upon the plants like a gentle rain. [Pg 109]

By another form of irrigation, the fields are divided at regular intervals by wide wooden troughs from which water is directed between the rows of plants. Main canals leading from the streams and intersected by short canals extend in all directions through the fields and orchards, and are distributed in various ways. This system is in general use throughout the arid portions of the West. The methods are said to be the most scientific and varied in southern California.

When water for irrigation is supplied from wells some underground system is generally used. One common method is to lay continuous pipes from the wells all over the fields and distribute from hydrants, plugs and standpipes.

By still another system, the water is carried below the surface through pipes which are broken every few inches and laid in beds of charcoal.

In the eastern states irrigation is only employed in dry weather to increase the yield of vegetable crops. In the arid western region it transforms what would otherwise be a dreary desert into fertile valleys.

William J. Bryan, speaking at the first Conservation Congress, said, "Last September, I visited the southern part of Idaho and saw there a tract that has been recently reclaimed. I had been there before. I had looked upon these lands as so barren that it seemed as if it were impossible that they could ever be made useful. [Pg 110]

"When I went back this time and found that in three years 1,700,000 acres of land had been reclaimed, that where three years ago nothing but sage-brush grew, they are now raising seven tons of alfalfa to the acre, and more than a hundred bushels of oats; when I found that ten thousand people are living on that tract, that in one town that has grown up in that time there are more than 1,900 inhabitants, and in three banks they had deposits of over half a million dollars, I had some realization of the magic power of water when applied to these desert lands."

The same thing might be said of other regions throughout the West. In the Salton district of California a marvelous change has been brought about by irrigation. A few years ago that was one of the most desolate and forbidding regions on our continent. Now it is covered with several thousands of acres of alfalfa and other crops, and it bids fair to be a great fruit region. Of southern California it is said, "The irrigation

systems of this part of the state are known all over the world, and have created a prosperous commonwealth in a region which would be a scene of utter desolation without them."

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This locality presents a better opportunity for the scientific study of farming by irrigation than exists anywhere else in the world. Here all land values depend directly on ability to obtain a water supply. So precious is the water and so abundant are the rewards that follow its application to the soil that the most careful consideration is given to the various sources of supply and distribution.

As land becomes scarcer and the cost of living greater on account of the increase in population, men are turning more and more to irrigation to solve the problem of food supply.

As showing what may be accomplished by irrigation, the report of the last census says: "The construction of large irrigation works on the Platte, Yellowstone and Arkansas Rivers would render fertile an area equal to that of some eastern states. Engineers are grappling with the great problems of conserving the flood waters of these streams, which now are wasted and help to increase the destructive floods of the Mississippi. The solving of these problems will change a vast area of country, now practically worthless, into valuable farms."

The "Great Bend" country, drained by the Columbia River, contains several million acres of land which only requires water to make it of great agricultural value.

The Gila River basin contains more than 10,000,000 acres of fertile land, capable of producing immense crops if irrigated, but without irrigation it is a desert land where only sage-brush and cactus flourish.

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From arid lands capable of producing excellent crops but lacking in the magical element of water, we pass to the consideration of lands where the richest of soils are shut off from productiveness because they are covered with water. On the lower Mississippi the soil is richer than in any other part of the United States, but much of it is overflowed so frequently that it is unfit for cultivation. Dykes and levees have reclaimed thousands of acres of such overflow land. Many states control large marshy sections that have been or may be reclaimed.

In southern Florida lie the Everglades, a vast country which has been worse than valueless; a malarial region abounding in alligators, rattlesnakes, scorpions and other dangerous animals and insects. The state of Florida has undertaken the work of draining this great swamp, and when the task is completed, Florida will have added to its resources 3,000,000 acres of the richest soil for the raising of winter vegetables and fruits.

Florida is engaged in another great project—the digging of an inside passage connecting its inland tidal waters by a canal system which will open to navigation a continuous inland waterway six hundred miles in length. In digging these canals through the marshes bordering the coast, thousands of acres of exceedingly fertile land have been reclaimed and are now producing valuable crops.

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The Kankakee marshes in Indiana have been drained, adding many thousands of acres of rich soil to the agricultural area of the state.

In all, about 80,000,000 acres are so wet that they must be drained in order to make them produce good farm crops, but which, while now covered only with marsh grass or undergrowth, is capable of being made the most fertile of all land.

This swamp land is ten times the area of Holland, which supports a population of 5,000,000 people. It is therefore easy to see how greatly we may add to our productive territory and our national wealth by reclamation through drainage.

We now come to the use of water as power; and although in the last fifty years this subject has received little attention, as manufacturing increases and as fuel decreases and becomes higher, the value of water becomes more evident, and water-power sites are being eagerly sought.

Our age may come to be known in the future as the age of power, because through the application of mechanical power man has gained such marvelous control over the world about him. Wind and water led in the production of power until about 1870,

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since which time they have scarcely increased at all, the greater advantages of steam and electricity having driven them out. [114]

As long as all factories had to be built by the side of streams having suitable water-power, the number and size of factories were always extremely limited. With the introduction of steam it became possible to build factories at mines, in forests, in fruit or grain regions, wherever the supply of raw material was plentiful, and to multiply factories of all kinds in cities near the markets for their product, or where labor was cheap and abundant. But power could only be used where it was developed, and the size of the power plant depended on the amount of business done by each individual user.

Now a new era of power has again enlarged the possibilities of manufacturing. By means of electricity the work, not only of factories, but also of the home and the farm may be done in any place where electricity can be installed. We must bear in mind that electricity is never a source of power, but is only the agent that carries power to the user. The source of all electric power is either steam or water, produced by water-wheels, turbines, steam-engines or gas-engines. The economical way to furnish electric power is to establish central power plants, and electricity may be conveyed from them for many miles. An electric railway, telegraph, or telephone system many miles in length is operated from a single power plant. Electric light and power are transmitted all over the largest cities. It is no longer necessary that a factory be of any specified size nor that it have any waste power. If it be within reach of the electrical current it may use as much or as little as is needed. [Pg 115]

The cheapness of electric power must always depend on nearness to the source of supply or to the market. Until a short time ago it was customary to locate electric power-houses near the market, that is, in cities. But the benefits to be derived from having the electric plant near the source of power, so that the cost of production is greatly lessened, are becoming better recognized. This will make water-power increasingly valuable.

It is even now practicable to develop water-power, wherever located, for the production of electricity. Although the lowest grade coals are used for electric power at the mines yet they can now be used for still other purposes. Coal or other fuel once used can not be replaced, but when electricity is derived from water-power only energy otherwise wasted is used. This energy, if derived from water-power, is all added to our assets instead of being lost.

For many years the amount of power used for manufacturing and other purposes has doubled about once in ten years, and the steady pace kept by different lines of development shows how closely they are related. Our power, our forest cut, the use of our iron and other minerals, our coal and petroleum, the railroad earnings, freight and passenger traffic, and our agricultural products all double themselves every ten years. This means that in ten years we shall require twice as much power as now, but will have far less coal to use. This raises the question,—have we available water-power to conserve our coal supply? Let us see. It is estimated that we are now using 26,000,000 horse-power of energy derived from steam, 3,000,000 horse-power derived from water, and 800,000 from gas or oil, a total of 29,800,000 horse-power. It is also estimated that there is now running idly over dams, falls, and rapids 30,000,000 horse-power of energy. In other words, we are wasting every day enough water to run every factory and mill, and to turn every wheel, to move every electric car and to supply every electric light or power-station in the country. [Pg 116]

The amount of water-power is gauged solely by the low-water stage of the stream. A river is considered to produce only as much power as it can furnish at its season of lowest water. At other times factories may be operated more actively, but usually most of the extra power is wasted during a large part of the year. [Pg 117]

If these storm or flood waters can be stored in reservoirs, the stream-flow throughout the year can be made fairly uniform and the power possibilities greatly increased. The Geological Survey believes that by storing the flood waters and regulating the flow of the streams, the large rivers of the United States may be made to furnish 150,000,000 horse-power, enough, if it could be utilized, to supply every power need of our country for many years to come without using a ton of our coal, and without in any way decreasing the water.

Of course this can never be practicable. Much power will always be needed where no stream for power is available. But the lesson is plain that where water can be used it should be, both in order to save the coal and because it can be produced more cheaply. The 30,000,000 horse-power now available, if produced in our most modern electric plants, would require the burning of nearly 225,000,000 tons of coal, and if in the average plant run by steam-engines, more than 650,000,000 tons of coal, which is fifty per cent. more than all the coal that is now produced in this country. At three dollars per ton it would cost $2,000,000,000 a year to supply the coal to furnish the power that we might have, one might almost say, as a by-product from the improving of the rivers for navigation. The development of the water-power possibilities of the country is now going forward at a rapid rate, however. [Pg 118]

Dams on the Susquehanna River will soon make 30,000 horse-power available, which could be increased to 200,000 by building storage reservoirs.

A dam just begun at the rapids of the Mississippi River at Keokuk, Iowa, will, when completed, furnish 200,000 horse-power. Niagara is producing 56,000 horse-power on the United States side. The Muscle Shoals Falls rapids in the Tennessee River is furnishing 188,000 horse-power. Illinois will greatly increase its possibilities for offering cheap power to factories, when the Lakes to Gulf Canal with 173,000,000 horse-power worth $12,750,000 yearly, and the Chicago Drainage or Sanitary Canal, which has nearly 60,000 horse-power, are complete. Both of these projects were undertaken by the state.

In California 250,000 horse-power is now in operation, and 5,000,000 horse-power might easily be developed in that state alone, which at the price of coal would be worth a billion dollars a year.

New England has the oldest system of water-power control, because before the era of steam it was the chief manufacturing region of the country. The Merrimac, flowing through New Hampshire and Massachusetts, is the most carefully conserved river in the world, and Governor Dingley of Maine said that the water-power of Maine is equal to the working energy of 13,000,000 men. [Pg 119]

The money value is counted at twenty dollars a year per horse power, but it frequently brings as high as one hundred or even one hundred and fifty dollars a year in a good manufacturing region, so that the value of our water-power facilities can hardly be computed.

An ideal picture of the harmonious development of our water resources for all purposes is one that is not too difficult to realize. It is the ideal that should be always before us in the improvement of our waterways, and we should bear in mind that although the expense will be heavy, it will not cost more than one-tenth as much to improve all the important waterways as to equip the railways to carry the traffic they will be called on to carry in the next ten years; and also that in the past, for every dollar that has been spent on waterways, almost twenty-five dollars has been spent on railways. The railways are a great and important part of our national development, but the waterways should not be neglected. Rather, the two should be so harmonized and adjusted as to make one great commercial system that will furnish cheap and abundant transportation for all our commerce.

The most complete plan for conserving our waters is as follows: First, build storage reservoirs along the upper stretches of the river to hold the overflow waters of the flood season which are to be turned into the main channel when the water becomes too low for ordinary navigation. [Pg 120]

These storage reservoirs should be on the lowest grade of land, that which would be least productive. The reservoirs should be well stocked with the best varieties of fish to make them profitable. The banks should be planted with forest trees and made as attractive as they can be made to form public parks and pleasure grounds for the people, where boating, fishing and bathing may be enjoyed.

The next point is to remove all obstructions from the river, to canalize it at shallow places or rapids, so that the whole river will be navigable, and, if necessary, to deepen the channel so that it will carry large vessels between two important points.

Dams should be built to take advantage of every opportunity for water-power. One of the worst mistakes in the past has been the failure to use the power that might have

been developed in improving the streams for navigation.

Rivers should be made profitable still further by stocking with fish and should be kept clear of factory refuse and sewage. Soil-wash should be lessened by planting trees and shrubs along the banks; and where overflow or erosion lowers the value of the land or repeatedly ruins the crops, dykes and levees should be built. [Pg 121]

The rivers most important commercially should be improved first. Canals should be cut between waterways where large benefits will result; overflow and swamp land should be drained, and in arid regions every particle of water conserved for irrigation purposes.

The irrigation canals may also be used to supply water-power, and the canals may be used as are other canals for towing barges. If electric power is produced, electric towing is cheap and very desirable as a means of transportation.

In short, our water supply should be as carefully used and with as little waste as the land of forests. The most important improvements needed are, a Lakes to Gulf Waterway that shall be safe and practicable at least for vessels of moderate size; the improvement of the Ohio, Missouri, Tennessee and Upper Mississippi Rivers; an inner coast passage from New England to Florida, and in navigable rivers dredging and deepening if necessary, to make many outlets to the sea which will afford cheap transportation.

In the West, the Columbia, San Joaquin and Sacramento Rivers with their branches should be made navigable. Many western rivers have been almost ruined by filling with rocks in hydraulic mining, but this is now prohibited by law and if the channels were cleared they would again become navigable. [Pg 122]

Appropriations for much of this work have already been made by Congress, but the work is not systematically planned. The cost of all of it would be about sixty-two and a half cents a year for each man, woman and child in the country and every one would receive some benefit.

The National Conservation Commission on Waterways found that the average family pays for transportation or freight on all its food and clothing and the necessities of life, nearly or quite one-third their actual cost. "It is estimated that the direct benefits would be a yearly saving in freight handling of $250,000,000, a yearly saving in flood damage of $150,000,000, a saving in forest fires of at least $25,000,000, a benefit through cheapened power of fully $75,000,000 and a yearly saving in farm production of $500,000,000; a total of $1,000,000,000, or twelve dollars and fifty cents for each person—twenty times the cost! And this does not take into account the benefits from irrigation, drainage, and the lessening of disease by a pure water supply." [Pg 123]

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CHAPTER V

COAL

When we begin to study the mineral resources of the country we pass to conditions altogether different from those which we have been considering. Heretofore we have been dealing with resources that can be renewed, the soil by proper management, the forests by replanting, the waters by nature's own processes; but the fuels, the iron and many other mineral resources once used are gone for ever.

As to their importance Andrew Carnegie says: "Of all the world's metals iron is in our day the most useful. The opening of the iron age marked the beginning of real industrial development. To-day the position of nations may almost be measured by its production and use. Iron and coal form the foundation of our prosperity. The value of each depends upon the amount and nearness of the other. In modern times the manufacturing and transportation industries rest upon them, and with sufficient land and a fertile soil, these determine the progress of any people." [Pg 125]

We are sometimes told that we need have no anxiety about the future, that new discoveries and inventions will take the place of the present fuels, and even substitutes for minerals will be devised long before the supply is exhausted. This may be true, and in a way the future must take care of itself, but until new inventions have actually been made it is criminal to waste present resources and blindly trust that time will make our folly appear good judgment and foresight.

We have vast mineral resources unused; the present generation, even its children and its children's children need have no fear of a shortage. But in the use of those resources that are steadily and for ever diminishing we must look a long way into the future. We are under the most solemn obligation to take only our part of the store, and leave the rest untouched and unspoiled for those who are to come after us. When we consider what these mineral resources have done for our country in the last fifty years, when we realize that it is only by having cheap and abundant coal, iron, and copper that our railroads, our various electric systems, and our great manufactories have been developed, we can realize our duty to give the coming generations an equal opportunity to develop their ideas.

The yearly products of the mines of the United States are now valued at more than $2,000,000,000. Sixty-five car-loads of freight out of every hundred carried by our railroads are made up of mineral products. More than a million men are employed at the mines, and more than twice that number in handling and transporting mine products. [Pg 126]

Of every one hundred tons of coal mined in the whole world, the United States produces forty-three tons. We supply forty-five tons out of every hundred of iron ore, twenty-two tons of gold, thirty tons of silver, thirty-three tons of lead, nearly twenty-eight tons of the zinc, about fifty-five tons of the copper, and sixty-three tons of the petroleum consumed by all civilized countries.

This would be a cause for great national pride if we did not need also to consider the shameful fact that our wastes or losses in the mining, handling, and use of our mineral products are estimated at more than $1,500,000 per day, or, for the year, the gigantic sum of $547,500,000. That is, more than one-fourth of the entire output is wasted!

Of all our minerals, the fuels which supply heat, light, and power for domestic and manufacturing purposes, are the most necessary and important. Other materials can not be manufactured without their aid. Almost every particular of modern life would be changed if we no longer had plenty of fuel. Its use means its immediate and complete destruction, which is true of no other resource, and the use of fuels is increasing and will increase so rapidly that their conservation is becoming a serious [Pg 127]

problem.

The principal fuels are coal, gas, oil, peat, alcohol, and wood, and of these, coal is at present by far the most important. The first record of coal mined in this country was in 1814, when twenty-two tons of anthracite, or hard coal, were mined in Pennsylvania. An increasing amount was mined each year, but until 1821 the production was less than five hundred tons per year. In 1822 the production advanced to nearly 60,000 tons, and since that time has increased by leaps and bounds.

During the seventy-five years from 1820 to 1895, nearly 4,000,000,000 tons were mined by methods so wasteful that 6,000,000,000 tons were destroyed or allowed to remain in the ground so that it could never be recovered. Within the next ten years as much was produced as in the entire seventy-five preceding years, and in this period 3,000,000,000 tons were destroyed or left in the ground beyond the reach of future use. Up to this time the actual amount of coal used has been over 7,500,000,000 tons; the waste 9,000,000,000 tons.

Experts estimate that in the beginning there were somewhere about 2,000,000,000,000 tons of available coal, so that we have now, with all our wastefulness, used less than two per cent. of our original inheritance. But we must remember that in the ten years closing with 1905, we used as much as during the entire history of our country up to that time, and the rate of consumption is still increasing. In 1907 the amount mined was about 450,000,000 tons. Counting on a continuance of the same rate of increase, in 1917 it will be 900,000,000 tons a year, and if the same conditions should continue for twenty years we should be using and wasting in one year as much as we have used in all our history up to the present time. By that time more than one-eighth of our original supply will be gone, and in less than two hundred years nearly all of it will have for ever disappeared.

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That is a long time to look forward, but a short time in looking backward. It carries us back only to the childhood of Benjamin Franklin and others prominent in our early history; and if this nation could look forward to only an equal period of prosperous development in the future the time would seem short indeed.

But the danger of our coal supply becoming exhausted lies not so much in its present use as in the rapid increase in its consumption. Fifty years ago (about the time of the Civil War) we were using an amount equal to a little more than a quarter of a ton for every man, woman and child then in the country. Now the rate is five tons, or twenty times that amount, for each person of all our greatly increased population.

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The Pittsburg Coal Company owns about one-seventh of the great Pennsylvania anthracite fields. From the amount it is now mining each year and judging from the amount of coal it is able, with present methods, to reclaim from an acre of coal land, the estimate is made that this Pittsburg field will be exhausted in ninety-three years. A like comparison of all the eastern fields indicates that by the beginning of the next century there will be practically no cheap fuel left in the entire Appalachian basin.

The Geological Survey reports that, taking into account the available coal which can be reached and mined by present methods, and supposing the present conditions of use, waste, and increase to continue, the coal supply will be exhausted by the year 2015 A. D., but taking into account the probable improvements in its use, the year 2027 A. D. is estimated as the time when the present coal fields will be exhausted, and the middle of that century as the time when all coal fields in the United States will be gone.

This true story well illustrates the need of conservation and the folly of careless waste. High in the hills of the Pittsburg region a thick bed of excellent coal was found by the early settlers. It was impossible for them to build roads up the steep cliffs, so some method of getting the coal down to the valleys had to be devised. Buffaloes roamed the western plains in countless millions, and were so abundant about Pittsburg that the supply seemed inexhaustible. So the pioneers killed the buffaloes, filled each skin with a few bushels of coal, sewed it up, and tumbled it down the mountain side.

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This was the way they marketed their coal—by destroying their buffaloes. For many years no one dreamed that there was any end to the supply of buffaloes. And so both east and west they were killed for their skins, which sold for a few cents, for their horns, for a supply of steak, or for mere sport; and then one day people woke up to

find that the buffalo had disappeared, not in one settlement only, as they had supposed, but everywhere. There are a few remaining, carefully cared for by the government. They are among our most valued possessions, and yet only a few years ago they were destroyed, wasted, by millions.

This passing of the buffalo, the skins of which, as common then as burlap bags are now, were used to market our first coal, carries with it a deep lesson as to what will happen to the coal itself, even within the present century, unless our people awake to [Pg 131] the consequence of what they are doing and make a determined effort to stop all unnecessary waste.

Let us see where and how these wastes occur. The first serious loss of our coal occurs at the mines. There are three great wastes in mining.

(1) A coal bed is not made up entirely of pure coal, especially if it be very thick. Sometimes there are layers of shale or clay, which makes a large amount of ash. This can never be sold as regular marketable coal; but it is rich in carbon, and much of it might be used if it could be marketed near the mines and sold as low-grade coal. In the past there has been almost no market for it, and if it were either in the roof or bottom of the coal bed, it has been left unmined. If mixed with pure coal, the low-grade coal was thrown into great heaps at the mouth of the mine. This refuse coal is called culm. The amount varies from one-tenth to one-half of the coal in nearly every coal bed, and would probably average one-fourth in all the mines of the country.

This material is rich in carbon, and when used in gas-engines will furnish more power than the best Pocahontas coal when steam-engines are used. Thus one-fourth of all our coal is wasted at the mines simply because steam-engines instead of gas-producer engines have been employed. [Pg 132] If in the future installation of power this fact is taken into consideration, it will make the cost less to the user, and at the same time utilize a large proportion of our impure coal and save the higher grades for other purposes.

(2) In the mining of coal it was formerly the unfailing custom to leave supporting pillars of coal for the over-lying rocks to rest upon, to make suitable working-rooms, etc. These pillars, twelve to eighteen inches square, and higher than a man's head, are scattered throughout the entire mines and are usually of the highest grade coal. In many mines, also, a roof of coal a foot or more in thickness must be left because the material above the coal is not solid enough to prevent cave-ins. When the mine is abandoned and closed these pillars and roofings remain untouched, because removing them constitutes one of the greatest dangers to life, and is one of the frequent causes of mine accidents. It is improbable that the coal thus left in abandoned mines will ever be reclaimed, because not enough is left to make it profitable at present prices to re-open the mines; and frequently the rocks cave in about these pillars and make the task almost impossible.

(3) By careless blasting an unnecessarily large amount of coal is blown into powder, —the slack which has not been marketed at all until within the last few years. [Pg 133] Much of this slack, which is the best grade of coal in a pulverized form, is left inside the mines. These wastes in abandoned roofing, pillars, and small-sized coal, together make a total which for all the mines in the country will average fully one-fourth more of the coal that is in the ground.

It is to be noted, however, that conditions are changing for the better. The most modern mines use fewer supporting pillars of coal, and these are of larger size, so that there is less danger of accidents. Wherever possible they use timbers of wood instead of these smaller pillars of coal. They also mine as near the top of the seam of coal as can be done safely, and so regulate the blasting that much less slack is made than by the heavy discharges. These changes in mining methods save a far larger proportion of coal, and also prevent many accidents, which are the most unfortunate feature of coal mining, and the one which should receive most careful consideration. (See chapter on Health.)

One large mining company in Kentucky raises its own timbers by planting trees in straight, close rows on its coal land, thus making the land produce its own mine timbers to conserve the coal below. This company claims to have lost but one life in ten years, and to save seventy-five per cent. of its coal. [Pg 134] This is a striking illustration of what better mining methods will do for both the miner and the mine owner and of how

forestry may be an aid to the conservation of coal and also of human life in the mines.

We have already shown how half of the coal is wasted, but there still remains another source of waste at the mines. This is a large but unknown quantity. Coal usually exists in beds or layers with shale or rock between, much as a "layer-cake" is made, the layers of cake being represented by the coal and the icing between by these "rock-partings," as they are called. In rich fields, there are from three to ten of these rich layers or beds of coal, one above another. It often happens that the thickest and best layer is the lowest, and when this is the case, it is usually mined first, regardless of the fact that some, and possibly all, of the higher beds are dislocated and broken or filled with deadly gases. Nearly all this loss could be avoided by simply mining the upper stratum first.

So much for waste at the mines. This is serious enough if it were all, but it is not all, it is only the beginning. Let us see now what becomes of the coal that is marketed. The railroads are the largest single users of coal, and here we are confronted with the surprising statement that our locomotives consume three tons of coal in doing the same work that is performed by English locomotives with one ton. This difference is said to be due to different construction of the engines themselves, and to more careful stoking, or firing. Our locomotives use 100,000,000 tons per year, and by even the best methods known a large proportion of the heat units is wasted. Great effort should be made to improve the locomotives so that they will consume less coal; but as long as the railroad companies own the coal mines, as they do in many instances, they can obtain coal so cheaply that the cost of the improved form of engine is greater than the amount saved.

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Another great use lies in the manufacture of coke, which is used in the making of steel, and here, too, we see where great wastes have existed. The old form of coke-oven was called the bee-hive on account of its shape. These old style ovens consume all the coal with the exception of the fixed carbon which is left behind as coke. At the prices which prevailed in 1907, the value of the by-products wasted in bee-hive coke-ovens was a little over $55,000,000—surely a loss worth considering. A different form of coke-ovens is much used abroad and is coming into use in this country. This is the retort or by-product oven, sometimes called the recovery oven.

The bee-hive ovens are usually located near the mines where the cost of coal is low, with small expense for transporting it. On the other hand, the by-product ovens are established near the larger cities in order to dispose of their gas and other by-products. Here the cost of transportation must be added to that of the coal, but the products are marketed near by instead of at a distance, as in the case of the bee-hive ovens. The most improved by-product ovens produce not only coke and gas, but coal-tar, pitch, ammonia, and creosoting oils, all extremely valuable and adding greatly to the value of the output of the ovens.

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Electricity is another form of light and power which involves a large waste of the energy of coal; only one-fifth of one per cent., that is, one-five hundredth of the value of the coal is used in electricity, and there is at present no known remedy for this.

There are methods, however, of lessening even this waste, and these are constantly receiving more attention. One is for the electric plants located in cities to sell their exhaust steam or water heated by the coal as it is converted into electric power, as a by-product. The electric power-house thus becomes a central heating plant to supply stores, offices, and residences. Another system being tried abroad, though scarcely past the experimental stage in this country, establishes great electric power-houses at the coal mines to use the culm, low-grade slack, and lignites, the lowest form of coal, in short, all the waste of the mines. Still another plan is the manufacturing of electricity by water-power, as we have seen in a previous chapter.

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The manufacturing industries of the country waste a large amount of fuel annually, but here the waste is mostly due to expensive methods of producing power, and to careless stoking, and is largely preventable. As we have shown, gas-engines are a far more economical form of producing power than are steam-engines. Steam uses from five to ten per cent. of the heat-units of coal, gas-producer engines use fifty per cent. and burn a lower grade of coal.

One of the great problems of cities is the heavy volume of bituminous or soft coal smoke that hangs over the entire surrounding region, levying a heavy tax in cleaning

and laundry work, making the air difficult to breathe, and shutting out the daylight itself. Every residence adds its mite, but the factories and public buildings are the worst offenders. There are several good smoke-consuming devices on the market that have been thoroughly tested by the government, which will furnish their names on application.

If factory owners who use steam power could realize that the gases, the highest heat-producing part of the coal, escape with the smoke, and that by using smoke consumers they not only prevent all the evils of the smoke nuisance but save fully half of the value of their coal, they would gladly put in this equipment. What manufacturer would not eagerly welcome any device that would cut his fuel bills in half? [Pg 138]

The other cause of waste of coal in the manufacturing industries is recklessness in the use of fuel, filling the furnaces with the drafts so disposed that much of the heat is wasted. Every factory owner should learn (from the government reports if he has no other means of learning) the best methods of firing furnaces, and should employ them in his factory.

The last great waste of coal is in households. In stoves and furnaces, and to a certain extent in kitchen ranges, this waste is through carelessness in firing, as it is in factories. There still remains a large amount of wasted energy in cooking that is unavoidable. The amount of coal consumed before certain articles can be cooked, the heat remaining after the meal is prepared, are wastes that it seems impossible to prevent, though wise management will prevent undue waste even here. Fireless cookers, an invention of recent years, go far toward solving the problem of waste by long hours of cooking single articles, and each year we see more prepared food bought in order to save the cost of heat. Housekeepers find that it does not pay to bake their bread themselves, since a dozen loaves can be baked in a large oven with the fuel used in baking one at home. [Pg 139]

Briquettes are a new form of fuel made from coal, principally for household use. They are made from the low-grade coals, culm, slack and lignites, blended with coal-tar pitch. They are commonly used not only in households, but for locomotives and ships, in several European countries, especially Germany; but in this country the cost of making them—about a dollar per ton—makes the retail price higher than the cheaper grades of coal, and their general introduction at the price of the higher grades is rather slow.

Let it always be kept in mind that we must not check the careful use, only the waste, and the best way to avoid an unnecessary drain on the coal and at the same time increase our manufactures is to substitute other power. Coal is only a form of energy that came originally from the sun. The same causes that produced coal still exist. Scientists tell us that coal is still being made, but it will take thousands of years to perfect it. If we could only learn to take the sun's heat directly and use it for our heat, light, and power, it would be one of the greatest discoveries in the history of the world, greater even than the discovery of electricity. [Pg 140]

Many attempts have been made to produce power directly from the sun through solar engines, or by concentrating it in furnaces. At the St. Louis Exposition a few years ago, a Portuguese priest exhibited a solar engine called a heliophore, in which, by means of the sun's rays, the temperature was raised to 6000 degrees F., and a cube of iron placed in it melted like a snowball. The sun helps to raise the tides and some day they may be used to produce power. Many experiments are being made with both solar and tidal energy, some of them successful in a small way, but nothing that is ready to stand the test of every-day use has been devised.

Doctor Pritchell says that on a clear day when the sun is high, it delivers upon each acre of the earth's surface exposed to its rays, the equal of 7,500 horse-power working continually. If the extra energy not needed for the growth of plants and animals could be used, all the work of the world could be done and the problem of fuel supply would be solved for ever.

But the greatest conservation of coal possible at present lies in the use of the water-power which now goes to waste, and which, if employed, would, as we have seen, give us 30,000,000 horse-power, or more than all that is now produced from fuel by all our engines combined. [Pg 141]

Alabama offers a striking illustration of this failure to take advantage of our

opportunities, for Alabama has both coal and water-power. Engineers estimate that the three principal rivers have power equal to 436,000 horse-power. At Muscle Shoals, on the Tennessee River, there is now developed 188,000 horse-power, second only to Niagara—and if the waters were conserved, the figures would reach 1,084,000 horse-power on the three rivers. This means that, according to the amount of coal required to produce each horse-power of energy, it would require 11,201,000 tons of coal each year to produce by steam as much power as these streams might easily be made to produce.

Alabama, as we have said, is also a great coal state. It is now mining about 14,000,000 tons per year and only four states produce a larger amount. It will be seen that four tons out of five mined in this state will be needed to produce by steam the power that is going to waste in its rivers. The Honorable W. P. Lay, of the Alabama Conservation Commission, in calling attention to this fact, says:

"Suppose for a moment that the coal fields of Alabama were sliding down an incline and pouring off over a precipice at the rate of 11,201,000 tons per year, how long would it take the people of the United States to do something to try to stop such a waste? Yet what else are we doing when we sit idly by and let the water of these streams go to waste over a precipice while we ourselves burn up the coal?" [Pg 142]

And what is true in Alabama is true to a lesser extent in most of the states. Wherever water-power is going to waste, coal is being used to take its place, and that coal is needed in some place where there is no water-power.

On a certain stream in one of the central states was a fine waterfall. The early settlers built a mill there. The water turned the mill-wheel and then passed on to water the valley and turn other mill-wheels. But one night the old mill was destroyed by fire. It was not rebuilt, but some distance from the stream a new steam mill was built, the motive power of which was natural gas. When, after a few years, the natural gas was all gone, the miller began to use coal, and he still uses coal—hundreds of tons of it—while the water which once turned the wheels, runs idly over the falls. This is an example of wholly useless waste of coal, and just such waste is to be found in hundreds of places in our country.

If wise mining methods be put into operation, if proper care be taken in its use, particularly in manufacturing, if the low-grade coals be utilized, and if other power be substituted wherever practicable, there need be no question of shortage. There is enough coal in the ground, if used rightly, to last for ages to come. But because we have wasted vast quantities of it in the past, and are still wasting it, so that if the same conditions continue we can distinctly see the end in sight, it is important that every one understands what these conditions of use and waste are, and how the abuse may be corrected, so that mine owners and consumers may all work together to preserve this most necessary resource. [Pg 143]

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CHAPTER VI

OTHER FUELS

WOOD

Wood, which was formerly the only fuel used in this country, has now largely given

place to other fuels. In rural districts and in lumber regions it is still used extensively; but in the cities, larger towns, and manufacturing regions, it is not used in commercial quantities. Its use for power production is limited to the wood-working factories which have a large amount of waste lumber and which employ this by-product to furnish heat for steam boilers.

The wood used for fuel or for power usually represents what would otherwise be lost, the dead trees and the unmarketable timber of the farmer's wood-lot, the refuse of lumber regions or the waste of wood-working factories. So that the use of wood as fuel now generally means the conservation of our coal supply, and a use for the low-grade parts of the forest.

In some cases, however, farmers cut for fuel fine young trees that would grow into excellent timber. Liberal planting of trees so that wood shall become plentiful in all parts of the country will tend to bring about again a larger use of wood as fuel, which will thus once more become a factor in the saving of our coal. Every farmer should learn to save all valuable trees for lumber, and to use only undesirable ones for fuel.

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PEAT

Peat is said by geologists to be only "coal in the making," carbon that is in the state of changing from vegetable matter to coal. It is probable that in the course of centuries this would become coal, and in its present state it has many of the properties of coal, though it has not nearly so high a heating value.

In this country we have had such a wealth of fuel resources—coal, wood, oil, and gas—that up to the present time we have done little to develop our peat beds, although in European countries ten million tons are used annually for fuel, as well as large quantities for other purposes. From the earliest times peat has been the principal fuel of the common people of Ireland and some of the countries of northern Europe.

Now, however, people are trying to make the best of many resources not heretofore developed, coal prices are steadily advancing and the two causes combine to turn people's attention to the peat beds of America. One point that is worthy of notice is that peat is found mostly in regions where there is no coal, oil, or natural gas. The development of peat beds in those regions, it will be seen, would give them a great advantage in the matter of cheap fuel.

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Large peat beds are found in Minnesota, Wisconsin, Michigan, New York, New England, New Jersey, Florida, the Dakotas, northern Iowa, Illinois, Indiana, Ohio, Pennsylvania, eastern Virginia, the Carolinas and Georgia; and near the coast in the gulf states, and a narrow strip along the Pacific coast, from southern California to the Canadian border. They cover an area of about 11,000 square miles and are supposed to contain not less than 14,000,000,000 tons of air-dried peat. At the rate of three dollars per ton, which is a reasonable price in the states having no coal, this peat would have a value of more than $40,000,000,000.

Peat is prepared for use as common fuel in two ways: (1) By cutting it into blocks or bricks, which are air-dried by exposure to sun and wind for a few weeks. This is called "cut peat," is bulky and easily breakable, and can be used only for local consumption. (2) By digging either by hand or machine, and grinding it in a mill. It is put in wet, ground, cut with rapidly turning knives, and passed out of the machine as a thick pulp that is cut into bricks as it comes out. It is then stored several weeks until thoroughly dried. This is called "machine peat," "pressed peat," or "condensed peat."

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Peat is being used in many ways. (1) Air-dried peat is used for fuel only. (2) Dry peat without a binder, or mixed with coal dust and tar or pitch is used for the same purpose. (3) Machine peat is used for many purposes, among them making into briquettes, peat charcoal, and peat coke.

It has been found practical to make illuminating gas of peat, but a far more general use is for running gas-engines and producer-gas furnaces. This is a practical use for it, since it will conserve the coal now used for that purpose, furnish satisfactory power without smoke or dirt, provide cheap power in regions that have no coal mines, and lastly may be made to yield valuable by-products: ammonia, acetic acid, paraffin, tar, creosote, and wood-alcohol. If all the peat in the United States could be used in producer-gas engines the ammonia yielded would alone have a value of

$36,000,000,000.

Peat is also used for packing material, as a fertilizer, for manufacturing paper, for coarse cloth and mattress filling. By mixing wet machine peat with cement it may be made into blocks for paving and other construction work. The most promising uses are for fuel, as bedding for stock, as a disinfectant, in briquettes for burning lime, brick, and pottery, in which it is finding a large use, and for which it is said to be particularly well fitted; and most satisfactory of all, its use in gas-producer engines. In Florida an immense plant is being built to manufacture electric power, using air-dried peat as fuel, the power to be transmitted to Jacksonville. [Pg 148]

Machine peat is supposed to have sixty-five per cent. the value of the same weight of Pocahontas coal, but on account of the lack of waste in peat its real value is higher than would appear from the comparison. From two to two and a half pounds will produce one horse-power per hour in gas-producer engines. By this estimate, we can see that the peat beds of this country, if properly used, may be largely employed, either now or in the future, as a substitute for the vanishing coal.

NATURAL GAS

Of all the fuels, natural gas may be said to be the ideal one. Coming from the ground, it is piped a greater or less distance and distributed to the home or factory for light, heat, or power; for all of which it is equally desirable. It is ready for our use at the turn of a key, is absolutely clean, having neither dust, ash, nor unconsumed portions. It requires no kindling other than a lighted match. [Pg 149]

Natural gas is found over an area which, if combined, would cover almost 10,000 square miles. It exists in twenty-two states—Alabama, California, Colorado, Illinois, Indiana, Michigan, Missouri, Montana, New York, Kansas, Kentucky, Louisiana, Ohio, Oklahoma, Oregon, Pennsylvania, South Dakota, Texas, Utah, Washington, West Virginia, Wyoming. In some of them the area has been large and the production very heavy, in others the field is small and unproductive. Until the last two or three years there have been no statistics as to the quantity of gas piped, but an account of its value has been kept for many years. For the twenty years beginning with 1888 the value is given at nearly $500,000,000.

It must be remembered that much of this represents extremely low prices, only the amount actually paid for its use. When gas is newly discovered in a region it is not considered an opportunity for the residents of the community to have cheap light, power and fuel for themselves, but instead as an opportunity to develop the country, to increase the population and attract new factories. In order to advertise and boom their communities free gas is usually offered to factories. So in dozens of instances large factories have been operated for years without a cent having been paid for fuel. For this reason no proper estimate can be made of the quantity of gas consumed, nor of its value even at a nominal price. In 1907, (the last year for which complete returns have been published in government reports) the amount of gas consumed was given at 404,000,000 cubic feet, which at present prices is valued at $63,000,000. [Pg 150]

It is impossible to determine in any way the future production of natural gas, or to guess at the quantity remaining in the earth. It may be much less or much more than present conditions would indicate; but the present known fields are limited, and the pressure is growing steadily less in all of them.

The Conservation Commission reports, "It is safe to predict that the known fields will be exhausted in twenty-five years." The decrease of natural gas is strikingly illustrated in Indiana. This state, perhaps more than any other, profited directly by the discovery of its natural gas about twenty years ago. Here, the mineral maps show, is by far the greatest natural gas region in the United States. With the discovery of natural gas, established towns grew to ten times their former size and new ones sprang up everywhere. Indiana, which had been chiefly an agricultural state, bade fair to become one of the foremost manufacturing states on account of its cheap and abundant fuel. In 1902 Indiana produced nearly $8,000,000 worth of natural gas, but for 1908 the State Geologist's report contained no figures for this product. It had ceased to be a prominent factor in the wealth of the state! There is no resource that has been so shamefully, so hopelessly wasted as our natural gas. [Pg 151]

With even more recklessness than characterizes the waste of our forests and our

coal, we have allowed this perfect fuel to escape. To the dwellers in each region where natural gas is found, it seems that the supply is inexhaustible. The roar of the wells, which makes the very earth tremble; the flames springing high into the air; the undiminished pressure after months of use, appearing to indicate a boundless reservoir below; the opportunity for whole communities to grow rich by its use; all these things tend to promote recklessness on the part of all who handle it. In the beginning the wells are usually not tightly cased, and there is a considerable quantity of gas escaping about every well. New wells are frequently lighted to show the volume of gas. In some cases the well has become uncapped on account of heavy pressure and to prevent the escape of unconsumed gas into the air it is kept burning night and day. The strongest wells are often kept burning for months in order to advertise a new gas field. In this way immense quantities of the most perfect fuel in the world have been wantonly wasted. From a single well in eastern Kentucky there flowed a steady stream of gas for twenty years which at present prices would be worth $3,000,000, and the same story of waste from burning wells comes from every natural gas field.

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In a new region where gas is abundant there is also a great waste from leaking pipe lines laid on the surface of the ground, from open flambeaux, and from careless home and factory consumption. In many communities the open flambeaux have been employed to light the streets, and allowed to burn day and night to avoid the expense of a man to care for them. Where natural gas is abundant, meters are not usually installed; instead, gas is sold by the month. The consumer is under no obligation to save the gas, in fact, he usually acts on the common American principle of wanting to get all he can for the money and so burns his open tip lights, and open burner stoves day and night. The factories waste in the same way, using open furnaces which are never banked during the season because it is easier and costs no more.

This, it seems, should be the whole history of natural gas waste, but the greatest source of loss still remains to be spoken of. In every gas region of any importance oil is found sooner or later, usually after the heaviest gas pressure has been exhausted; and the oil driller is the greatest of all foes to the life of a natural gas region. He finds that the gas interferes with the flow of oil, spraying it into the air and causing loss, and that the danger of fire is much increased by its presence. This frequently causes explosions, tearing out the side of the well or blowing out the casing, and making the oil-well useless. The surplus gas is usually piped to one side out of the reach of danger, and then burned to get rid of it. Drillers often try to force the gas out in the hope that it will be followed by a rush of oil.

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This is the heaviest drain on the gas. In the Caddo field in Louisiana alone the loss is seventy million cubic feet per day, enough to light ten cities the size of Washington, D. C., and equal to ten thousand barrels of petroleum per day. In Indiana a few years ago fourteen wells, all within a space of a few acres in extent, were burned by oil drillers continuously for six months, the light being visible twenty miles away.

Greater care in the management of the wells and slight additional expense for casing are all that is required to stop the waste of gas from oil wells and heavy pressure gas wells.

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All of these wastes taken together constitute a fearful loss. In 1907, more than 400,000,000 cubic feet were used and an almost equal number wasted. In other words, the daily waste is over a billion cubic feet, or enough to supply every city in the United States of over one hundred thousand population.

The heating value of a billion feet of gas is equal to a million bushels of coal. If some great conflagration were sweeping away our coal fields steadily every day in the year, and destroying our best coal at the rate of a million bushels per day, how quickly we should all arise to aid in checking it! And yet this imaginary case is actually true in regard to the best fuel in this country, which is burning uselessly an equal value in coal, and our coal must some day be used to supply the loss.

We are apt to ignore the greatness of this loss because the gas escapes into the air and we can not see it, or it burns and we see only its effect, not the loss of fuel, but if we could see it in the form of oil we should find that a billion feet of gas is equal to more than a hundred and sixty thousand barrels of petroleum. Think of it, the equivalent of one hundred and sixty thousand barrels of oil, for which no price is paid and of which no use is made, for ever destroyed every day in every year! Would the oil companies permit it? Would we not all assist them in saving their property from

[Pg

destruction, and shall we not ask of them equal help in saving the fuel that in turn conserves our coal supply? Little objection can be made to the present method of using gas in the older regions. The waste in domestic use is comparatively small. Much is used for lighting with incandescent burners, and asbestos grates and gas ranges have replaced the open-burner stoves and grates. These are all efficient methods of use, and but little could be done in the way of further conservation. In factories the gas-engine is in many instances replacing the open furnace, which requires many times as much gas to produce an equal amount of power. They should be used in every factory, and gas companies should also require the use of the best devices for saving gas in places where meters are not used. [155]

Until last year but one state—Indiana—had an effective law preventing the waste of natural gas by oil companies. This law says in substance that a man can not take the oil from the ground where nature has safely stored it, unless he also provide a market for the gas which accompanies it. It also says that neither the producer nor the consumer shall be allowed to waste this valuable fuel, as such waste is against public policy.

Mr. I. C. White, of West Virginia, in discussing this question at the Conservation Congress said, "This Indiana statute should be enacted into law in every state where these fuels exist." Since that time Pennsylvania and Ohio have passed laws, which are said to be effective, for the conservation of natural gas. [Pg 156]

Much has been accomplished by gas companies, who, since they became alive to the danger of loss of their investment, have been extremely watchful of their property. In West Virginia the gas companies buy the gas which has been obtained in the drilling of oil wells, thus providing a market for the waste gas and making it possible to continue the oil business and at the same time to furnish cheap gas.

Another hopeful sign is the pumping of all of the product of a well. Formerly as soon as a well dropped greatly in production it was abandoned, but now it is pumped until dry.

One method by which the gas from oil wells may be utilized consists in compressing it in steel cylinders for shipping. This in a small way has been found to be successful.

Experiments are being tried on a large scale in Ohio to prove that gas may be returned to reservoirs within the earth which are tight enough to hold it under heavy pressure.

Fuel gas made from low-grade coal is a satisfactory substitute for natural gas. Like the natural product it may be piped for long distances. Some natural gas companies have bought up the culm banks and heaps of refuse coal, so that if the natural gas becomes exhausted they can manufacture cheap gas at the mines and pipe it to the cities they now serve. [Pg 157]

PETROLEUM

Petroleum, or rock oil, is a dark greenish brown liquid which when refined yields gasolene, naphtha, benzine, kerosene, lubricating oils, and paraffin. The name petroleum applies only to the crude petroleum as it comes from the ground, and the word oil is applied to the products obtained by refining.

The early history of the petroleum industry in this country is interesting as showing what great results spring from small beginnings. From salt wells in Pennsylvania there was an occasional flow of petroleum, but it had had no commercial value. Samuel Kier, of Pittsburg, had salt wells at Tarantum from which he had accumulated so much petroleum (fifty barrels) that he decided to try to dispose of it, but there was no market. No one knew what to do with it. He then partly refined it, making a poor quality of kerosene, and introduced a lamp with a chimney. This proved so popular that A. C. Ferris, also of Pittsburg, undertook to sell this in other cities, and these two men not only sold the fifty barrels and the other petroleum that accumulated from the salt wells, but they had created such a demand for the new light that they could not supply enough oil, and in 1859 Colonel Drake drilled at Titusville the first well solely for petroleum. In the half-century since that time nearly two billion barrels, or almost two hundred and fifty million tons, worth one and three-quarter billion dollars, have been produced. [Pg 158]

Petroleum is now mined, or drilled, in many countries besides the United States, but the United States furnishes sixty-three barrels out of every hundred produced in the world. Russia produces twenty-one barrels, Austria four, and the East Indies three barrels, Roumania two, India and Mexico one each, Canada, Japan, Germany, Peru, and Italy each less than one barrel; so we can see that the United States is the one great producer of petroleum, and that it is to this country that we must look for the principal world supply for the present, and as far as known, for the future. Let us see, then, what we may expect the United States to do to supply this demand.

The known petroleum lands cover an area of about 8,500 square miles and are in six large fields and several smaller ones. The largest and best is the Appalachian, of which the best known is the Pennsylvania field. It has a grade of petroleum that differs from [Pg 159] any other thus far found in the world. It is most easily converted into kerosene or lamp oil, and contains a larger proportion of such oil. It is the finest petroleum in the world, except that found in Indiana and Ohio, and that costs more to refine.

The Appalachian field includes, besides Pennsylvania, western New York, West Virginia, a narrow strip in eastern Ohio, Kentucky and Tennessee. These southern oils are of a much lower grade, but are better than the Russian or other foreign oils.

The next great field is called the Lima-Indiana, and covers a considerable portion of northwestern Ohio and eastern Indiana. This petroleum contains less gasolene and less lamp oils, and more sulphur, which makes refining difficult. The Illinois field lies next. Here, in a strip about thirty miles long and six miles wide on an average, an enormous quantity of petroleum is produced. This oil is slightly lower in quality and contains considerable asphalt.

The mid-continent field lies in Kansas and Oklahoma. This petroleum also contains asphalt and other chemical products. Such immense amounts are produced here that it has not been possible to care for all of it, either in the matter of storage tanks or cars for transporting it, and as a result large amounts have been wasted. In Oklahoma [Pg 160] within a space of less than two square miles one million barrels of forty-two gallons each of petroleum were wasted in the year 1906.

The Gulf field lying in Texas and Louisiana has been developed entirely since 1901. The first well was drilled near Beaumont, Texas, as an experiment to determine whether oil could be found. Small storage tanks were provided and it was hoped to find oil enough to make drilling profitable. The well proved to be a "gusher" of such magnitude that before sufficient tanks could be provided, or the flow checked, more than half a million barrels were wasted on the ground.

The Gulf petroleum contains a large amount of asphalt and a small amount of gasolene and lamp oil. It has been used principally for burning as crude oil in locomotives and has sold as low as ten cents per barrel; but lately methods of refining have been perfected which produce good lubricating oil and a gasolene of high value from these low-grade oils.

The last great field is found in California. The oil is similar to the Gulf oil, and investigation has shown that the quantity is greater in this field than in any other. It is used largely for fuel and power on account of lack of other fuels in that region.

In addition to these fields there are small ones in Colorado and Wyoming, and [Pg 161] promises of fields in New Mexico, Utah, Idaho, Montana, Oregon and Washington.

Estimates of the amounts of petroleum yielded are made by computing the amount usually produced per acre, which varies from eight hundred barrels produced in Pennsylvania, to eight thousand barrels per acre produced in Illinois. In most of the fields it is about a thousand barrels per acre. Even then the amount is extremely difficult to estimate. The Geological Survey concludes that the lowest probable calculation of the entire amount stored in the rocks of the United States is ten billion, and the highest a little less than twenty-five billion barrels. The last report officially published shows that we are producing one hundred and seventy million barrels per year. If the same rate of production continues, we might expect our petroleum to last from fifty-five to one hundred and thirty-five years, according to the amount found; but tables of statistics show that throughout the life of the petroleum industry, as much has been produced each nine years as the entire product before that time. For example, up to the present, we have produced one billion eight hundred million barrels and if the present rate continues, in the next nine years alone we shall produce

an equal quantity again. The causes of such rapid growth are many. One is the great increase in the use of some of the products, such as gasolene, which has increased many fold since the automobile became popular. Another, and the greatest cause, is the ease with which any quantity of oil can be sold for cash at any time, and at prices much above the cost of production. [Pg 162]

Another reason is based upon the nature of the product. In pumping from one well oil is apt to flow in from other leases, under other farms, and exhaust them without the holders of those leases having received any compensating benefit. It is therefore necessary for each lessee to get his share before it flows away. Under these circumstances, it is impossible to prevent an entire field from being drilled over very rapidly, unless there is a combination of all the interests; or unless the law limits the amount that each producer shall extract per acre within a given time.

Pennsylvania and New York have declined to one-third their former value and yet it is only seventeen years since they reached their highest point. This would seem to indicate that the life of that field will not exceed ten years. West Virginia is producing only a little more than half its former yield and is rapidly declining. Ohio and Indiana are declining more rapidly than Pennsylvania. Texas is also in the rapidly declining class, and in Kansas the production is only a fraction of what it was formerly. On the other hand, Illinois, Oklahoma, and California can be expected to increase steadily for several years. [Pg 163]

Taking into account all these factors, it is estimated that the entire supply now known to exist would be exhausted before the middle of the present century. It appears more probable, however, that increasing prices long before that time will help to conserve the supply; and that petroleum will be produced for a long time to come, though not in sufficient quantities for industrial and general use.

The principal uses of petroleum are for burning as crude oil in furnaces and under boilers, particularly in locomotives. The refined products have various uses. Probably the most important is the lubricating oil. This is necessary in the development of all kinds of power. At least one-half pint of lubricating oil is used for every ton of coal consumed for power. All engines, all street and steam railways, steamships, sewing-machines, clocks, watches, and automobiles, in fact all operating machinery requires its use; so that a large amount of oil must always be conserved for lubricating purposes.

Coal oil, or kerosene, may be regarded as absolutely necessary for the lighting of houses or other establishments not connected with gas or electric supply. [Pg 164]

Gasolene is sometimes used for lighting, though such use is not common. It is largely used for cooking, and still more largely used in the various types of gasolene engines.

Naphtha is used for power, especially for motor-boats, and for cleaning, in which it is very valuable by reason of its power to dissolve dirt.

Paraffin is used in polishing, in laundry work, for waxing floors, and as a covering to exclude air in preserving articles.

Waste has been markedly absent in the petroleum industry. It is necessary that oil drilling outfits shall contain steel storage tanks for holding the oil when it is reached. Usually the supply is large enough, but sometimes, as in the case of the big well at Beaumont, Texas, the oil gushes forth in such volume that the drillers are not prepared to take care of the overflow, and much is wasted before the well can be capped. In general there is no waste in storage in this country. In European countries where there is oil, the loss through lack of tanks and by using wooden tanks which leak, is very great.

Another form of waste which is common in foreign countries, but which has been avoided in the United States, is evaporation of gasolene and similar light products when the petroleum is exposed to the air in open tanks. This is the most valuable part of petroleum, and if it be exposed to the sun a single day it loses greatly in value. [Pg 165]

The refining processes of the petroleum industry are probably carried out with better system and less waste than in any other resource, owing to the fact that the business is controlled by large companies. There is no waste material in its manufacture, except some slight residue that might be used for oiling roads, instead of using the crude oil. The principal waste lies in its use. In view of the fact that the

supply is not unending, is, indeed, rapidly disappearing, the uses should be confined only to the necessary lines for which there are no substitutes at similar prices. These are for lubricating oils and for the lighting of homes. The unnecessary uses are for burning in locomotives and for the development of power.

Whenever new petroleum fields are opened up, there is a corresponding drop in price. In order to dispose of it quickly such petroleum is usually sold for the lowest grade uses, and the price for this crude petroleum is not more than one hundredth as much as for high grade petroleum products. The report of the National Conservation Commission is so excellent that it is quoted almost word for word. [Pg 166]

"At present more petroleum is being produced than is necessary for the demands of the industry. Within ten years the present fields will be unable profitably to produce enough for these requirements. The only direction in which production can be checked is with the petroleum contained in public lands.

"Offering such public lands for entry at a low price is nothing more than temptation to the private citizen to waste petroleum by over production, since lands yielding hundreds of dollars per acre in this product can be obtained for a small sum. Every acre of public land, believed to contain petroleum or natural gas, should be withdrawn from public sale and leased under conditions that regulate production.

"Its use for power is justified on the Pacific coast, if used in gas-producer engines."

ALCOHOL

As a substitute for other fuels, wood, or denaturated alcohol, will probably come into greater use each year, and is regarded by many as the great fuel of the future, because the materials of which it is made are waste vegetable products and will always be plentiful. [Pg 167]

It is made from cellulose, the woody part of plants, and may be manufactured from sawdust when freshly cut from live trees, from small, and refuse potatoes, from inferior grain that is not worth marketing, and from low-grade fruits and vegetables of all kinds. It is even said that the hundreds of acres of sage-brush in the West that have always been considered worse than useless can be made into wood-alcohol and thus become a valuable product.

It can be used for any purpose that gasolene can, although a different style burner is required. It must be made much hotter before it is changed into vapor, and on account of this it has been difficult to make satisfactory burners for all the kinds of heating, lighting, and power work; the machinery being far from perfect as yet. Wood-alcohol can not yet be made cheaper than gasolene, and is not so easy to burn, so that it is slow in reaching an important place in the industrial world; but gas and gasolene prices will advance, and better methods of manufacturing and burning alcohol will be found, and then we shall have a fuel that can take the place of either coal or petroleum for lighting or power.

It is thought that wood-alcohol will be of especial use to the farmer, since he has so many waste vegetable products, has so much need of power in small quantities and is far from the sources of public service power, such as electric and gas plants. Alcohol-driven motors can be used to take the place of the labor of both horses and men on the farm. On level farms they can run the heavy machines, such as mowers, reapers, and binders, plows and cultivators. On any farm they may be used to run stationary engines, to chop and grind food for live stock, to pump water, churn, run sewing-machines, operate fans, drive carriages and wagons and do many other things. [Pg 168]

Wood-alcohol produces ammonia as a by-product, is used in the manufacture of dyes and coal-tar products, of smokeless powder, of varnishes, and of imitation silks made from cotton.

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CHAPTER VII

IRON

We have already stated the importance of iron in our modern life. It can not be overestimated. All the many articles of iron and steel, our tools, our machinery, our vehicles, our bridges, our steel buildings, and a thousand and one other things are dependent on our iron supply.

Of all the elements that make up the earth's surface only three are more plentiful than iron, so that we might think that we should always have an abundant supply of it; but when it occurs in small quantities, as is usually the case, it can not of course be profitably mined. It is only when enough of it is found together to permit it to be mined to advantage that it is called iron ore.

Iron ore is found in only twenty-nine states of the Union, and eighty per cent. of the present production is in two states, Minnesota and Michigan. We can see that iron is very unevenly distributed, and it is on a few regions that we must depend for all the future.

Before we can calculate how much iron we have we must understand that it is not [Pg 170] found in pure form, but mixed with various other substances: clay, shale, slate, quartz, sulphur, phosphorus, etc. These must all be removed, some by washing, but most of them by roasting, or "smelting," in blast furnaces, after which it is called pig iron. This of course requires large quantities of fuel.

It is these things and also the position of the ore that must be taken into consideration in estimating the amount of iron in the country. If ore yields a large per cent. of iron in smelting, with a small amount of waste, it is, of course, far more valuable than if the amount of iron in every ton of material taken from the ground is small.

In all minerals, the relation of supply to price is marked. The cost of labor and of power is exactly the same whether ore yields fifty-five tons of pure iron to the hundred, or whether it yields only thirty tons, but the price received is little more than half.

So if the price is low, it may cost more to mine and smelt the one hundred tons of earth than will be paid for the thirty tons of iron that the low-grade ore would yield. So the lands that produce only thirty tons to the hundred will never be mined till the price of iron is so high that it is above the cost of producing—that is, till it can be worked at a profit. [Pg 171]

The Lake Superior iron found in Minnesota is usually more than fifty-five per cent. pure iron. That is, if a hundred tons of earth be mined, more than fifty-five tons of pure iron would be obtained from it. This is the highest grade of ore. Some ore is mined that yields only forty tons or less. There are vast quantities, billions of tons, of iron ore in the United States, that would yield less than thirty tons of iron to the hundred. These low-grade ores and the ones known to lie so deep in the earth that the cost of mining them is more than the finished products of iron, are classed as "not available," that is, they can never be profitably mined under present conditions. But we must remember that as the higher grade ores are exhausted it will become necessary to use the lower grades, and that prices will steadily advance as a result.

Iron is sometimes found almost directly under the ground, at other times deep in the earth. That which is found just below the surface is, of course, mined much more easily, more safely, more cheaply, and with far less loss than that which requires deep

mining. Such conditions are found in the Lake Superior region, and there is almost no loss at all, the low-grade ores being piled up at one side where they can be easily reached in case of need.

On the other hand some iron mines now in operation are as much as two thousand feet in depth. In these mines, as in coal mines, pillars are left to support the rock above. A roof of the iron ore is often left also. The low-grade ore is left in the ground and no effort is made to preserve it for future use. These constitute the principal waste in iron mining. [Pg 172]

The pure iron of the ore is separated by washing out the clays and soft elements, but the harder substances must be smelted by means of heat. In the beginning this was done by charcoal, which is still used in Sweden. The latest method is to employ electricity manufactured by water-power, but most of the iron smelting in this country has been done by coal. Every ton of iron smelted requires its portion of coal for firing. If low-grade fuels in gas-producer engines, or water-power can be used it will be a great aid in conserving coal.

If a limited supply of rather low-grade iron exists near a coal region, it can often be mined profitably, when, if it be far from an abundant fuel supply, it must be shipped to distant blast furnaces. The cost of shipping causes ore containing a small percentage of iron to be classed as "not available."

Sometimes a large company with many mines has several varieties of ore of different strength and hardness. If these can be mixed to produce a medium grade by adding a small amount of high-grade ore to a large amount of lower grade, the value of the product will be doubled. [Pg 173]

Sometimes, too, the by-products can be made extremely profitable by manufacturing large amounts when the expense of undertaking the work is too great to be attempted with a small amount. So if iron mines are owned by a small company much ore may be classed as "not available" that could be used by a large company. All these things must be considered in estimating the iron resources.

The first smelting of iron ore in this country was done at Lynn, Massachusetts, in 1645, using the low-grade bog-ores and smelting with charcoal from the surrounding forest.

Now if we look over an iron map of the United States we shall find that there are four hundred and eighty blast furnaces, but that only nine of them are west of the Mississippi River and most of these are in Missouri. The greatest of all the iron regions now lies in upper Michigan and Minnesota. This furnishes eighty tons out of every one hundred mined in the United States, but the smelting is done along the southern shores of Lake Michigan. The reason for this is that the iron region itself is far distant from a cheap fuel supply. Pittsburg, Pennsylvania, has been the great iron city of the United States on account of its nearness to great supplies of both coal and iron. Birmingham, Alabama, is the heart of the great smelting region of the South. [Pg 174]

The iron is divided into districts as follows:

(1) The Northeastern, comprising the states of Vermont, Massachusetts, Connecticut, New York, New Jersey, Pennsylvania, Maryland, and Ohio, supplies a little more than five per cent. of the iron mined in the United States.

(2) The Southeastern, containing Virginia, West Virginia, eastern Kentucky, and Tennessee, North and South Carolina, Georgia, and Alabama, gives us twelve per cent. of our iron.

(3) The Lake Superior district, containing the northern parts of Michigan, Minnesota and Wisconsin, supplies more than eighty per cent.

(4) The Mississippi Valley district contains western Kentucky, and Tennessee, Iowa, Missouri, Arkansas and Texas. This region furnishes less than half of one per cent. of the total supply.

(5) The Rocky Mountain district contains Montana, Idaho, Wyoming, Colorado, Utah, Nevada, New Mexico, Arizona, western Texas, Washington, Oregon and California; and all this great region now supplies but a little more than one per cent.

The official report, which is as thorough as can be made but is naturally subject to

mistakes, gives the amount of available iron, that is, that which can be mined under present conditions, as nearly five billion tons. [Pg 175]

Let us see how long this may be expected to supply the demand.

Before 1810 the amount of iron ore produced was so small as to be scarcely worth considering. From 1810 to 1870 a little less than fifty million tons were mined, from 1870 to 1889 nearly 154,000,000 tons, and from 1889 to 1907, 475,000,000 tons, or altogether nearly 680,000,000 tons. The production has been found to double itself about every nine years. In 1907 alone it was 52,000,000 tons or about one-thirteenth of all that has been mined.

In 1880 we used 200 pounds of pig-iron for every man, woman, and child in the country; in 1890, 320 pounds; in 1900, 390 pounds, and in 1907, 696 pounds. According to the rule of increase, by 1916 we shall be using 104,000,000 tons a year; by 1925, 208,000,000, and by 1934, 416,000,000 tons, and if the same rate of increase should continue, by 1940 we should have required for our use in the meantime, six billion tons. But we have less than five billion tons of what is now classed as available ore, which means that before that time (when the school-boys of to-day are business men) we should have exhausted all our good and cheap ore, and be obliged to depend only on the low-grade ores, the cost of which will be very great. [Pg 176]

Unlike coal, the forests, and the soil, there is no great and entirely useless waste of iron. But the uses of iron are so many and so varied, and the supply of high-grade ores which can be cheaply mined is so small in proportion to the needs of the future, that we should in all ways lessen the drain on it by substituting other cheaper and more plentiful materials when possible.

The chief use of iron is for the carrying of freight. Here are some figures given by Mr. Carnegie. Moving one thousand tons of freight by rail requires an eighty-ton locomotive and twenty-five twenty-ton steel cars, or five hundred and eighty tons of iron and steel to draw it over—say an average of ten miles of double track with switches, frogs, spikes, etc., which will weigh more than four hundred tons. Thus we see that to move a thousand tons of freight requires the use of an equal weight of iron. The same freight may be moved by water by means of from one hundred to two hundred and fifty tons of metal, so that if freight were sent by water instead of by rail the amount of iron needed for this service would be reduced at least three-fourths, the amount of coal would be reduced not less than half, and at the same time the coal used in extra smelting would be saved. No single step open to us to-day would do more to check the drain on both iron and coal than the use of our rivers for carrying heavy freight. [Pg 177]

The next great use of iron is for buildings and bridges. The greatly increasing use of cement and concrete is reducing this and will reduce it still further. Cement is made from slag, or the refuse of iron ore—the clays and shales—and the cost of this valuable product is little more than the former cost of piling it away. By making the useless slag into cement the cost of iron production is lowered and at the same time the drain on the iron is lessened.

A large use of steel of the highest quality is for battleships, cannon, and war supplies. If the great nations of the world would agree to reduce their armament, one of the great drains on the world's iron, coal, and wood supply would cease, and these materials be put to improving the world.

The worst feature of it is that these war supplies are continually changing. They must be of the latest pattern, or they are of small value for fighting purposes. The construction of battleships differs greatly year by year, and the older ships are discarded to make place for newer and larger ones. It is said that our newest battleship alone could with a few shots destroy all of Admiral Dewey's fleet. The following is from a recent magazine article: [Pg 178]

"It is admitted by naval officers that the ships of ten years ago are of obsolete type and would be useless against the new vessels. It is admitted that within ten years or less the new types will in turn become obsolete, and will be useless against the type of vessel certain to be evolved. That is, as soon as a vessel costing millions of dollars leaves the docks, she enters into active competition for a place on the junk pile."

The greatest improvement that can be imagined in the iron situation will be in the

discovery and use of alloys or mixtures of iron with other materials. Steel, the strongest of all forms of iron, is an alloy of iron and carbon, and for various purposes these are further mixed with nickel and silicas. Many other alloys have been discovered within the last few years, and each makes possible new uses for iron requiring greater strength. One of the best of these is a mixture of iron and silicon, called ferro-silicon. Silica is one of the cheapest and most abundant materials of all the earth's products, so its combination with iron will greatly lengthen the life of the iron supply; and it is probable that in the future combinations of other materials will yield better and cheaper metals than any thus far produced. [Pg 179]

The amount of metal which can be reworked is constantly increasing. Most of the iron factories remelt large quantities of old iron, to be used with the new, and this will lessen each year the demand on the ores. It is also possible that new deposits of iron ore will be found and these will greatly increase the supply. But from the whole iron situation we may draw the following conclusions:

First, the amount of iron remaining in the ground is very uncertain. It may be more, or it may be less, than the present estimate.

Second, if the estimates are nearly correct, and if the present rate of increase continues, all the high-grade ores will be exhausted by the time the small boys of to-day are the business men of the nation.

Third, the best methods of reducing the drain on the supply are, (a) The use of old iron as a mixture; (b) Carrying a part of the freight by water to reduce the amount of iron required by the railroads; (c) The larger use of concrete and cement to take the place of steel in buildings; (d) Lessening the amount used for war; (e) The use of alloys. This opens a large and promising field for invention. (f) More care in preserving articles made of iron. This is a practical thing for every person in our country to do. Every farm implement, or tool, that stands out in the rain or is left without shelter during the winter, every article carelessly lost or broken, has its part in making conditions worse. All that are well cared for help to make the iron supply last a little longer. [Pg 180]

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CHAPTER VIII

OTHER MINERALS

GOLD

Iron, in its usefulness to man, stands in a class to itself; but there are dozens of other minerals that have their part in the comfort and convenience of our daily life. Most of these, however, are found in comparatively small quantities and have few uses.

The minerals which are in constant use by nearly all people and that are found abundantly in the United States, are gold, silver, copper, lead, zinc, and the elements used in manufacturing building materials.

Gold is valuable chiefly because it has been made the standard of money value of the world. Africa produces one-third of the world's supply, next come the United States and Australia, producing almost equal amounts, Russia and Canada each produce a limited amount, and various other countries together produce about one-sixteenth of the whole. (In the statements of the gold supply of the United States the territory of Alaska is included.) [Pg 182]

Gold is not found alone but contained in quartz rock or sand. The method of taking gold from the rock is first by blasting, and afterward grinding the rock in a stamp mill, which reduces it to powder, after which the gold is separated by refining processes. The gold which occurs in the sand, gravel, or clay soil, is washed out. When done on a small scale this is called "panning." The larger operations of this kind are called "placer" and "dredge" mining. There is also a considerable amount of gold obtained as a by-product from copper mining.

Generally speaking, quartz mines are in the mountains and placer mines in the river valleys. Placer mining by powerful water pressure, called hydraulic mining, destroys the banks, and also fills up the river beds with masses of rock and gravel. Some of the large rivers of California have been made unfit for steamboat traffic, and serious damage has been done to the harbor of San Francisco. For this reason hydraulic placer mining has been stopped by law. This has greatly lessened the gold production of California.

In 1907, the United States produced $94,000,000 worth of gold. Of this, Colorado produced more than any other state. Next in their order come Alaska, California and Nevada. Each produced from $15,000,000 to $20,000,000 worth. Together they [Pg 183] furnished nearly four-fifths of the entire supply. The remaining one-fifth comes from Utah, South Dakota, Montana, Arizona, Idaho, and Oregon, with very small amounts from the southeastern states, the two Carolinas and Georgia, New Mexico, Washington, and Wyoming. South Dakota has the most profitable single gold mine in the United States. It has produced nearly $60,000,000 in gold, and is now turning out about $5,000,000 worth a year.

The United States has many unworked gold mines, "gold reserves" they are called, whose value can not in any way be exactly estimated. The value of the placer mines can be better judged than that of the lode or quartz mines. The placer mines are chiefly in Alaska and California. These mines may yield gold to the amount of a billion dollars. There are lesser, but important resources of placer gold in Montana, Idaho, and Oregon.

The placer gold mined in 1907 was valued at $24,000,000, and it is thought that about this quantity can be supplied for a long time.

The amount of gold yielded in the reduction of copper ores was about $5,500,000. It is probable that this amount will be gradually increased, and can be relied on to last many years. From the lead ores a little over $2,000,000 worth of gold was taken. This [Pg 184] will probably slowly decrease for the next ten or twenty years. From gold and silver-bearing quartz mines $55,000,000 was taken.

No calculation can be made as to the amount of gold contained in quartz mines. New discoveries are always probable and many new mines are opened up each year, but their value can only be estimated as the work in them progresses.

Just how long they will last nobody knows, but it would seem that their decline is far off. The government report says, "Unless very important new discoveries are made it is thought unlikely that the production of gold in the United States will rise much above $110,000,000; nor is it likely that it will sink below $60,000,000 within a long period of years."

The amount of gold used in the United States is about equal to the production. Nearly $80,000,000 is coined into money, and about half as much is used in the arts,—that is, for jewelry, tableware, in dentistry, in bookbinding, and various chemical processes. The quantity used in the arts has doubled since 1900. In 1907 the stock of gold coin in the United States, according to the Director of the Mint, was $1,600,000,000, which is almost exactly one-fifth of the gold coin of the world.

The production of gold is rapidly increasing. Since 1850 we have mined three times as much gold as in all the previous time since the discovery of America. Such rapid [Pg 185] production greatly shortens the life of the gold supply. When the gold fields of southern Africa were first opened they were said to be inexhaustible; but they have been mined so rapidly, and the supply has proved so far short of the first excited estimates that experts say that the entire region will be almost exhausted within twenty years. The loss of gold in mining and refining is comparatively small. In extracting gold from the cheaper ores the percentage of loss is large; but as only a small part of the gold is gained in this way the total loss is relatively small. By other

methods ninety-five per cent. or more is saved. In many cases the loss is too small to be considered.

Unlike other minerals little gold is destroyed by use. It is melted and remelted, all scraps are used, even the sweepings from the mint and from manufacturing goldsmiths' shops are saved and the gold used. The waste of the world's gold and silver would be much greater but for the use of paper money, bank checks, and notes. Their very general use keeps the gold as a reserve, held in banks and storage vaults much of the time. If it were in constant use, the continual rubbing together of the coins would mean a no less steady, though slight, wearing away of their surface. This is very noticeable in old silver coins, which are kept in more constant circulation. [Pg 186]

SILVER

The conditions in regard to silver are entirely different from those of the other resources. The production of silver is not increasing, in fact, the mining of silver alone is decreasing and the reason is not because the supply is lessening, but because the price is too low to make a larger working of the mines profitable, and the supply is kept down to the level of the demand. A great number of silver mines have been closed for the last few years. The production could be greatly increased at any time to meet an increased demand.

The highest production was in 1902, but there have been only slight changes since 1895; the production being a little less than 60,000,000 ounces, or about one-third of the world's supply—Mexico being the only other great producer. In many countries with a small supply the output is growing less each year on account of the low price, and the difficulty of competing with the United States.

The states now producing the most silver are Colorado, Montana, and Utah; each of these produces about one ounce out of every five ounces mined. Most of the remainder was produced by Nevada, Idaho, Arizona, and California. [Pg 187]

Although nearly 60,000,000 ounces were mined in 1907 only one and a half million ounces were mined for the sake of the silver alone. The rest was obtained as a by-product in the mining of gold, lead, copper and zinc, or, as is often the case, it was distinctively silver ore, but could not be profitably mined unless some other ore could be obtained at the same time.

The richer regions seem to have been exhausted, and as the process of extracting the ore is expensive the lower grade ores will probably be held for several years till prices advance. A great silver region has recently been opened in northern Canada. This contains immense quantities of very rich ore, and will probably keep the price down for many years.

So the care and conservation of silver is not an important issue for the people of the present generation. As silver is now obtained largely as a by-product, there is almost no waste.

The United States sends considerably more than half of its silver to other countries, principally to India and China, which use much silver coin, but have little in the way of silver resources. The amount used at home is divided between coinage and manufacture. The quantity coined varies greatly from year to year, eight million ounces being about the average. For manufacturing, jewelry, tableware, chemicals, etc., about twenty million ounces, of which one-fifth is remelted silver, are used. The demand for silver in manufacturing has doubled since 1898, and may lead before many years to the reopening of the silver mines. [Pg 188]

COPPER

The conditions of copper mining are exactly opposite from those of silver. The Indians used almost no metal except copper, and for three hundred years white men used the old Indian mines and refined the copper by Indian methods. Better methods of mining copper and extracting it from the ores have been employed for the last fifty years, but within a dozen years the refining of copper has been revolutionized by electric methods. An enormous amount has been produced, but production has been kept down on account of the high prices. It is said that if the price could be reduced one-half, ten times as much copper would be used. Most of the uses of copper have

arisen in the last twenty-five years. Its greatest use is for electric wiring. Nothing can take its place, and the use is increasing astonishingly.

Copper is used largely in alloys. Bronze is an alloy of copper and tin, and its use has greatly increased in castings, fittings for buildings, tablets, and statues. [Pg 189]

A much more useful alloy is brass, made from copper and zinc. Brass is very extensively used for parts of machinery, engines, automobiles, and also for fittings for buildings. Sheet copper is used for sheathing for ships, for boilers, and for various chemical processes carried on by electricity or by acids. Very many of these processes have been discovered within ten or fifteen years, and have largely increased the uses for copper. One of the older uses of copper which is less common now was for cooking utensils. Copper is used by the government for coining one-cent pieces.

No single country compares at present with the United States in the production of copper, but if reports be correct there is enough copper in central Africa to supply the world for years to come. Next to the United States, Spain mines the largest amount at present, and Japan ranks next.

For many years the rate of increase was enormous. In 1845, 224,000 pounds were mined; in 1888, 226,000,000 pounds. Eight years later, in 1896, it had doubled; after another ten years, in 1906, it had doubled that quantity, and reached 918,000,000 pounds. In 1890 we were using three pounds of copper for every man, woman and child in the country. And in 1907, six and one-half pounds.

Michigan, Montana, and Arizona produce the bulk of the copper. Utah, California, Colorado, New Mexico, Wyoming, and Nevada each produce copper in amounts ranging from the 66,000,000 pounds mined in Utah to the 2,000,000 pounds mined in Nevada. It is probable that the use will not increase so rapidly in the near future. Much old copper will be remelted. [Pg 190]

There are large areas of copper lands which are now classed as "available" with copper at about its present price of thirteen cents a pound. If the world production should grow so great as to cause a decided drop in the price, much that is now considered available could not be mined at a profit, and the copper supply from this country would be greatly reduced. If, on the other hand, copper should rise to fifteen or twenty cents or higher, the amount of available copper land would be vastly increased. The report on the Conservation of Mineral Resources says in effect: "The copper resources of the United States are believed to be large enough to allow for a number of years for a demand increasing at the rate of 30,000,000 pounds a year. Should this demand continue for a long period the scarcity would be felt and result in a rising price, which would open up a market for these low-grade ores and also cause the use of other metals, like aluminum, to take the place of copper whenever possible."

There is no great waste in the mining of copper, but in the extraction of copper from the ore the waste is often as much as thirty per cent., and it is not easy to avoid this on account of the chemical changes that take place. [Pg 191]

LEAD

The United States produces about one-third of the lead in the world. The remainder comes from Spain, where the production remains about the same from year to year; from Germany, where in spite of higher prices production is growing less; and from Australia and Mexico, in both of which the supply is rapidly decreasing.

These facts show that the lead resources of the United States will be drawn on heavily in the future. The production of the United States increased from about 70,000 tons in 1880 to 365,000 tons seventeen years later, and if continued the yearly production by 1920 will amount to 580,000 tons, or more than a billion pounds.

The principal lead-producing states are Missouri, Idaho, Utah, and Colorado. In Missouri it is probable that the present rate of increase could be kept up for at least fifty years. The other states could keep up the present production for many years but could not greatly increase it without exhausting the supply.

As with most mineral resources in the United States, it is only the richest ores that are now drawn upon (except where lead is a by-product extracted with some other ore). If prices would advance, so as to make the low-grade ores profitable, the amount [Pg 192]

of our resources would be greatly increased.

There is little waste in the mining or smelting of lead ores, and the slag, the waste, is always ready to be used again. In the refining and concentrating of lead the loss often amounts to as much as fifteen per cent. or twenty per cent. The best way to prevent final loss is to store all refuse until such time as the reworking becomes profitable. Improvement in methods has been great in the last fifteen years but more economical methods everywhere will be one of the necessities of the future. We can see that the lead resources of the United States are not large and that when our own supply is exhausted we can not turn to the rest of the world.

The waste in mining is not large, and most of it can not be avoided at present prices; so that for the conservation, which we see is so important, we must turn to the uses of lead. The most necessary of these is for lead pipes in plumbing. Another use is for war supplies, which not only makes heavy drains on our stores of coal and iron, but also on lead, which is much less plentiful.

One ton out of every three produced in the United States is used in the manufacture of white lead and consumed as paint. This, of course, is entirely lost, and it seems that some other material might be used, instead of so valuable a mineral, especially when the resource is not abundant. White lead is used more than any other substance for paint, although zinc white has come into considerable use in the last few years. No other nation uses lead paint to such an extent as does the United States, partly because no other nation could afford so general a use of such an expensive material, and partly because so many wooden buildings are erected. By using brick, stone, or cement, of which we have practically an unending supply, to take the place of wood, our store of which is rapidly disappearing, we could avoid much of the drain on our mineral resources which are used for paint.

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As production and price advance a greater quantity of lead is remelted. About 25,000 tons are returned to use each year.

ZINC

Zinc is a whitish metal. It is used in galvanizing iron to prevent its rusting. It is used also in the manufacture of white paint, which consumes about one ton out of every six tons mined. This, of course, is permanently lost, but the price and its value as a resource is much lower than lead. This takes more than half of the entire product. The remainder of the output is about equally divided between brass and sheet zinc. All these uses are extremely necessary and it is believed that the production of zinc will rapidly increase for many years.

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The United States is the largest producer, Germany ranks second. Large amounts are mined in Australia, and very large deposits, entirely undeveloped, are said to exist in Africa. In 1880, the United States produced 23,000 tons of zinc; in 1907, 280,000 tons. This indicates the rapid rate at which we are increasing our use of zinc.

If the same rate should continue, in 1920 we should be using 475,000 tons, or almost a billion pounds, and if zinc oxide should take the place of white lead in painting to the extent that now seems probable, the quantity would be still further increased.

Missouri is by far the heaviest producer of zinc, having a little more than half of the output. New Jersey ranks next, then Colorado, Wisconsin and Kansas. Some of the other western states each produce small amounts. Most of the pure zinc ore is mined at a depth of from one hundred and fifty to two hundred and fifty feet and occurs in sheets, but a large part of the ore is a by-product obtained from the reduction of other ores. In New Jersey the zinc alone is found in a single region, where it was estimated a few years ago that there were eight million tons, of which two and a half million tons have been mined since 1904. The zinc in Missouri, Wisconsin and Kansas is found alone or underlying lead deposits, while that of the western states is almost always found in limestone, and is mixed with silver, copper, lead, and, more rarely, gold. In these states there has been little attempt to discover zinc; in fact, ores containing zinc have been rather shunned because of the difficulty in extracting them.

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It is thought that our resources of zinc, especially in the West, have just begun to be developed, and that the supply, even at the present rate of increase and at present prices, will last many years. However, with increasing use for the product, we can not

be sure of supplies for more than a generation; and in view of the importance of zinc it becomes necessary to inquire into its wastes.

In no mineral is the waste more startling than in zinc. In Missouri it is necessary to leave supporting pillars as in coal mining. This can not be remedied, as the use of timbers is too expensive, but it causes a heavy loss. In the West, owing to the expensive treatment and shipment, much of the low-grade ore is left in the ground. In refining the loss is enormous, often as much as forty per cent. In order to produce zinc at a low cost there must be a heavy loss of metal. Better plants and equipment for refining, and the saving of all refuse for later use will be necessary if we are to conserve the zinc supply for future generations. [Pg 196]

MISCELLANEOUS

The supplies of many of the materials used in buildings and bridges, such as stone, gravel, clay, cement and lime are so great that they appear inexhaustible, and need of care in their use is not so much to be considered as is their development to take the place of other resources.

In the past they have not been used freely because wooden buildings have been so much cheaper; but cement, concrete and brick are now manufactured much more cheaply, on account of improved methods, while the price of lumber has been increasing rapidly. Within the last ten years, the value of cement manufactures has increased nearly six times. In 1900 we used seventy pounds of cement for each person; in 1907, two hundred and twenty-eight pounds. The value of brick and other products made from clay has doubled in the same period and is now $160,000,000, while the value of building-stone quarries is three times as great as it was ten years ago. There are many reasons why these materials should take the place of wood; as they are stronger, more durable, do not require paint, and are so much less liable to loss by fire.

The waste of minerals used in building is due to improper and reckless methods of taking them from the ground and preparing them for market and in careless methods in manufacturing. [Pg 197]

Of such minerals as quartz, grindstone, millstone, emery stone, mineral paints, talc and salt, there seems to be enough to meet the needs of the future as well as the present. Such supplies as sulphur, asphalt, magnesia, borax, and asbestos, as well as coal and iron, are not very plentiful. If used carelessly, they will be exhausted in a few years; if wisely, they may be expected to last beyond the limits of the present century.

Our supplies of quicksilver, antimony, graphite, mica, tin, nickel, platinum, and many minerals less well known, as well as our petroleum, natural gas, copper, gold, silver, lead, zinc, and phosphate rock will be almost exhausted well within the present century unless large new deposits are discovered.

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CHAPTER IX

ANIMAL FOODS

GRAZING

Food is of two classes: vegetable, which comes directly from the earth, and animal, which has fed on vegetable life. This is, of course, a more concentrated form of food, and much less of it is needed to sustain life.

For the plentiful supply of vegetable food we must depend upon the fertility of the soil, as we have seen. Our animal food can not be classed among our natural resources, but as a product of them, and requires the same care and wise use.

In the early history of our country natural animal food was abundant. Fishes swarmed in the sea, lakes, and streams. Wild turkeys and other game birds, deer, and bison formed a large part of the food of our forefathers. But these have been gradually disappearing. We have caught and destroyed so many fish that we have only a fraction of our former number. The game birds have disappeared either because they have been killed in great numbers or because their nesting-places have been destroyed. Of the big game nothing is now left except in a few remote regions, and it is growing less plentiful each year.

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Although large quantities of fish and game are marketed every year at certain seasons, they form a small fraction of the animal food required in the country, and we must now depend for most of our animal food, not on that which was at first given us for a natural resource but on that raised by man.

The poultry—the chickens, ducks, geese and turkeys; the cattle, beef and dairy, the hogs and the sheep that are raised in such vast numbers have taken the place of wild game. The cultivated varieties have higher food value, and are far more satisfactory, since they are ready for use at any time.

The conservation of our animal food resources presents a different problem from any other. It is true that we have wasted and exhausted our natural food supplies, but we must remember that to a certain extent their preservation was neither possible nor desirable. They have been driven out by advancing civilization.

Wild birds and animals leave as the forests are cut out, destroying their natural homes. Many of them can not be kept in captivity, so this supply never could have been regulated. It was necessary to destroy some of them to insure man's safety, and others were needed for his use. But we can take their places with other animals which are better fitted for our food, and it is the task of keeping up a sufficient supply of these on the most suitable land and under conditions that will yield the best results, that constitutes the problem of the conservation of our animal food resources.

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The raising of poultry and live stock on a large scale is a separate occupation, usually followed in a scientific manner and it is not of that industry that we need to speak, but rather of the benefit to every farmer and to the dwellers in small communities, of raising at least a part of the animal food used by the family.

Every farm has some bits of unoccupied land that can be fenced off for poultry. The gleanings from the fields will supply their food, and they will furnish meat and eggs for the family throughout the year, with enough left to sell to provide other comforts.

Live stock, cattle, sheep and hogs, as well as goats, horses and mules, are profitable to every farmer. Many farms have woodland; land that overflows at some seasons, and so is unfit for raising crops; or some rocky unproductive land where stock can be raised more profitably than anything else, and if every farmer would use all the land not suitable for farm crops for pasture land the problem of an abundant meat supply, of dairy products and of fertilizers to enrich the soil would be largely solved. Some farming experts advocate letting each field in turn be used for pasture every five years, because the stock raised on it is equal in value to any other farm crop, and because the rest and fertilization almost double the value of the succeeding year's crop.

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In the West and Southwest there are large tracts of public land untilled. Much of the land can never be used for agricultural purposes, because it is arid or mountainous.

This land is well adapted to grazing and the government has allowed free use of it to stockmen as pasture lands.

These public pasture lands are called "ranges." In the early years when this part of the country belonged to Mexico, the ranges were traversed by Indians and Mexicans who tended the herds of wild cattle and horses, raised mostly for their hides. But in

the last quarter of a century the business has fallen into the hands of Americans who have introduced better breeds of higher value. In California, Arizona, and New Mexico there are now on the open ranges eight million sheep, nearly three million cattle and nearly a million horses, worth much more than one hundred million dollars. Wyoming and Utah have great sheep ranges and do much to keep up the wool supply. On Texas, [Pg 202] with its great cattle ranges, we depend for a large part of our beef and leather. In all these states where stock is fed on public land, there are many questions as to ownership of animals, rights of rival rangers, and other points to settle.

In some of these states the government has set aside national forest reserves. Within these is much good grazing land. In order that the government may have some revenue from the land, a regular price has been set on these forest lands. The charge is forty cents a year each for horses, thirty-five cents a year for cattle, and twelve cents for sheep. The land is properly divided, so that each kind of stock has suitable pasture. Each person who pays this tax is given a certain range and no one else is allowed to use it. There is sufficient pasture for each so that it need not be too closely cropped. A man may lease the same range year after year, may put down wells to supply his stock, live on it, and do many things to improve it.

The forest rangers who patrol the forest to watch for fires or for timber thieves also protect these stockmen in their rights and prevent trouble about grazing privileges.

Outside the forest reserves the grazing is free, but the advantages offered by this system are so great that nearly all rangers now wish to use the forest reserves. [Pg 203]

As each ranger has his land assigned to him and no one else can use it, the grass is not overcropped as it often is in regions outside the forests. If pasture is good, so many herds are pastured there that soon the grass is all trampled down and eaten off. Large areas are so badly injured that it will not naturally resod itself.

Cattle men are asking that the same rules that apply to the national forests be applied to other public lands, so that the pasturage may be improved and each man may have protection in his rights.

If all grazing lands could be thus leased, it would give the business a far more permanent character, better breeds of stock would be raised, and individual owners would direct their efforts to improving both stock and pasture, after the manner of stock raisers on private lands.

So large a part of our animal food, our wool, our leather and many smaller needs depend on this industry, that every effort should be made to encourage it, and to provide the wisest laws and best methods both for conserving and developing it.

In conclusion it is interesting to note that the Department of Agriculture is making a study of food birds and animals in various parts of the world, and trying to domesticate them, to add to the variety of our food supply. The quail, the golden [Pg 204] pheasant and some species of grouse among birds, and two or three species of deer, including the reindeer, appear to be adapted to domestic life in this country, and may, before many years, become a part of the animal industry of the United States.

FISHERIES

One who has never seen the big catches of fish brought in by a mackerel fleet or visited a wholesale fish market can have little idea of the importance of that industry, nor of the immense amount of food that is taken from the waters of the United States every year.

The word fish is made to include not only fish proper, but oysters, clams, scallops, lobsters, crabs, shrimps, and turtles. Fish is liked by most persons, is more easily digested than meat and is nourishing. As a food resource, it is different in many respects from any other. It does not exhaust the soil, nor take from the earth anything of value, the food of fishes consisting of water plants and animals that are not used by man in any other way. Fish also purify the water in which they live, and so cause a great, though indirect, benefit.

It is so plainly the wise thing, then, to keep our rivers stocked with fish and to use them for food only, that it seems that this valuable resource has been more seriously and unnecessarily wasted than any other. [Pg 205]

Fish are wasted on inland streams in the following ways: (1) By dynamiting. If a charge of dynamite be exploded on the bed of the river, great numbers of fish, killed by the shock, rise to the top of the water and can be taken. This practice was quite common at one time, but is now prohibited by law in several states.

(2) By seining. A seine or net is placed entirely across the stream, and all the fish which come down the stream are caught. In several states seining is not allowed at all. In others it is allowed only at certain seasons. And in still others the meshes of the seine must be large enough to allow all fish below a certain size to slip through.

(3) By catching with a hook, (angling) more fish than can be used or catching small fish and then throwing them away. This is a very common custom among sportsmen, but should be prohibited by law. From a certain small inland lake, it is said that during the entire season an average of five thousand fish a day is taken. These are almost all caught by summer residents, and it is unlikely that a large per cent. of them are eaten. In a few years the lake will be exhausted, and will cease to furnish fish for the people of the community, and there will, of course, be no more fishing for the sportsmen. [Pg 206] Equal waste is going on all through the summer at every resort where good fishing is to be had. Some states have laws regulating the size of the fish that may be caught and the number that one person may take in one day, and all states should have such laws.

(4) The worst waste of our fish is caused by turning large quantities of sewage or refuse from factories into streams. All the fish for miles up and down a river are often destroyed in this way. As we have seen, this is only one of the bad results of allowing such refuse to drain into streams; every state should have strict laws prohibiting it.

From the waters of the New England states more than five hundred and twenty-eight millions of fish are taken each year. Here are the great cod, mackerel, and herring fisheries. From the Middle Atlantic states, the great region for oysters, lobsters and other sea food, come eight hundred and twenty million more; one hundred and six million come from the South Atlantic states; one hundred and thirteen million, including the much sought tarpon and red snappers, come from the Gulf states; two hundred and seventeen million are caught in the Pacific states, including the great salmon catches; ninety-six millions are taken from the Mississippi River and its tributaries, and one hundred and sixty-six millions, largely salmon, from Alaska. The [Pg 207] Great Lakes, with their pickerel, and other fine fresh-water fish furnish one hundred and thirteen millions and the small inland waters at least five millions more.

When they are taken from the waters the 2,169,000,000 pounds of fish caught in the United States are worth $58,000,000, but by canning, salting, and other processes of preserving, the value is greatly increased.

Fortunately, there is a method of conserving our supply of fish and not only preventing it from growing less, but of greatly increasing the number and improving the quality. The United States government has a thoroughly well organized fish commission, and many states and counties and even private clubs carry on the same work, which is a general supervision of the fish supply.

The government maintains stations which are regularly engaged in hatching fish, keeping them until the greatest danger of their being destroyed is past, and then placing them in various streams all over the country. These fish are always of good food varieties, and are carefully selected to insure the kind best suited to the stream, as to whether it is warm or cold, deep or shallow, clear or muddy, fresh or salt, slow and placid, or swift and turbulent, for each kind of stream has certain varieties of fish that are especially adapted to it. [Pg 208]

With all these things taken into account, stocking only with the best food varieties, if a state has laws which require that a stream be kept free from sewage and refuse, that no tiny fish be taken from the water, and that only a stated number can be taken in a day by a single person, hundreds of small streams, ponds and reservoirs all over the country may be made to yield food supplies for the entire community near by.

Governor Deneen, of Illinois, in urging that streams be improved for navigation, says, "No estimate of the benefits to flow from stream development would be complete without allusion to the fisheries which have been established on the Illinois River, largely by restocking with fish from hatcheries. The fisheries located on that stream are second in value only to those of the Columbia River.

"Our experience thus far indicates that the food resources of the water may be brought up in value to those of the land. The Illinois valley contains 80,000 acres of water area and yields a fish product worth ten dollars an acre each year, very nearly all profit. The average value of the land product near by is a little less than twelve dollars an acre, and the labor, cost of seeding, and exhaustion of fertilization of the land must all be counted before there can be a profit."

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In 1908 the United States Fish Commission distributed nearly two and a half billion of young fish and half a million fish eggs. These were such excellent varieties as salmon, shad, trout, bass, white fish, perch, cod, flat fish and lobsters.

The Bureau of Fisheries has its fish-hatching stations, its boats for catching fish in nets and its tank cars for carrying the young fish and eggs to the streams that are to be stocked.

Some of the most important work is interestingly described in a history of the Bureau of Fisheries issued in 1908. Among other things it tells of the lobster industry in both the Atlantic and Pacific Oceans. Lobsters are not found naturally in the Pacific, but shipments of lobsters have been made from the Atlantic coast. At the last shipment, after carrying them across the continent packed in seaweed, more than a thousand lobsters were safely placed on the bed of the Pacific Ocean.

On the Atlantic coast the lobsters were rapidly disappearing when the work of artificial "planting" of young lobsters and eggs began. The results can be seen now, for more lobsters are being caught each year, and the price to users is growing less as the supply becomes more plentiful.

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The shad and the salmon are considered the finest of all fish for eating. Both are salt-water fish and both have the habit of going some distance up fresh-water rivers to lay their eggs. No eggs are ever laid in salt water. The mother fish goes up beyond where the tide comes in, so that the baby fish may have fresh water, which is necessary for them. Salmon and shad are never caught in the sea, but in the rivers, where they go in large numbers to lay their eggs in the spring. This, of course, means the destruction of both fish and eggs,—the present and future supply.

Shad eggs, or roe are sold in large quantities. The Bureau of Fisheries has planted three thousand millions of young shad in streams along the coast, and the eggs from which these fish were hatched were all taken from fish that had been caught for market, and would have been totally lost if the Bureau had not collected them from the fishermen.

Shad have been planted in the Sacramento and Columbia Rivers flowing into the Pacific Ocean. From these two sources they have spread until now they are found as far south as Los Angeles, and as far north as Alaska, a coast line of 4,000 miles, and it is said that more shad could now be caught in the Sacramento and Columbia Rivers than in any other water courses.

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In addition to supplying the streams with young fish, it is necessary to leave a part of each river clear so that some of the fish may find their way up-stream to deposit their eggs. The salmon have been almost driven out from the waters of New England, except in the Penobscot River, where they have been kept by the watchfulness of the Fisheries Bureau. It is believed that the entire salmon industry in Maine would be wiped out in five years if fish culture should cease, and in the West, where the drain on the salmon for canning purposes is so heavy, artificial planting is used very largely to keep up the supply.

The experiments with oysters are full of interest. In Chesapeake Bay, where the best natural oyster beds were found, the demands on them were so great that the supply began to fail. In 1904 only a little more than one-fourth as many were produced as in 1880. The natural oyster beds were then marked and set aside as public fishing grounds.

These are to be used by whoever wishes but under strict protective rules. All other ocean beds may be planted with oysters by any one who leases the privilege from the state, and the right to collect the oysters from a certain bed belongs to the person who leases it as fully as does property on land.

Louisiana had a small number of natural beds. About ten years ago the planting of oyster beds began, and soon 20,000 acres had been planted. Conditions were

particularly favorable, and within two years after the eggs or spawn were placed it was found that oysters three and a half to four inches in size had grown in quantities [Pg 212] of 1,000 to 2,000 bushels per acre. For a long time it has been the custom of fishermen to fatten their oysters by transplanting them to new beds where the food is abundant, and in a short time the oysters are much plumper, it takes fewer of them to make a quart and they also sell at a higher price, because they are of the finest quality.

These rich food beds are not plentiful, and many dealers are compelled to put small oysters on the market. The Bureau of Fisheries has made a study of these food beds, and by using fertilizer, such as farmers use on their land, have been able to make such beds of sea-plants grow where they do not naturally exist. These experiments have been tried only a short time, but the results have been entirely satisfactory, and it is hoped that before long, rich oyster beds may be made to grow in any part of the ocean where oysters will thrive.

In the Great Lakes the fishing is so heavy that it is probable that the supply of perch and white fish would be very low by this time if fish-culture had not been carried on to so great an extent. White fish, lake trout, pike and perch may be hatched in such large numbers as to keep the fisheries up to their present yield.

Another important work of the Fisheries Bureau is to keep up the supply of cod for the great fisheries on the New England coast. For the last twenty years profitable [Pg 213] shore cod fishery has been kept up on grounds that had been entirely exhausted before and also where cod had never been found before. At the wharves, government officers from the Fisheries Bureau board the fishing boats when they come in and take the eggs from the fish. These are taken to the government hatchery and either the eggs or the young fish are put back into the sea, and so keep up an unending supply.

Alaska is one of the most important fishing regions of the world. For this entire Territory, the United States paid Russia $7,200,000 and many thought that the money was practically thrown away, since it apparently bought for us nothing but barren, ice-bound shores. But since it became a part of the United States, Alaska has yielded fishery products alone amounting in value to $158,000,000—twenty-two and a half times the price paid. Of this, $49,000,000 came from the fur seal fishery, $86,000,000 from salmon and $23,000,000 from other fish.

About $1,500,000 worth of sponges are now taken from Florida waters each year. Naturally the failure of the industry would be a serious loss to the state. But the natural sponge beds are being rapidly exhausted, and the Bureau of Fisheries is convinced that the continuation of the sponge fisheries must depend on artificial [Pg 214] planting. Sponges can be produced from cuttings at a cost much less than that of taking them from the natural beds.

Rhode Island has been successful in cultivating soft-shell clams and in increasing the area of its clam beds.

The Mississippi and its branches are subject to great floods in the early spring and occasionally in summer. After these floods millions of fishes are left in small pools some distance back from the river. These pools gradually dry up; the larger fishes are caught and the smaller ones die. The state and National Fish Commissions are now collecting these fishes in large numbers, and using them to stock ponds and rivers in other parts of the country.

They are used to supply many parts of the West and South and there is much greater demand for them than the Commissions can meet. Not that there is a lack of fish, for millions are left to waste because the Commissions can not distribute them rapidly enough to save them. If large storage ponds could be established to collect and keep the fish during the flood season, so that all the time might be spent in collecting fish during the overflow, and they could be sent out later, the amount of fish saved would be increased many fold. [Pg 215]

The fish thus saved are being made to serve another useful purpose. Pearl buttons are made from the shells of mussels or fresh-water clams. This business, which is now worth $5,000,000, can not last many years unless some means of increasing the supply of mussels can be devised.

Now these men, who are always studying new plans, have thought of a wonderful

way in which to let the fish help in carrying on this work. They obtain the mussel eggs, and when they are hatched place them in the pools with the fish from the overflowed lands. The tiny mussel larvæ attach themselves to the fish and are carried to the rivers and ponds with the fish. Soon they are ready to drop to the bottom and find food for themselves.

In this way 25,000,000 mussels were carried last year to streams where mussels are known to thrive. If these mussel-bearing fish can be obtained by farmers having private fish ponds, the ponds can be drained each year and the mussels gathered, thus adding considerably to the owner's income, and also keeping up the pearl button industry, in addition to the food supply which he gains from the fish.

Enough has been said to show clearly how desirable and how possible it is to conserve and increase our fish supplies. With the coöperation of all who waste the fish at present, and those who might aid in stocking the streams, we could add greatly to the food supply of the nation at a less cost than in any other way. [Pg 216]

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CHAPTER X

INSECTS

If we look at a watch, we see that one wheel can not move until the one next in order to it moves, and that, in turn, must be set in motion by another wheel. In the same way nature adjusts itself in its various parts. Before man enters a region, the balance is perfect. Plants crowd each other out of the way, the weaker giving place to the stronger; then insects come to destroy them. These insects are destroyed by birds, small mammals or other insects. The birds are killed by animals and other birds, which in turn are the food of larger animals. And so through all nature runs this law of balance; nothing increases in too great a proportion.

But when man comes, he thinks only of his own needs and wishes and begins at once to upset the delicate balance. Year after year, he plants large fields of a single crop, and, calling other plants weeds, because they hinder the growth of his grain, he drives them out entirely. The insects that feed on these plants, finding no food, soon disappear, while the ones which feed on the farmers' crops, finding food so plentiful, are able to increase in great numbers. They increase all the more rapidly because man, not knowing or not caring to know who his real helpers are, has killed and driven away the birds that would feed on them. [Pg 218]

In order to readjust matters, he must learn how to destroy the insects, or he can not have crops. Both the plant enemies, the weeds, and the insects are always trying to bring about nature's balance again by driving out the over-abundant field crop, so he must constantly fight them in order to secure his harvest.

In no country is more harm done by insects than in the United States. The losses to live stock and to plants, both growing and stored, resulting from insects are greater than all the expenses of the National Government, including the pension roll and the yearly maintenance of the army and navy.

Immense as is the value of our farm products, it would be much greater if it were not

for the work of these insects. Careful calculations indicate that this loss will amount to not less than the enormous sum of $1,100,000,000 annually and probably far more. The loss is usually estimated at ten per cent. of the crop, but often is much heavier than this, and many indirect losses are not taken into account in this table, though we shall speak of them later. [Pg 219]

Most insects pass through four stages: (1) the egg; (2) the worm or larvæ; (3) the chrysalis, cocoon, or pupa; (4) the full-grown insect or imago. Butterflies, moths and beetles are examples of insects in this last stage.

As eggs, they are, of course, harmless, and during the chrysalis state they lie perfectly inactive and are harmless, but many of them are very destructive when they are worms or larvæ, others do most injury in the full-grown state.

The insects that man has most reason to dread are: (1) Plant-lice, tiny insects with soft bodies, usually green. They attach themselves to the stems and leaves of plants and suck their juices, leaving them to wilt and die. They are found on many kinds of plants—on corn, wheat and other grains. They also flourish on garden vegetables and flowers.

(2) Scale insects. These are flat and appear to be only a scale on the stem or fruit. They are usually covered with a hard crust-like covering and are found on trees and bushes. They are usually the color of the bark on which they are found.

(3) Worms and caterpillars are soft-bodied, the bodies being in segments, and either smooth or covered with short bristly hair. They spend nearly all their time in eating, and do immense damage to the foliage of trees and vegetables and to fruit. The adult is a moth or caterpillar. This class is among the farmer's worst insect enemies. [Pg 220]

(4) Borers attack trees and tough-stemmed plants. The eggs are laid on the stems, and after hatching, the larvæ bore into the stem or under the bark, causing the foliage to wilt and die. We are all familiar with what we call "worm-eaten" wood, with canals that have been eaten by these borers running through it in all directions. This completely ruins some of the best forest trees for lumber, and makes one of the greatest losses of the forests.

(5) Beetles are insects in the adult state. They have hard, shiny wing-covers. Many of the borers are beetles, and there are other varieties which do great damage, though other kinds are useful to man in destroying harmful insects.

(6) Bugs have their mouth parts prolonged into a sharp beak with which they puncture the skin or bark, instead of chewing the leaves, as do beetles. Flies, gnats, and other similar insects do not usually injure vegetation so much as do some other classes of insects, the principal damage being done to fruits; but they have been found to be the cause of some of the most serious diseases in both man and the lower animals.

The Department of Agriculture divides the injuries done by insects into classes according to the products injured, and in the list they place first the injury done to cereal crops. [Pg 221]

The insects which damage the corn crop most seriously are the corn-root worm, which feeds on the roots of young corn, causing it to fall over and die, and which sometimes takes the whole corn crop of a large region. The next most important is the boll-worm or ear-worm. Most persons have seen this worm in the ears of sweet corn; ninety ears out of every hundred contain a worm which destroys from one-tenth to one-half the corn. Some years every ear in large regions is infested. In the South the field corn is attacked as badly as the sweet corn, but in the great corn states the injury is much less. Even here, however, the total loss is very great.

Almost equally important is the damage wrought by the chinch-bug, which is also one of the greatest pests in wheat and oats.

Every year in different sections of the country, bill-bugs, wire-worms, cutworms, cornstalk borers, locusts, grasshoppers, corn plant-lice and other insects, destroy millions of bushels of corn.

Of the cereal crops, wheat suffers most from insects. Of the large number of insects that attack wheat, the three important species are the Hessian fly, the chinch-bug and

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the grain plant-louse or green-bug. [222]

The Hessian fly has been known to destroy as much as sixty per cent. of all the wheat acreage of a state. Fortunately, this damage is done early in the year, so that when whole fields are destroyed they can be replanted with other crops and only the cost of seed and labor is to be counted as a loss. But more often the field is only partly destroyed by the fly; it is not necessary to replant, but the yield is small, often not more than one-third. Some years the loss from the Hessian fly is very heavy, at other times comparatively light, yet there are few years when the loss is less than ten per cent. of the total crop from this insect alone,—which meant last year a loss of 72,500,000 bushels.

The chinch-bug is responsible for the loss of five per cent., or one bushel out of every twenty. It attacks the straw, causing the heads of wheat to fall over and wither away.

The injury done by the green-bug comes just as the wheat begins to ripen, the tiny green creatures attaching themselves in great numbers to the heads of the wheat. Other insects which prey on the wheat crop are grasshoppers, the wheat midge, cutworms and army-worms.

If it were not for the attacks of these various pests the wheat crop would be at least one-fifth larger than it is. Instead of 725,000,000 bushels, it would be 870,000,000; which, with wheat at a dollar a bushel, amounts to a loss of nearly $150,000,000. [Pg 223] Further, the world loses all this valuable bread-stuff.

Oats, rye and barley suffer far less than wheat from insect ravages but they are all attacked by the same insects, and on the whole, much damage is done to them each year.

Hay, clover, and alfalfa have their enemies which destroy a considerable part of the crops. The locusts and caterpillars, the army-worms and cutworms are the best known, but the tiny leaf-hoppers, which spring up at every step as we walk across the path or lawn, and the web-worms and grass-worms and grubs which work about the roots of the plants all do their part in lowering the production.

The principal insect enemies of cotton are the cotton boll-weevil, the boll-worm, the cotton red spider, and the cotton-leaf worm. The control of the boll-weevil is considered one of the most serious problems confronting the agricultural men of the country. In the first years after its introduction, it reduced the cotton crop fully fifty per cent., and was the cause, not only of serious loss to the farmers, but of the closing of the cotton mills in New England, of a scarcity of cotton cloth and a decided rise in its price. The boll-weevil is a beetle about a quarter of an inch in length. This little beetle eats into the heart of each boll, which soon falls to the ground. [Pg 224]

The cotton-leaf worm formerly caused heavy damage, as much as $20,000,000 to $30,000,000 a year, but the loss has been greatly reduced by the war which farmers have waged against it. It is still estimated at from $5,000,000 to $10,000,000.

The boll-worm is chiefly destructive in the Southwest and does damage to the extent of $12,000,000.

All in all no article of commerce is more seriously affected by insect ravages than cotton, on account of its necessity, and the fact that it can be raised only in certain regions.

Tobacco is one of the principal crops in several states and it suffers heavily from insect damage. The large, showy tobacco-worm and the tiny tobacco-thrips cause serious injury to the leaves.

Sugar-cane has its insect enemies which take on an average one stalk out of every ten raised in this country, and reduce the crop in the same proportion.

The cranberry is another valuable commercial plant that has been greatly affected by an insect known as the cranberry fruit worm, but by spraying, growers have been able to reduce the damage from sixty per cent. down to fourteen per cent. [Pg 225]

Garden vegetables suffer more than anything else from insects. Potatoes are attacked by two species of insects, both destructive unless held in check. One is the reddish brown blister-beetle. The eggs are laid on the ground, and do not become adult insects until the second year. The other is the striped Colorado beetle, the eggs

of which are laid on the under side of the leaves, and develop into adults in a short time. Two broods of this beetle develop in a single season. Thus it may be seen that the two are entirely different, though they are often supposed to be the same. The Colorado beetle, by the immense damage it was doing to a necessary food crop, first led to a regular method of fighting insects in this country. This potato-bug is not feared as it was in the past, since farmers have learned to control it in a great measure, but they have only been able to lessen the evil, never to drive it out completely.

Other insects that destroy garden vegetables are the well-known green cabbage-worm, the harlequin cabbage-bug, the cabbage hairworm, the asparagus-beetle, the squash-bug, the squash-vine borer, the striped cucumber or melon beetle, the melon aphis, the corn boll-worm, the cornstalk borer and many others.

In addition to these insects that attack special plants, all vegetables are preyed on by the grub-worm, the cutworm, the aphis and various tiny hoppers. [Pg 226]

The grub-worms which work about the roots of plants are, in the adult state, the June-bugs or cock-chafers which fly about our lights in the spring and early summer, and which themselves do considerable damage by eating leaves of trees and bushes.

Orchards and small fruits suffer heavily from insect pests, both on account of the direct loss and on account of the expensive treatment. There are several hundred insects which ravage fruit trees, attacking the roots, trunk, foliage and fruit.

Among these are the scales, of which there are many species, but of which the most widely known and dreaded is the San Jose scale, so called because San Jose, California, was its starting place in America. It is the only one of the scales which, if not checked, will, in two or three years, completely destroy the tree on which it feeds. It attacks the citrus fruits, orange, lemon, grape-fruit, and the apple, pear, and peach as well as small fruits, particularly currants.

Among the many varieties that do serious damage are the black olive scale, plum scale, hickory scale, locust scale, frosted black scale, red oak scale, the cottony maple scale, greedy scale and oyster shell scale. [Pg 227]

The woolly aphis injures the roots of our fruit trees; the trunk and limb borers, the peach tree borer, the apple borer, all stand ready to assail the life of the entire tree. The various leaf worms attack the life of the tree also. The grape-leaf skeletonizer eats every particle of green from the leaves, leaving only the veins. The canker-worms and the destructive tent-caterpillars also cause the death of many fruit trees.

Of insects which attack the fruit, the list is long. The codling-moth of the apple causes a greater money loss than any other enemy of fruits. Various estimates of the loss have been made, and in general it is believed that it causes the loss of one-fourth to one-half of the apple crop of the United States each year.

The plum-curculio attacks nearly all stone fruits. Its natural food plant is probably the native wild plum, and the plum continues to be its favorite food, consequently this fruit suffers most from the attacks of the insect. In years of short crops very little fruit remains on the tree to ripen. But peaches, apricots and cherries also suffer heavily, and apples and pears in a less degree.

The insects which injure the hardwood forest trees are principally the leaf-eaters, such as the gypsy and brown tail moths, which have almost stripped the New England shade trees, and done great damage to the forests; the elm leaf beetles and the numerous borers, both beetles and grubs, which from eggs laid in or just beneath the bark, hatch into larvæ which burrow into the wood, destroying its usefulness for lumber. Among the borers which do most injury in destroying valuable timber are the hickory-bark beetle, the bark-boring grubs which kill oak, chestnut, birch and poplar trees, the locust borer, the chestnut timber-worm and the Columbian timber beetle. [Pg 228]

All these represent the loss from insects to the growing product; but when it is stored, there is seemingly no less danger of attack by a different class of insects. These include grain weevils and beetles, flour-moths, the small fruit and vinegar flies, buffalo-moths and dozens of others.

After these comes the loss to man and animals from insects. The cattle tick alone, through the dreaded Texas fever, causes a loss of from $10,000,000 to $35,000,000 in

various years. The ox warble also preys on cattle and causes a loss of probably $3,000,000 more. The buffalo-gnats, gadflies, and other flies do on the whole a large amount of damage each year.

Man has only discovered in recent years how serious a factor in his own health as well as comfort, is the insect life about him. This subject is more fully treated under the subject of health, so for the present we need only say that flies, mosquitos and other insects are supposed to cause some of our most serious diseases, and to be the indirect cause of the loss of hundreds of millions of dollars and many human lives each year. [Pg 229]

Having thus summed up the damage done by insects, let us see what may be done to prevent their spread and if possible drive out the most harmful species entirely. Unfortunately, that seems almost impossible; so far all man's efforts have only resulted in saving a larger or smaller proportion of the various crops each year.

In insect control we turn first to the natural means of destruction. Chief among these means are birds,—of which we will speak in another chapter,—snakes and toads.

Toads live entirely on insects and catch large quantities of them. It is estimated that a single toad is worth almost twenty dollars a year in a field or garden. English gardeners are said to pay high prices for them and to keep as many as possible in their gardens. Toads will eat almost any kind of insect, are absolutely harmless, and should be carefully protected.

There is one class of insects which, so far from being an enemy to man, combines with him to kill the harmful insects. Among these are the black beetles which feed on cutworms and other larvæ which injure the roots of plants. Lady-bird beetles destroy large numbers of plant-lice, and the Asiatic lady-bird has been found to be the natural destroyer of the San Jose scale. These little insects are now being hatched in this country, and it is hoped through them to stamp out the pest. A number of larger insects prey on the smaller ones. [Pg 230]

Other insects, such as the Hessian fly, the green-bug or spring grain aphis, the army-worm and various species of grasshoppers are killed by tiny parasitic insects whose eggs are laid in the bodies of the larger insects, but which, after being hatched, feed on them.

To these natural methods of control man has added others. Cultivation is one of these methods. As insects flourish when given an unusually large amount of food of a particular kind, and starve when that food is taken away from them, so rotation of crops proves to be one of the best means of getting rid of those insects which can not travel far for their food. Farmers who practise rotation of crops are much less troubled with insects that injure the roots of plants than those who do not.

One of the best means of preventing damage from the Hessian fly is to sow a narrow strip of wheat all around the edges of the field several weeks before the main crop is to be sowed. The flies will gather in this strip and lay all their eggs in the early wheat. Just before the main crop is sowed, the narrow strip is plowed up and thoroughly harrowed and the larvæ perish for want of food. [Pg 231]

The best known means of getting rid of grasshoppers is to destroy the eggs. This should be done by plowing and harrowing all roadsides, ditch banks, uncultivated fields and grassy margins around fields in the fall or winter.

Fall harrowing and deep spring plowing will prevent many of the bugs and beetles which spend the larval state in the ground from hatching. This method will also destroy the plum-curculio in orchards.

In attempting to control the boll-weevil of the cotton fields, it has been found that the best method to pursue is the simple one of planting the crop very early, so that the cotton passes the danger stage before the insects emerge, and removing all the plants in the fall.

Worms that infest fruit can be checked for the following year by fall plowing in the orchard and by destroying the decayed fruit as it falls. The farmer who lets his decayed fruit lie on the ground is preparing for a heavy crop of insects to eat his fruit the following summer.

Fruit and forest trees are both protected by a burlap band or a band of "sticky" fly-paper placed around the tree, to prevent insects from crawling up. [Pg 232]

The use of poison in destroying insects is now the one most generally and successfully employed by farmers and fruit growers.

Poisons may be liquid or dry. The liquid is made by mixing with water, and for large plants and trees is put on with a spray or force-pump that carries the poison to every part of the plant.

Some insects, such as beetles, caterpillars and grasshoppers, chew the leaves or stems of plants, and the poison may be applied to their food; but others, such as plant-lice, scale insects and all bugs suck the juice, usually from the stem or bark. Poisons must be applied to the insect itself to be effectual in this case.

These are some of the insect poisons most in use:

Paris green, which will kill all insects that chew the leaves, may be used in small quantities in gardens by mixing one-half teaspoonful to a gallon of water, or in large quantities with one pound to one hundred and fifty or two hundred gallons of water.

White hellebore is used to destroy currant worms and is usually dusted on dry.

Pyrethrum is used as a spray, mixing one ounce to two gallons of water, to destroy cabbage-worms and many other garden insects. If the dry pyrethrum powder is blown from a bellows into a tightly closed room, it is said to destroy all the flies. [Pg 233]

Bordeaux mixture is made by dissolving four pounds of copper sulphate in hot water and mixing with an equal quantity of a solution made by mixing four pounds of lime with water. This is then mixed with fifty gallons of water. Paris green is sometimes added. This mixture is largely used in orchards and for destroying insects on a large scale. It is also useful for curing diseases of plants.

An excellent spray for orchards both for removing fungous diseases and scale insects is a home-made lime-and-sulphur solution. Enough for spraying a large orchard is prepared as follows:

Add three gallons of boiling water to fifteen pounds of lime. Then add ten pounds of sulphur and three gallons more of hot water. Allow this to boil about twenty minutes in its own heat, then add enough water to make fifty gallons of the mixture. Dilute with water in the proportion of one part of the solution to seventy-five of water.

Small quantities are made by using a fractional part of this recipe.

Whale-oil soap dissolved in water and used as a spray is an effective remedy for the San Jose scale.

Kerosene emulsion is used to kill the insects which suck the juices of plants and trees. It is made by mixing a half-pound of hard soap with one gallon of hot water and stirring into it, so as to mix thoroughly, two gallons of kerosene oil. This may be kept on hand for use, and is mixed with ten parts of water to one of the emulsion. [Pg 234]

For use in large orchards force-pumps operated by compressed air and drawn by two horses are used. The spraying should be done as soon as the blossoms drop, and many orchards are sprayed three times in a season, but the work should never be done while the trees are in blossom. Vegetables should be sprayed many times through the season.

A careful study of these methods of control, adapted to the various plants and the insects which prey on them, with the natural enemies of insects encouraged and protected, would go far to prevent the wide-spread and serious damage now affecting our crops, our vegetables, our orchards, and our forests.

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CHAPTER XI

BIRDS

Birds give us pleasure in three ways: by their beauty, by their song and by their usefulness in destroying animals, insects or plants which are harmful to man.

But although they are among man's best friends they have been greatly misunderstood, so that to the many natural enemies that are constantly preying on birds, we must add the warfare that man himself wages on them, and the cutting down of their forest homes. This work of bird destruction has gone on until all the best species are greatly reduced in numbers and some species have been almost entirely driven out.

To see how serious a matter this is we must study the food habits of birds, and we shall find that although the different species eat a large variety of food, in almost every case their natural food is something harmful to man.

The large American birds, the eagles, hawks, owls and similar kinds, are called birds of prey because they feed on small birds and animals. Some of these are of the greatest benefit to the farmer, while others are altogether harmful. Another large class of birds lives almost entirely on injurious insects and this class is entitled to the fullest care and protection from the farmer.

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Still another class lives largely on fruits, wild or cultivated, and on seeds, which may be either the farmer's most valuable grains, or seeds of the weeds that would choke out the grain.

It can not be denied that birds often do serious damage through their food habits; but the great mistake that has been made in man's treatment of birds has been in hastily deciding that if birds are seen flitting about fields of grain they are destroying the crop. A better knowledge of their food habits will lead to proper measures for destroying the harmful kinds and protecting the useful ones.

Successful agriculture could hardly be practised without birds, and the benefit to man, though amounting each year to millions of dollars, can hardly be estimated in dollars and cents, since it affects so closely the size of our crops, the amount of timber saved for use in manufactures, and even the health of the people.

Here again we see the careful balancing that runs through nature; how carefully each thing is adjusted to its work. Naturally the balance between birds, insects and plants would remain true, no one increasing beyond its proper amount. But when man begins to destroy certain things, and to cultivate others, this balance is seriously disturbed. The birds that destroy weed seeds being killed, weeds flourish in such vast numbers as to drive out the cultivated crops. The birds which destroy mice, moles, gophers, etc., being killed, these animals become a nuisance and cause serious losses. If insect-destroying birds are driven out, the farmer will be at the mercy of the insects unless he employs troublesome and expensive methods of getting rid of them. Certain favorable conditions cause large numbers of birds to gather in a small region and they

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become a pest. Very careful observation has shown that in nearly every case the favorite food of the birds is something which is not valued by man, and if this food is provided, the farm grains and fruits will not be seriously molested.

Few birds are altogether good, still fewer are altogether bad; most species are of great benefit, even if at the same time they do some harm. Some birds do serious damage at one season, and much good at another. The most notable example of this is the bobolink, which in northern wheat fields is loved no less for his merry song than for the thousands of weed seeds and insects he destroys; while in the South he is known as the reed-bird or rice-bird, the most dreaded of all foes to the rice crop. [Pg 239]

Flying down on the fields by hundreds of thousands these birds often take almost the entire crop of a district. The yearly loss to rice-growers from bobolinks has been estimated at two million dollars.

If crows or blackbirds are seen in large numbers about fields of grain they are generally accused of robbing the farmer, but more often they are busily engaged in hunting the insects that without their help would soon have destroyed his crop; and even if they do considerable damage at one season they often pay for it many times over.

Whether a bird is helpful or the reverse, in fact, depends entirely on the food it eats and often even farmers who have been familiar with birds all their lives do not know what food a bird really eats. As an example of the misunderstanding that is often found in regard to birds, when hawks are seen searching the fields and meadows, or owls flying about the orchards in the evening, the farmer always supposes that his poultry is in danger, when in reality the birds are quite as likely to be hunting for the animals which destroy grain, produce, young trees, and eggs of birds.

In order to correct such mistaken ideas the Department of Agriculture has made a most careful and accurate study of the habits of birds, and it is the results of these observations that are recorded here. [Pg 240]

Field workers from this Department who have observed the habits of the principal birds that live among men, have watched them all day and from one day to another as they fed their little ones, and, to be more certain of their facts, they have examined the stomachs of hundreds of birds, both old and young, to learn exactly what each bird had eaten. In this way they have proved absolutely that many species that are supposed to eat chickens, or fruit or grain, in reality never touch them, but are among the farmer's best friends.

Among other things they have learned that while they are feeding their young, birds are especially valuable on a farm. Baby birds require food with a large amount of nourishment in it that can be easily digested. Almost all young birds have soft, tender stomachs, and must be fed on insects; as they grow older, the stomach or gizzard hardens and is capable of grinding hard grain or seeds. The amount of food required by the baby birds is astonishing. At certain stages of their growth they require more than their own weight in insects. And the young birds are to be fed just at the season that insects do the most injury to growing crops of grain and young fruit and vegetables.

Birds vary so much in the kind of food eaten, not only by different varieties of the same species, but by the same birds at different seasons, that it is necessary to make a careful study of each bird to know whether, if he is sometimes caught eating cultivated fruit and grains, he helps in other ways enough to pay for it. [Pg 241]

When insects are unusually abundant, birds eat more than at other times and confine themselves more strictly to an insect diet, so that at such times the good they do is particularly valuable.

Birds of prey may do harm in a particular place, because in that region mice, rabbits and other natural food are scarce, and they are driven to feed on things that are useful to man, while in places where their natural food is plentiful the same birds are altogether helpful.

In the same way, birds which naturally eat weed seeds frequently find these almost altogether lacking where the farms are most carefully cultivated, but in their place are fields of grain whose seed also furnishes them desirable food. Is it any wonder, then, that, their natural food being taken from them, they turn to the cultivated crops? The

fruit eating birds seem always to choose the wild fruits, but where these are not to be had they enter the orchards and soon become known as enemies of the farmer.

[Pg 242] A careful examination of the harm done by birds leads to the belief that the damage is usually caused by a very large number of one species of birds living in a small area. In such cases so great is the demand for food of a particular kind that the supply is soon exhausted, and the birds turn to the products of the field or orchard. The best conditions exist when there are many varieties of birds in a region, but no one variety in great numbers, for then they eat many kinds of insects and weeds, and do not exhaust all the food supply of one kind. Under such circumstances, too, the insect-eating birds would find plenty of insects without preying on useful products, and the insects would be held in check, so that the damage to crops would be slight.

The following are examples of the food eaten by birds and the good that they thus accomplish to man:

During the outbreak of Rocky Mountain locusts in Nebraska, a scientific observer watched a long-billed marsh wren carry thirty locusts to her young in an hour and the same number was kept up regularly. At this rate, for seven hours a day, a nest-ful of young wrens would eat two hundred and ten locusts a day. From this he calculated that the birds of eastern Nebraska would destroy daily nearly 163,000 locusts.

A locust eats its own weight in grain a day. The locusts eaten by the baby birds would therefore be able to destroy one hundred and seventy-five tons of crops, worth [Pg 243] at least ten dollars a ton, or one thousand seven hundred and fifty dollars.

So we see that birds have an actual cash value on the farm. The value of the hay crop saved by meadow-larks in destroying grasshoppers has been estimated at three hundred and fifty-six dollars on every township thirty-six miles square.

An article contributed to the New York *Tribune* by an official in the Department of Agriculture estimated the amount of weed seeds annually destroyed by the tree sparrow in the state of Iowa on the basis of one-fourth of an ounce of seed eaten daily by each bird. Supposing there were ten birds to each mile, in the two hundred days that they remain in the region, we should have a total of 1,750,000 pounds, or eight hundred and seventy-five tons, of weed seed consumed in a single season by this one species in the one state. In a thicket near Washington, D. C. was a large patch of weeds where sparrows fed during the winter. The ground was literally black with the seeds in the spring but on examining them it was found that nearly all had been cracked and the kernels eaten. A search was made for seeds of various weeds but not more than half a dozen could be found, while many thousands of empty seed-pods showed how the birds had lived during the winter. [Pg 244]

In no place are birds more important than in the forests, where they save hundreds of thousands of dollars worth of valuable timber each year. In forests there can be no rotation of crops and no cultivation, and spraying, which keeps down the insect pests in the orchard, is impossible here because of the expense. It would not pay to spray two or three times a year a crop of timber that requires a lifetime to grow. So in the forests the owner must depend entirely on birds for his protection. How great the destruction of our forests would be is shown by the fact that the damage at present is estimated at $100,000,000, in spite of the fact that a vast army of birds is working tirelessly, summer and winter, to devour the insects! The debt of the forester to the birds can hardly be estimated.

A full variety of birds will thoroughly protect a farm and orchard. The sparrows will destroy the weed seeds; the hawks and kites, flying by day, will catch the meadow mice and other small mammals, and the owls will pounce on those that venture forth at night. Of the insect-eating birds, the larks, wrens, thrushes and sparrows search the ground for worms, eggs and insects under leaves and logs everywhere. The nuthatches, vireos, warblers and creepers search every part of the tree, while the woodpeckers tap beneath the bark for grubs and worms. The fly-catching birds catch their insect food on the wing among the trees and branches, and, last of all, the [Pg 245] swallows skim high in the air and catch the few insects that rise high above the tree-tops.

Thus each family has its part of the work and the good they do is almost too great to calculate. Without this check it would be impossible for any green thing to flourish. So vast an amount of food is required to feed the great army of insects that the task

would be impossible in any other way.

A brief description of some of the common birds and their food habits is given here that farmers may know their friends, and that people everywhere may learn to protect the useful birds and drive out the few that do the mischief.

All of these observations have been made by field workers from the Department of Agriculture, and no statement has been made that has not been proved by the examination of many bird stomachs at different seasons.

Highest of all in the list come the bluebirds. They are among the most beautiful of our native birds, with their bright blue coats and soft red breasts. They are sweet singers, and are among the first to return in the spring to tell us of the return of summer. In addition to this they have many good habits and absolutely no bad ones. More than three-fourths of their food consists of insects,—beetles, grasshoppers and caterpillars. The remainder is weed seeds and fruit, but there were no reports of cultivated fruits being eaten by bluebirds. On the contrary they eat the most undesirable of the wild fruit, chokeberry, pokeberry, Virginia creeper, bitter-sweet and sumac, as well as large quantities of ragweed seeds. Other birds are equally useful but none combines usefulness with so much beauty and sweetness of song.

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The tiny wrens are another class of wholly useful birds. Their food consists almost entirely of insects with a very little grass-seed. They search every tree, shrub, and vine for caterpillars, spiders and grasshoppers.

Sparrows are almost equally useful. The tree sparrow, song sparrow, chipping sparrow, field sparrow and snowbird or junco are all great weed-seed destroyers. Many of them remain throughout the winter, when they feed entirely on the seeds of weeds. Each bird eats at least a quarter of an ounce of seeds per day, and they are often found by thousands in a region. At least a half dozen varieties of birds are feeding in the same ratio all over the country, reducing the crop of next year's weeds. During the summer they turn to a diet composed partly of insects and here again they help the farmer by eating the weevils, leaf-beetles, grasshoppers, bugs and wasps that infest his crops.

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The various species of swallows rank high as insect-eating birds. The tree, bank, cliff and barn swallows and the purple martins all eat small beetles, mosquitoes, flying ants and other high-flying insects, and the number destroyed is almost beyond our power to imagine.

The most important service performed by swallows, however, is in the South, where they migrate for the winter. There they feed largely on the cotton boll-weevil, one of the most destructive of all insects, as we have seen. The Department of Agriculture is urging strongly that farmers in the North protect the swallows so that they may winter in the South in large numbers to feed on the boll-weevil, which, if allowed to flourish, will affect not only the southern planters, but every user of cotton goods, and every one who profits in any way by the sale and manufacture of cotton goods.

Among swallows, the beautiful and graceful purple martin is most worthy of protection. Both North and South, the swallows are among the most useful of all birds to the farmer and fruit grower, and should be protected from English sparrows and encouraged in every possible way.

The seventeen species of titmice which inhabit the United States, and many of which remain all winter, are all insect eaters to a great extent, eating large quantities of tent-caterpillars, moths and their eggs, weevils, including the cotton boll-weevil, plum-curculio, ants, spiders, plant-lice, bugs and beetles. They also eat small seeds, particularly those of the poison ivy.

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The bush-tit feeds largely on insects that destroy grape-vines and on the black olive scale. Other species eat most of the scales which infest fruit and forest trees.

The rose-breasted grosbeak, while it eats a few green peas, is to be classed among the wholly beneficial birds, for it is the great natural destroyer of the Colorado potato beetle. In fact, it eats enough potato-bugs at a single meal to pay for all the peas eaten in a whole season. One family of grosbeaks, nesting near the field, will keep an entire patch cleared of potato-bugs throughout the season. In some parts of the country the grosbeak feeds largely on the plum scale, the hickory scale, the locust and oak scales and on the tulip scale, which is very destructive to shade trees. The black grosbeak is

another variety that deserves encouragement in every way, for it eats the chrysalis of the codling-moth that is so serious a foe to our apple crop. It eats also many other injurious insects, such as wire-worms, many of the most harmful of beetles, caterpillars, and scales.

Among the most useful birds, we must mention the phoebe, which nests near houses and lives almost entirely on harmful insects which it catches on the wing. [Pg 249]

Night hawks eat flying ants in great numbers, as many as eighteen hundred having been found in a single stomach. They eat insects that fly by night and are classed among our most useful birds.

Quails are almost unequalled as weed-destroyers. Throughout the fall and winter they spend the time destroying weed seeds. In summer they eat Colorado potato beetles, chinch-bugs, cotton boll-weevils, squash-beetles, grasshoppers and cutworms. The mother quail, with her family of twelve to twenty little ones, patrols the fields thoroughly for insects. Quails should be prized as among a farmer's most valuable helpers and protected at all seasons.

Similar in the good work it does is the meadow-lark. Grasshoppers, caterpillars and cutworms form a large part of its diet, and its vegetable food consists of weed seeds or waste grain.

King-birds are useful in protecting poultry and song birds from hawks, and are also great fly catchers, taking many beetles on the wing.

Doves eat great quantities of seeds of harmful weeds. They also eat some grain, but almost altogether after the crop has been gathered. Old damaged corn and single grains scattered along the roads are eaten, but there is no complaint of doves doing injury to fields of growing grain. [Pg 250]

The orioles are beautiful, are sweet singers, and no exception can be taken to their food habits. Caterpillars are their principal article of food, but plant-and bark-lice, spiders and other insects are also eaten. Orioles do not eat much vegetable food. They have been accused of eating peas and grapes, but there seems no evidence to show that this habit is general.

The food habits of cuckoos render them very desirable, since they eat hairy caterpillars, particularly tent-caterpillars, for which they seem to have an especial fondness, fall web-worms and locusts, besides other injurious insects, but they are accused of bad habits in relation to other birds, and can therefore hardly be classed among the wholly useful birds. Warblers and vireos are among the most helpful birds in an orchard, devouring large quantities of insects.

There is no class of birds concerning which it is more necessary that the farmer should be well informed, than the hawks and owls, since some of them are wholly good, and of the greatest possible benefit to him and the fruit grower, while others are extremely harmful in their food habits.

The harmful varieties live almost entirely on poultry and wild birds, and include the goshawk or partridge hawk and the Cooper hawk, which is a true chicken-hawk and should be recognized by all farmers at sight. [Pg 251]

The goshawk and chicken-hawk, in the amount of damage done, far exceed all other birds of prey. The sharp-shinned hawk rarely attacks full-grown poultry, but preys heavily on young chickens and song birds. In fact, it is known to eat nearly fifty species of our most useful birds. There is no question that these birds are a serious pest and should be destroyed, but they should not be confused with other members of the family which are among the best friends that a farmer has in keeping his farm clear of small enemies.

Owls and hawks eat the same class of food, the hawks flying by day and the owls by night. Owls remain North in winter, while hawks fly farther south.

The small species of both eat large quantities of insects, such as grasshoppers, locusts and beetles. The larger ones are the farmer's great protection against the meadow-mouse, the most destructive of all animals to farm crops. It tunnels under fields and eats the roots of grass, grain and potatoes, eats large amounts of grain and does even more damage by girdling young trees in orchards. Rabbits injure trees in

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the same way, often during the winter ruining an entire orchard in this manner. [252]

Squirrels, ground-squirrels, gophers, prairie-dogs, and other small animals do serious damage in the course of a year on almost every farm.

The rough-leg hawk feeds entirely on meadow-mice, but if the supply fails, it eats mice, rabbits and ground-squirrels, but in no instance attacks birds. Its cousin, the ferruginous rough-leg, lives largely on ground-squirrels, rabbits, prairie-dogs and pouched gophers. This species also never attacks birds, and neither do any of the four members of the kite family.

Another large class of birds,—the marsh-hawk, Harris hawk, red-tailed hawk, red-shouldered hawk, short-tailed hawk, white-tailed hawk, Swainson hawk, short-winged hawk, broad-winged hawk, Mexican black hawk, Mexican goshawk, sparrow-hawk, barn-owl, long-eared owl, short-eared owl, great gray owl, barred owl, western owl, Richardson owl, screech-owl, snowy owl, hawk-owl, burrowing owl, pigmy owl and elf owl—live mostly on destructive mammals, insects, frogs and snakes, but they eat some birds and some of them occasionally catch poultry. Young ones do much more harm than the full-grown ones, probably because they find poultry and birds easier to obtain than other food. These species all do great good on the farm and in the orchard and if their natural food is plentiful and the number of the birds of prey limited, they should be allowed to remain, even though they occasionally do harm; but they can not be allowed to increase greatly in a region without becoming a nuisance. [Pg 253]

In another class the golden and bald eagles, pigeon and Richardson hawks, prairie falcon and great horned owl do considerable harm, and the good and bad qualities about balance. In a poorly settled region, where there is plenty of natural food, a few of these birds will bring forth little complaint, but in a section where there are few ground-squirrels, prairie-dogs, gophers, rabbits and woodchucks, where poultry is raised extensively, and useful birds are numerous they will do great harm and farmers will usually want to keep them down entirely.

The gyrfalcons, duck-hawks, sharp-shinned hawk, Cooper hawk and goshawk live almost entirely on food that is desired by man,—poultry, game birds and many varieties of our best insect-destroying birds, and they eat almost nothing that is harmful to man. The numbers of these birds should be reduced as much as possible: but in general it may be said that the birds of prey—the hawks and owls—are among the most, if not the most, valuable birds that are engaged in helping the farmer by destroying the natural enemies of agriculture.

Among the smaller birds which do much good, but of which complaints are made because they eat some fruit and grain are the woodpeckers, including the flickers, cedar-birds, robins, cat-birds, thrashers, crows and blackbirds. [Pg 254]

The woodpeckers are the great natural protection of the forests by waging constant warfare on the wood-boring insects and ants beneath the bark where no other birds can reach them. They are equally useful in an orchard except that here man may only at great trouble and expense partly hold them in check. Downy woodpeckers are also great eaters of scales, and the fruit grower need not begrudge the red-headed woodpecker a meal of cherries or apples, especially as it will usually be found that it is the wormy fruit that is attacked.

The flicker or gold-winged woodpecker lives largely on ants, of which he eats immense quantities, seeking them not only in the trees but on the ground.

Robins are so well loved for their cheery song, for their friendliness to man, and their red breasts coming as a touch of color in returning spring, that except where they are present in great numbers, there is little complaint of the fruit they eat, even without taking into account the good work they accomplish as insect eaters. In fact only four per cent. of a robin's food is cultivated and a little less than half of it is wild fruit not prized by man. The remaining half consists of caterpillars, beetles, spiders, snails and earth-worms. [Pg 255]

The cat-bird is also known as a cherry-eater and he frequently helps himself from strawberry and raspberry patches. He eats a larger proportion of cultivated fruit than the robin, but about twice as much wild fruit, including the sumac and poison ivy. The cat-bird eats many injurious insects, which constitute only a little less than half of his food.

The cedar-bird is sometimes called the cherry bird, and is accused of being a great cherry-stealer, but an examination of stomachs showed that only nine birds out of one hundred and fifty-two had eaten any cherries and that cherries formed only five per cent. of the food of these few. There is even evidence that this bird prefers wild fruits, which form its principal food though it eats a few insects.

The crows and blackbirds are accused of many bad habits, such as pulling up young corn, destroying large quantities of grain and injuring much fruit by pecking holes in it which are later entered by insects. Crows eat fruit to some extent, but the greater part of it is wild. Both crows and blackbirds are accused of robbing the nests of other birds. Blackbirds are injurious chiefly because they gather in such large flocks that when they descend on a field they can eat a large amount of grain in a short space of time. The greatest good accomplished by the blackbird is in the spring when it follows the plow in search of grub-worms, of which it is extremely fond. It also does much good in destroying insects in the early summer, the young birds being fed almost entirely on insect food until they are grown.

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Of the crow, Doctor Merriam, who is at the head of this branch of work in the Department of Agriculture, says, "Instead of being an enemy of the farmer, as is generally believed, the crow is one of his best friends and the protector of his crops. True, during corn-planting time, the crow's bill is turned against the farmer during one month, and one month only is he his enemy. But during the other eleven months the crow is really working overtime for him. It eats thousands upon thousands of destructive insects and bugs every week, and when it comes to feeding its young, gives them a diet composed almost entirely of worms and insects that prey upon the crops."

Another government report says, "The crow should receive much credit for the insects which it destroys. In the more thickly settled parts of the country it probably does more good than harm, at least when ordinary precautions are taken to protect young poultry and newly planted corn from it." It is probable that in many parts of the country some farmers will find it desirable to reduce the number of crows and blackbirds on their farms.

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The brown thrasher is a beautiful singer and eats many insects, mostly injurious. It eats some cultivated fruits. It also eats a small amount of newly planted corn, but at the same time clears the field of May beetles. Altogether it is a useful bird but not one of the highest benefit.

There are a few species of birds of which but little good can be said, and which it may be desirable to attempt to drive out in many parts of the United States. Chief of these is the English sparrow. It is of a quarrelsome disposition and is much given to driving other birds from their nests. In some districts it has completely expelled some of the most useful kinds of birds. It exists everywhere in such numbers as to render it a nuisance, and it may be said to be the greatest pest among American birds. Its favorite food is dandelion seeds, and it destroys many thousands of seeds, but as the dandelion does no real injury this habit does not offset all the harm done. It also eats other weed seeds but the greatest thing to be said in its favor is that it feeds on the cottony maple scale. It is probable that in small numbers the English sparrow might be classed among the useful, or, at least, one of the only partly harmful birds, but there is no bird whose numbers it is more desirable to reduce.

The common blue-jay is accused of some very bad habits, among them eating the eggs and young of small birds. It is a fruit eater and also a grain eater and frequently robs corn-cribs and injures newly planted fields. However, it eats some insects, mice and other small enemies of the farmer and as it is nowhere very plentiful, and does not live in flocks, there is not much cause for complaint. However, its cousin, the California jay, has an extremely bad record. It is a great fruit eater, and devastates prune, apricot, and cherry orchards. It is a serious robber of the nests of small birds and hens, and though it eats some grasshoppers and a very few weed seeds, it is thoroughly disliked by western fruit growers. It should be greatly reduced in numbers. Another California bird that has gained a bad reputation is the house finch or linnet. It does serious harm in the cherry and apricot orchards, not so much by eating as by pecking at the fruit. It probably pecks, and thus destroys, five times as much fruit as it eats. As the bird is very abundant, it sometimes causes the loss of almost the entire crop of a small fruit grower. It does not deserve protection, for it eats the buds and blossoms of fruit trees and does little to compensate for all the harm done. Its best

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habit is eating woolly plant-lice.

No article on birds would be complete that does not dwell on the enormous destruction of birds for trimming hats. As one writer puts it, we pay eight hundred million dollars a year for hat trimmings, assuming the insect ravages to be due to the killing of our birds for millinery purposes. While this is exaggerated, it is undoubtedly true that this is the largest cause of the destruction of the birds of America. [Pg 259]

The Audubon society says that we, as a nation, use 150,000,000 birds a year for trimming hats alone and that this single item would save our crops from insect destruction and largely rid our fields of weeds.

If a few hundred dollars are stolen from a bank, the greatest efforts are made to catch the thief, and if possible to get the money back; but the great army of insects destroy each year, almost as much in money value as all the national banks in the country have on deposit, and this wholesale destruction might largely be prevented if every woman and girl took (and kept) a pledge not to use wings, breasts, or birds on her hats. There is no objection to the use of ostrich feathers, which are carefully plucked from the live birds. The feathers grow again, just as the wool grows on sheep that have been sheared. Neither is there any objection to using the feathers of the barn-yard fowls which are killed for food.

Only a little less is the loss caused by so-called "sportsmen," men who kill only for the pleasure of shooting, or who, because they like the taste of quail, shoot as many as they can in a day instead of only enough to satisfy hunger. Often a farmer sells for a very small amount the privilege of hunting on his farm, thinking he is making money when in fact he is losing ten dollars for every one he makes. [Pg 260]

The quail, sparrows and other birds on the farm are destroyed. As a result the weed seeds are not eaten and a big crop comes up in the spring. In the summer there are no quail on the farm to destroy insects. The insects and the weeds together make the crop poorer, and the owner feels that farming is growing less profitable, when in fact he has failed to take ordinary precautions to obtain a good crop by protecting the birds.

With the huntsman and his bag of birds we may class the small boy with his rifle or sling-shot. A single boy does little harm but all the boys in the country taken together do a grave amount of damage.

Last in the list comes the egg hunters, who by robbing nests can kill four or five birds at a time, simply for mischief. A party of boys can, by a day's sport, make a serious difference in the number of birds in a region where they are not plentiful and thus have a large share in damaging the crops.

If, then, birds play so large a part in the welfare of the farm and in turn in the prices of farm crops, fruit, lumber and cotton cloth, it is most desirable that every effort be made to reduce the numbers of harmful birds and to encourage the useful species. [Pg 261]

Many of the states now have excellent laws for the protection of birds; but without a large number of game wardens, it is difficult to enforce the laws closely unless the public sentiment is strongly against the killing of birds. Laws should be made to protect birds against the egg hunter, (except for the purpose of study, and then a license should be required), sling-shots should be prohibited, as they already are in many places. All hunters should be required to have a license, the number of birds killed by a single person in a single day should be limited, and certain birds should always be protected by law. These laws should be as nearly uniform as possible in all the states and there must be a desire on the part of all the people to see these laws obeyed.

The boys and girls should be banded together in the schools or in societies and pledged to protect birds and not to destroy them. The girls should pledge themselves not to wear birds for ornament.

Women's clubs might do much to popularize the movement for the protection of birds, and to that end should try to establish a sentiment among their members against their use for millinery.

All these agencies working together will make a vast difference in the number of birds, and as a result, in the good that they do, but the great work must be done by [Pg 262]

farmers themselves. They will need to protect themselves in certain ways against the harm done by many of the birds that on the whole are extremely useful.

To protect poultry from owls do not allow it to roost in the trees; to protect from hawks, keep the young ones near the house, and if possible cover their runways with wire netting.

To protect against grain eating, use scarecrows or put up a dead crow as a warning. Mixing seed corn with tar so as to coat it will prevent crows from pulling it up at planting time.

To protect against fruit eating, plant wild fruits. The best of all trees for this purpose is the Russian mulberry, which ripens at the same time that cherries do and is particularly relished by all fruit-eating birds. If planted in barn-lots, chickens and hogs will eat all the fruit that falls to the ground, making it serve a double purpose. The fruit of wild cherry, elder, dogwood, haws, and mountain-ash are eaten by birds, and if a farm be planted with such trees and bushes in the barn-yard, along the lanes or in some of those unproductive spots that are to be found on every farm, birds will be attracted to the farm and will pay well for themselves, and the farmer's crop of cultivated fruit will be protected. Birds themselves distribute many seeds, particularly of wild fruits. [Pg 263]

The farmer who keeps several cats must pay for it in the loss of birds, for birds will not nest where they are constantly watched by cats. Boxes for martins and other birds, bits of hay, horse-hair and string scattered about will often encourage birds to build about an orchard or farm. A wood-lot, besides paying in other ways, will afford nesting places for a large number of birds. To place a drinking and bathing place near the house is one of the best methods of attracting birds, which will use it constantly.

By all these methods and a little winter feeding with crumbs, apple peelings or waste fruit and grain, the farmer will be able to induce a good variety of birds to nest on his farm, and will receive in return great protection from the small mammals, insects and weeds that would lessen the amount of his harvests.

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CHAPTER XII

HEALTH

When we have improved our soil and replanted our forests and learned the most economical methods of mining our great deposits of coal, iron, and other minerals;

when we have made the waters do our work and carry our freight and water our waste places; when we have learned to care for our birds and our fishes, and taken measures to stop the ravages of insects; when we have preserved our natural beauties and increased them by planting trees, shrubs, and flowers, and filling unsightly corners; there still remains to be considered the greatest subject of all,—the people who are to enjoy this wonderful inheritance. If they were to be weak and sick, suffering from all kinds of diseases, dying in great numbers, all these things would count for little. But men and women, as they are learning how to conserve their natural resources, are thinking far more than ever before of health and how to keep it. It is necessary to think of these things, for as people crowd into cities, where they live a life different from that which nature intended, sickness and the death-rate increase greatly. [Pg 266]

Health, by which we mean the possession of a strong, well body, free from pain, should bring with it great power to work and to think and to benefit the world; and should also bring great happiness and enjoyment to the person who possesses it, for though sick people may be happy, and well people unhappy, yet it is a general rule that to be strong and well is the first great step toward being happy.

The question, "Is life worth living?" was once happily answered, "It depends upon the liver;" and it is true in both senses, for not only does happiness depend on what one gets out of life, but on good digestion. It is only the person who feels well who really enjoys life.

The person who can get up each morning able to do a day's work or have a day's enjoyment, is the one on whom we must depend for the world's work and invention. We seldom find a strong, vigorous mind in a weak body.

On the other hand, the invalid is the idle member of the family or the community. He can not find pleasure for himself nor do anything to help others, and not only that, but he must be cared for by others, thus taking the labor of the sick person himself and of his nurse. It is coming to be seen that this is a great waste of time, of money, of work, and of happiness, and people are determining that if these wastes can be stopped, it is well worth all the time and thought and money necessary to bring about the change. [Pg 267]

People everywhere are thinking about health, and because of this, Christian Science, the Emmanuel Movement and the various sects which practise faith or mental healing have sprung up.

Hospitals and health officers are doing much for the public health. Doctors themselves are changing their ideas and are teaching us not only how to cure but how to prevent disease.

Doctors are also seeking not only to prevent disease but to find new ways of treating it. They are discarding drugs in as many cases as possible, frequently using serums in which cultures from the disease itself are used for its cure.

Health means more ability to work, more means of learning, of accomplishing great things, more pleasures in every day that is lived; and so it is as important to preserve health, in order to enjoy life, as it is to prevent death. We can realize how few persons have perfect health by noting the common salutation "How do you do?" or "How are you?"

Serious sickness is such as renders a person entirely unable to work. Benefit societies have found that the average number of days of sickness per year from each person under seventy years of age is ten, of which at least two are spent in bed. [Pg 268]

About a million and a half people die each year in the United States, and it is estimated that twice that number, or three million persons, are constantly unable even to care for themselves. The effect of this is felt on the patient himself, in suffering, in loss of time in which he is unable to earn money, and in the amount spent for doctors, medicine, and nursing. It is felt on the family, in which the household machinery is thrown out while the wife and mother nurses the sick members of the family, or is herself too ill to work, or when the father's income stops on account of sickness.

The entire community suffers from the constant idleness of three million persons, as well as from the deaths which withdraw a still larger number of persons from actual work for a period of two to five days during the time of death and burial of the bodies of members of the family.

Then there is all the long train of small ailments, which do not make us seriously ill, often do not even keep us from work, but which do take away from the pleasure and enjoyment of life, which render work a burden instead of a delight, and lessen our ability to work by many degrees.

Not only this, but they all have within them the possibility of developing into serious diseases. Such lesser troubles are colds, headache, catarrh, dyspepsia, nervousness, neuralgia, sore throat, skin eruptions, rheumatism, toothache, earache, affections of the eyes, lameness, sprains, bruises, cuts, and burns. [Pg 269]

Civilization has brought us great blessings but it has also brought with it many dangers to health. Professor Irving Fisher of Yale says:

"The invention of houses has made it possible for mankind to spread all over the globe but it is responsible for tuberculosis or consumption. The invention of cooking has widened the variety of man's diet but has led to the decay of his teeth. The invention of the alphabet and printing has produced eye strain with all its attendant evils. The invention of chairs has led to spinal curvature, etc., etc. Yet it would be foolish even if it were possible to attempt to return to nature in the sense of abolishing civilization.

"The cure for eye strain is not in disregarding the invention of reading, but in introducing the invention of glasses. The cure for tuberculosis is not in the destruction of houses but in ventilation. It is a little knowledge that is dangerous. Civilization can, with fuller knowledge, bring its own cure, and make the 'kingdom of man' far larger than the 'nature' people can ever dream of."

Until within the last few years, sickness and death were regarded from a religious standpoint. All sickness was to be borne with patience and resignation because all our sufferings were sent by an all-wise Providence. But since science has clearly proved that typhoid fever is usually caused by an impure water supply, and that boiling the water would prevent the suffering, expense and possible death; that the dreaded yellow fever can be banished from communities that destroy the eggs of certain mosquitoes; and many other facts in regard to health have been learned, a great change has come over the popular belief. It is seen that, to a great extent, man holds his own fate and is responsible for his own suffering, and people are eager to learn more about their own bodies, how to cure them and how to keep them well. [Pg 270]

This knowledge has already done much to prolong life. The average length of life in India, where no attempt is made to check disease, is twenty-five years. In England the length of life has doubled in a few generations. In Sweden, where the people live a sanitary life, the average is over fifty years, in this country, forty-five years.

Insurance companies and benefit societies keep close watch of their members and they report that a person ten years old may now count on living to be sixty years of age. That is the average age, whereas a hundred years ago the average expectation of life at that age was only fifty-three years. [Pg 271]

And this is true in spite of the fact that people have been crowding into cities, that they are living on richer foods, taking less exercise in the open air, living in houses which shut out the fresh air, and doing dozens of other things that have tended to lower rather than to raise the average.

We can scarcely realize the possibilities of life if, with all the present scientific knowledge of disease and health, we could have a generation of people living according to nature's laws.

Life can be not only lengthened but strengthened. There are many instances of frail, feeble children who have developed into exceptionally strong men and women. One of the most noted is Von Humboldt, the great scientist, who as a child was very weak physically, and, he himself says, was mentally below the average, but who lived to the age of ninety, and developed one of the greatest minds of his century.

Doctor Horace Fletcher, noted for his theories in regard to eating, was rejected at the age of forty-six for life insurance but so strengthened his constitution by careful living that by the time he was fifty he not only obtained his life insurance but celebrated his birthday by riding one hundred and ninety miles on his bicycle. [Pg 272]

If we could imagine a person who all his life had lived in a locality where the air was

pure; in a house where fresh air entered day and night, and which was heated to a uniform temperature; whose food had always consisted of the most pure and nutritious material prepared in the most wholesome way, eaten slowly and in proper quantity; if bathing, sleep, rest, exercise, brain work and pleasure had each its due proportion; if he could be always guarded from contagion and accidents, we can imagine that such a person would be free from disease and that death might be long deferred. Of course, death can not be prevented, only postponed, but disease can be prevented, and so we can increase the chances of postponing death. Doctors tell us that under ideal conditions there would be only one cause of death—old age.

There is no question that under such conditions life could be prolonged far beyond what is now usually considered its span. One hundred years or more might easily, we imagine, become the average of life, instead of the great exception.

We can hope for these things in the future though it will take several generations at least to bring them all about, but we need not wait so long for some of the best results. There are many things that can be done at once to prolong life and prevent illness. Since we know that many diseases are preventable and we know the suffering and sorrow, as well as expense, that come from sickness and premature death, we should all eagerly unite in doing all that we can to stop these ravages. [Pg 273]

There are two agencies that will help to bring this about: individual or private means, and general or public means. Both are absolutely necessary if we are to be successful in stamping out disease. Professor Fisher says: "Personal hygiene means the strengthening of our defenses against disease. Public hygiene seeks to destroy the germs before they reach our bodily defenses."

In the first place, in order to learn what we may do to lengthen the span of life we must learn something of the nature of disease. Doctors tell us that diseases are of two classes. The first are hereditary, or inherited; those which pass from parents to their children and often run through an entire family. It is more often the *tendency* to disease that is inherited, rather than the disease itself, and so even these inherited diseases may often be prevented by careful living.

Diseases which may be inherited include rheumatism, gout, scrofula, diabetes, cancer and insanity. This class of diseases is the most difficult to prevent and to cure. For some of them no cure has been found.

The other class comprises the diseases of environment, or personal surroundings,—that is, our manner of living both as regards our private life and our relations to other people. These diseases are largely preventable and it is with them that most of the work of prevention is to be carried on. [Pg 274]

A disease is considered preventable if, by using the best known means of treatment, it might be prevented or cured, so that either the disease or the death usually resulting from it would be avoided.

Of course, not all deaths from a given disease could be prevented even with the best known means. Infant diseases constitute one class which is considered most hopeful of betterment through a pure milk supply and better hygiene; and yet many authorities believe that not more than half the deaths could be prevented owing to the large part played by weather conditions, feeble constitutions, and other unchangeable conditions.

Preventable diseases may be divided into six classes:

(1) Diseases caused by lack of proper hygiene.

(2) Diseases caused by bad habits.

(3) Contagious diseases.

(4) Diseases caused by insects.

(5) Accidents, wounds, or operations and their resulting diseases.

(6) Diseases remedied by slight means. [Pg 275]

We will treat each of these in turn.

(1) By proper hygiene is meant the proper treatment of the body as to breathing,

eating, drinking, sleeping, bathing and rest. This treatment includes plenty of fresh air, both day and night, keeping outdoors as much as possible, and in well-aired houses the rest of the time. Vigorous but not violent exercise, brisk walking, regular physical exercise, such as is practised in gymnasiums, will go far toward keeping the body in good condition.

The question of fresh air in the home is one of the most important points to be considered. The bedrooms, the living-rooms, and the kitchen should have the air changed constantly, not once or twice a day. In order to prevent drafts, and that the house may not be kept at too low a temperature in winter, a board, eight to twelve inches in height, may be placed across the bottom of a window that is raised.

Many diseases, not only of the throat and lungs, but of the other organs, may be prevented by the constant introduction of fresh air into our rooms day and night.

Tuberculosis causes more deaths than any other single disease in America, and the sickness and disability continue longer than with most diseases. It is extremely contagious, being a germ disease, and not an inherited one, as was formerly supposed. [Pg 276] It increased very rapidly for a few years but is now slightly decreasing, owing to better knowledge of its cause and cure.

Its prevention and its cure both lie largely in fresh air. Physicians say that no one who lives an open-air life with plenty of fresh air night and day will contract it. The cure which is restoring hundreds to health is to find a place where the air is pure, and live and sleep practically outdoors; to eat as much milk, raw eggs, and meat as can be digested and to observe the other rules of hygiene. Incipient cases, those in the earliest stages, may sometimes be cured while continuing at work by following the other rules as nearly as possible.

On account of the extremely contagious nature of tuberculosis, special care should be taken to prevent its spread. The sputum coughed up from the lungs is the principal carrier of the disease, and the person who, having tuberculosis, even in its earliest stages, spits in a public place, is an enemy of mankind, for he endangers the lives of hundreds of others. The only excuse for this is that he usually does it through ignorance, but the knowledge of the danger should be so impressed on all the people that no one could plead ignorance, and for a consumptive to spit on the street should be counted as much a crime morally as for a smallpox patient deliberately to expose [Pg 277] others to the disease.

Great care should of course be taken in the home of a consumptive patient to prevent the infection from spreading through the family. Separate sleeping-rooms, thorough disinfection, and the use of paper napkins which are burned at once, to take the place of handkerchiefs, should be some of the means employed.

Pneumonia, pleurisy, bronchitis, grip, colds, and catarrh are some of the other ailments which may be largely banished by living the outdoor life. The method of treatment is medical, is different in each case, and should be decided by the family physician. The constant habit of breathing impurities, day after day and year after year, brings about a gradual change in the tissue of the lungs.

In the same way, simple food to take the place of the rich, heavy foods eaten in large quantities, will prevent many of the diseases of the stomach, liver, and kidneys, and improve the general health and strength. A diet of less meat and more eggs has been tried by football teams in training and found to give an equal amount of strength with greater endurance. A diet of milk, cereals, vegetables, nuts, and fruits, raw or simply cooked, with a small amount of animal foods, will perhaps give the best results in this [Pg 278] climate. Food fried in fats, rich pastries and gravies are the hardest to digest, and better health will usually follow discontinuing them.

The purity of the food eaten should receive careful consideration. Artificially preserved foods are usually more or less dangerous, for although dealers urge that the poison contained in them is too small to do harm we must remember that it is not the single dose that does harm, but the many foods each containing a very small amount of poison, taken day after day.

Pure food laws, national and state, have done great good in driving adulterated and impure foods out of the markets by requiring all foods to be properly labeled.

Thorough mastication or chewing of the food is only a little less important than the

character of the food itself. Rapid swallowing without chewing in childhood lays the foundation for many of the digestive diseases of later life. If food be thoroughly masticated much that would otherwise be hard to digest can be eaten without bad results. One of the best known examples of this is meat, which, while full of nourishment, sets up in the large intestine a condition known as "auto-intoxication," a species of digestive poison. If meat be eaten slowly and chewed thoroughly, this condition is almost entirely absent. [Pg 279]

Pure drinking water is almost as necessary as pure food. We take water into the body for three principal purposes: first, it is needed to dissolve and dilute various substances and carry them from one part of the body to another; second, it forms a large part of the blood and other important fluids of the body, and is a part of many substances formed in the body; third, it serves to carry from the body the worn-out and useless tissues, the waste products of the body.

These are extremely poisonous and must be promptly disposed of to prevent sickness. This can not be done except by an ample supply of water. Few persons, especially grown persons, drink enough water. Ten glasses of pure water are needed properly to supply the body. "Insufficient water drinking is perhaps the commonest cause of the interruption of the normal life processes," says Doctor Theron C. Stearns.

But the common drinking cup in public places probably causes far more disease than the drinking itself prevents.

Particles of dead skin and disease-germs are left in the cup by each drinker. Some of the most serious diseases may be carried in this way. A cup made of heavy waterproof paper, cheap enough to be thrown away after being used once, is a recent invention that is highly recommended for use by school children and those who are obliged to drink away from home. The water in a public drinking-fountain should come out in a small steady stream so that those who have no cups may drink from the stream itself as it rises. Many school-houses are so equipped. [Pg 280]

Sleep is a necessary part of good hygiene. It promotes health and prevents disease. It is largely in sleep that the system renews itself, that growth takes place, that waste products are thrown off, and the body repairs its wastes. No less than eight hours for grown persons and ten for children should be employed in sleep. Late hours and sleepless nights are the frequent cause of nervousness, eye strain, nervous prostration, and the beginning of brain troubles and insanity.

Bathing is also necessary to good health. The pores of the skin play a large part in carrying off the wastes of the body, through the perspiration, and if these become clogged, this poisonous material remains in the system. We have all noticed how a bath refreshes and gives tone to the entire body by opening the pores.

The skin is composed of minute scales, arranged in layers like fish scales. The tiny crevices between these form a lodging place for dirt and germs. If these remain, our own bodies are constantly exposed to their infection, if they drop off, as some are constantly doing, we may spread the contagion to others. This is strikingly illustrated by scarlet fever, smallpox, and similar diseases where these minute scales are the sole source of contagion. [Pg 281]

Exercise is another necessity of health. Regular physical culture in a gymnasium will develop any muscle or part of the body almost at will, but if this be not possible much can be accomplished in developing the body by simple work. Gladstone found health in chopping wood, Roosevelt in a daily tennis game, and President Taft in golf. Many find it in gardening or farming. These all help to develop vigorous bodies.

Anything which brings into moderate play any set of muscles, which increases the circulation, or stimulates the secretion is beneficial. House-work, which, in its various forms, brings into use all the muscles of the body, is a wholesome exercise for women. Those who do no house-work seldom substitute for it any other active exercise, and many diseases which are caused by deposits of waste tissues that are not thrown off by the body, are the result.

Rest—recreation—pleasure—these are as necessary to health as anything else, but the American people are slow to learn the need of them. We hear much of nervous prostration as an American disease. It is due to a variety of causes,—high living, late hours, ill-ventilated rooms, and climate; but chief of all the causes is the long hours of [Pg 282]

work under strong pressure. Work done in a hurry and without rest may accomplish many things, but it invariably causes a corresponding loss of nerve force. Fatigue, by checking bodily resistance, gives rise to all kinds of poisons in the system. Every part of the body feels the ill effect of continued exhaustion.

Of the diseases caused by bad habits, it can only be said that all the evils they cause, directly and indirectly, are entirely preventable; that they are usually wrong morally, and that the suffering which results is sure.

Under this head come the effects of drinking, of the use of tobacco and drugs, and of bad personal and social habits. It is only necessary to refrain from these bad habits to prevent all the diseases that arise from them, with all their train of suffering, poverty and crime.

It is not the province of this book to deal with scientific temperance, but merely to state a few of the most serious results of the use of alcohol and other poisons. The white corpuscles of the blood have been called our "standing army," because they are [Pg 283] natural germ-destroyers. One class of the white cells has the power of motion, and another class has the power of absorbing outside matter, such as disease-germs. One destroys the germs and the other moves them through the blood and carries them off with the waste products of the body.

The white corpuscles thus stand as the defenders of the body, ready to destroy the germs as they enter, and are, for each individual, the best of all preventives of germ diseases. The person whose blood is lacking in white cells is always liable to "catch" contagious or infectious diseases, and the one who has that element of the blood in proper proportion is best fitted to withstand disease.

Leading physicians believe that the greatest harm that comes from the use of alcohol lies in the fact that nothing else so weakens the resistance of the white corpuscles, and that therefore the person who is an habitual user of alcohol lacks the power to repel all classes of disease. English and American life insurance companies give us almost exactly the same figures, which show that of insured persons, the death rate is twenty-three per cent. higher among those who use alcohol than among total abstainers. It is probable that the proportion of persons carrying life insurance is much less among the drinking classes and that if we had complete statistics the [Pg 284] difference would be far greater than appears in the life insurance tables.

Of time lost by sickness, directly and through other diseases caused by alcoholism, drugs and other bad habits, the percentage is very great, according to all hospital records.

The number of prominent persons who have died of "tobacco heart" indicates that the rate of those whose heart action is weakened by the use of tobacco is probably very large.

Doctor Morrow says that if we could put an end at once to diseases caused by bad habits it would result in closing at least one-half of our institutions for defective persons, and almost all of our penal institutions.

There is another long list of diseases which are contagious, that is, which one person may transmit to another. These are usually serious but their spread may be largely prevented by keeping the sick person alone, except for the necessary nurses, quarantining the house and disinfecting everything when the period of infection is past.

In this class are smallpox, diphtheria, scarlet fever, measles, mumps, chicken-pox and whooping-cough.

These latter are the so-called "childish diseases" which it was formerly considered impossible to escape, and little attempt was made to guard against them. Now they [Pg 285] are recognized as serious, whooping-cough for its close relation to brain and spinal trouble; measles for their effect on the eyes and lungs; chicken-pox for its similarity to smallpox, and mumps for its general lowering of the tone of the system, allowing other diseases to gain a foothold.

Special serum treatment for diphtheria and vaccination for smallpox have greatly reduced the danger from these once greatly dreaded diseases.

Of preventable diseases none should receive more attention than typhoid fever, because it is a great scourge and yet it can be prevented by simple means. If we understand that typhoid is a dirt disease, that it comes only from dirt, we shall feel it a disgrace to have an epidemic of typhoid, though one of the saddest features about it is that we must suffer for the sins of others. The one who is attacked by typhoid fever may not be the one who has left dirt for the disease to breed in.

Typhoid fever germs are bred chiefly in manure piles, sewers, or cess-pools, and would not be transmitted to man directly, but there are several indirect ways in which they may be carried. Flies also breed in the same places. Their legs become covered with typhoid germs, and then they fly into houses directly on the food and cooking utensils. This is one of the most common ways in which the disease is carried, and [Pg 286] doctors tell us that the common house-fly should be known as the "typhoid fly" so that people may know the serious danger that lurks in what was formerly considered as nothing worse than an annoying foe to clean housekeeping.

If houses are thoroughly screened, if cess-pools, manure piles and garbage are kept tightly covered, screened, or, still better, disinfected with chloride of lime, there will be no breeding-places left for flies and this will remove one of the greatest dangers.

The other danger lies in a polluted water or milk supply. Every sewer that is carried into a stream, every manure pile that drains into a water course is a menace to health.

Very frequently the farm well for watering stock is near the barn,—near the manure pile, which, as it drains, carries down millions of typhoid germs to the water-level below. The well becomes infected, the family drink from it, and soon there may be several cases of typhoid fever in the home.

Worst of all, the milk pails are rinsed at the well, and all the milk that is poured into them spreads the germs wherever the milk may be sold. In this way an epidemic may be carried to an entire town, and to persons who themselves have taken every precaution against the disease. [Pg 287]

Drinking water should be boiled unless one is sure of the water-supply, and surface wells are never safe unless we know that they drain only from clean sources, and then the water should be analyzed frequently. Boiling absolutely destroys typhoid and other germs, and well repays the extra work it makes. One case of typhoid fever causes more work than boiling the water for years, if we consider the work only.

If you can not buy pasteurized milk, and are not sure of conditions about the dairy, your milk should be boiled, or, still better, sterilized at home by putting it in bottles or other containers, and placing in a vessel of hot water, keeping the milk for several hours about half-way to the boiling point, then cooling gradually.

All these means of prevention are troublesome and require time and work, but as the result in health for the family is sure, every housekeeper should gladly take this extra burden on herself if it be necessary. In some states and many cities, the laws governing dairies are now so strict that there is no need of doing this work in the home. This care in the dairies should be insisted on everywhere, even if it raises the price of milk, because it means the saving of many doctor and drug bills and also raises the standard of public health.

Yellow fever was formerly dreaded more than any other single disease because it [Pg 288] was so wide-spread, so fatal, and was thought to be violently contagious, but during the Spanish-American War it was proved that it is not contagious at all, but comes only from the bite of a certain mosquito, the stegomia, which is usually found only in hot climates. It is conveyed in this way: the mosquito bites a yellow fever patient; for twelve days it is harmless, but after that time it may infect every person that it bites.

If every yellow fever patient could be screened with netting to prevent his being bitten, we could prevent the yellow fever mosquito from becoming infected. Further, if we can prevent healthy people from being bitten by fever-infected mosquitoes, they will escape the disease, and still further, if we can destroy the eggs of mosquitoes, we can entirely obviate all danger of yellow fever in a community.

The mosquito breeds only in water; by having all cisterns, rain-water barrels, and other water containers carefully covered, and by spreading the surface of pools of standing water, especially dirty water, covered with greenish scum, with a thick coating of kerosene oil, we can prevent the eggs from hatching. This has been done in

many communities in Cuba and the southern part of the United States, and has resulted in completely stamping out the disease in those places. [Pg 289]

Malaria is caused by another mosquito, called the anopheles and while malaria is seldom fatal as is yellow fever, it causes much suffering and loss of time, and strong efforts should be made to prevent it. The same measures that are used to prevent yellow fever will banish malaria from any community. They are the screening of patients to prevent spreading the disease; screening all houses closely and keeping close watch for mosquitoes in the house, and covering all ponds in the neighborhood with oil. New Jersey mosquitoes were formerly known far and wide, but such an active campaign has been waged against them, that they have been almost completely driven from the state.

The ordinary mosquito has never been found to do any harm beyond the discomfort of its bite.

Of other diseases caused by insects, an affection of the eyes called pink-eye is carried by very tiny flies, and the dreaded bubonic plague is supposed to be transferred from sick people to well ones by the bites of fleas, which in turn are brought to this country by rats.

The hook-worm which affects so many persons in the South is often called "the lazy disease" since the persons afflicted with it are not totally disabled, but are lacking in energy and vigor because the small insects take from the blood the red corpuscles which should carry the digested food all over the body. These insects can be destroyed by medicine, of which only a few cents worth is required to cure a case and make the patient fit for work and enjoyment. In Porto Rico almost 300,000 cases have been treated by the United States government in the last six years. [Pg 290]

Another matter which should receive careful consideration is the large number of preventable accidents. Mining accidents come in a few cases from failure to provide the best appliances in the mines, but in many cases are due to carelessness or ignorance of the operators themselves. There still remain a large number of accidents which occur in the best regulated mines, and when no instance of special carelessness can be traced. For years these disasters have puzzled mining engineers, but within the last few months it has been discovered that the minute particles of coal dust in a dry mine completely fill the air, so that the air itself is ready to burn.

When a light is taken into this coal-filled atmosphere, it bursts into flame, causing a violent explosion. Sprinkling the mines, forcing a fine spray of water through the air of every part of the mines, it is thought, will prevent this class of accidents, which have furnished long lists of killed and injured each year.

Reports show that one miner is killed and several injured for every one hundred thousand tons of coal mined. The mining accidents of one year total 2,500 killed and 6,000 seriously injured. [Pg 291]

Other industries do not cause such wholesale injuries, but there are thousands of individual accidents each year where the injury varies from mangled fingers to death.

When the cause is failure to provide suitable safeguards to machinery, or to warn employees of danger, the penalty to the employers should be made severe, so that no consideration of money will prevent them from taking precautions. More often, however, the injury is due to the carelessness of the men or to the fact that they try to run machines with which they are unfamiliar.

Manual training schools, night schools for working-men, with a short apprenticeship in the running of machinery and an explanation of the dangers, will go far to prevent this class of accidents, but the fact will still remain, that often those who are most familiar with machinery become careless and are more liable to injury than beginners.

The number of accidents that have been added to the world's list by automobiles, both to those riding and to persons who are run over by them, is great and is in a large measure due to carelessness in handling the machine or to reckless driving.

The entire number of accidents in the United States, including railway accidents, reaches the immense total of sixty thousand killed and many times that number injured. A most appalling waste of life and labor value! [Pg 292]

Professor Ditman says, "Of 29,000,000 workers in the United States over 500,000 are yearly killed or crippled as a direct result of the occupations in which they are engaged—more than were killed and wounded throughout the whole Russo-Japanese War. More than one-half this tremendous sacrifice of life is needless."

Until the last quarter of a century there was a large addition to the death rate each year from the blood poisoning following operations and injuries making open wounds. It was not until the discovery of the germs which cause septic poisoning that deaths from these causes could be checked. The use of antiseptics, such as carbolic acid, alcohol, and various other preparations, the boiling of all surgical instruments, and the boiling or baking of all articles used in the treatment of open wounds and sores has reduced the death rate at least one-half.

The rate could be lowered much more if all sores were treated as surgical cases and carefully sterilized from the beginning. About eighty-five deaths out of every hundred from these causes might be prevented. [Pg 293]

Every Fourth of July a great many entirely preventable deaths and minor accidents occur. The toy pistol has come to be considered almost as deadly as the larger variety. The tiny "caps" that are used in them are fired back into the hand of the person shooting them, tiny particles of powder enter the skin, burrowing into the flesh, and the skin closes over them, shutting out the air. If these particles carry with them tetanus germs, as is often the case, because these germs are found chiefly in the dirt of the street where most of this shooting is done, lock-jaw or tetanus, a severe form of blood-poisoning, results, and is usually fatal. The same results come less frequently from fire-crackers and other explosives, and in addition many accidents which injure hands, eyes, and other parts of the body, are the result of the use of the heavier explosives.

The Pasteur Treatment is saving many lives each year by treating cases of infection from "mad dogs" and other animals affected with hydrophobia.

Among the diseases which can be remedied by slight means are enlarged tonsils and adenoid growths back of the nose, both of which can be removed by a slight and almost painless operation, but which, if allowed to develop, often cause serious throat and lung troubles, deafness, and weakened minds. Slight defects of the eyes can be remedied by the wearing of glasses, but which if unchecked give rise to various nerve and spinal diseases as well as more serious eye troubles. It is believed now that most of the blindness of later life could be prevented by proper care of the eyes in early life and by prompt attention to slight defects of the eyes when they begin. [Pg 294]

Doctor Walter Cornell, who has made a study of eye strain says, "Eye strain is the chief cause of functional diseases. It is almost the sole cause of headache, is the frequent cause of digestive diseases, of spinal curvatures, and indirectly of neurasthenia and hysteria."

Decayed teeth in children, slight in themselves, give rise to more serious troubles in later life,—ill-shaped mouths and jaws and crooked teeth result from teeth that have been drawn too early in life. Decayed teeth lead also to many stomach and digestive troubles.

Medical inspection in the schools shows a surprising number of children suffering from these minor troubles. About 80,000 children were examined, and the records show that out of every one hundred children examined sixty-six needed the services of a doctor, surgeon, or dentist, and some needed all three.

Forty out of each hundred had badly neglected teeth. [Pg 295]

Thirty-eight had enlarged glands of the neck.

Eighteen had enlarged tonsils.

Ten had growths of the nose.

Thirty-one needed glasses.

Six needed more nourishing food.

This meant that more than 52,000 of the number needed some medical care that they would not have received at home because their parents had never noticed the

need of it. Every one of them could by prompt attention, a small dentist's bill, a slight operation of the throat or nose, or the use of glasses, (almost 25,000 needed glasses) be saved great suffering or inability to work in later life.

As we learn more of disease, and especially of germ diseases, we are oppressed by the feeling that we are in constant danger, but we must bear in mind that it is the weak and unfit that are attacked, and that fitness, while partly inherited, is almost altogether a matter of proper hygiene. Keeping our bodily defenses in good condition against disease is as much a matter of necessity and good policy as keeping the defenses of a city in fighting condition in time of war.

That life may be prolonged and so strengthened that the average height, weight, and endurance will be increased, admits of no doubt. The same rule of cultivation runs through all nature. The original or natural apple was a small, sour, bitter crab. The [Pg 296] difference between that and the finest products of western orchards, is altogether a matter of cultivation, selection, and proper treatment. In 1710 the average weight of dressed cattle did not exceed three hundred and seventy pounds. Now it is not far from one thousand pounds. An equal change could be made in the human race, but because we believe so fully in personal liberty to live our lives as we choose, little has actually been done to raise the human standard.

The care and hygiene of children is receiving universal attention, with the result of a wonderful reduction in the sickness and death of children, but as yet comparatively few grown persons apply these lessons to their own lives, and the rates for older persons remain almost unchanged.

When individuals have done all that they can, there still remains much that must be done by the city, the state, and the nation. Boards of health can do much toward controlling epidemics by placing infected households under quarantine, by compelling householders who are ignorant or careless to clean their premises and to take other precautions for the public health.

Hospitals, both public and private, have done excellent work, not only in curing disease but in gaining more definite knowledge of the nature of diseases through the [Pg 297] study of large numbers of cases.

The cleaning of streets and the removal of garbage regularly are among the great factors in keeping a city in a sanitary condition. New Orleans and some of the cities of Cuba and Porto Rico show strikingly what may be done in that direction.

Medical inspection of schools is a new and valuable aid to health. Epidemics of childish diseases which sweep through the schools with a fearful record of illness and a lesser one of death, may often be checked entirely by the close watch of the medical inspector, who removes the first patients from the schools when the disease is in its beginning.

Public playgrounds for children in cities have an influence that it is as good for health as it is for morals, providing, as it does, fresh air and active exercise for children. Open air schools for tubercular children are being operated in several cities with excellent results in health and school work.

Many states are making an organized effort to fight tuberculosis by establishing fresh-air colonies where, with pure air, rest and plenty of the most nourishing food, patients are restored to health.

Care of epileptics and the insane by the state, with proper hygiene and treatment, accomplishes many cures. [Pg 298]

The nation is doing excellent work in a few lines, notably the Pure Food Bureau and the Marine Hospital Corps, but perfected organization of all the forces is lacking. The Department of Agriculture has done a wonderful work in investigating and curbing insect pests that injure farm crops and trees, and in stamping out disease among live stock. Forty-six million dollars have been spent and well spent in the work in the last few years, but it is a matter of reproach that more pains are taken to save the lives of cattle and farm crops than human lives.

There should be a strong central Bureau of Health with power and money scientifically to investigate disease, to distribute information as the Department of Agriculture does to farmers, and to carry out their ideas, as do state and city boards of

health.

We have dealt with only one side of the question—the suffering and sorrow; but in a work on conservation, we must consider also the money question, the loss to the nation in time and money of these great wastes of health and life.

There are no trustworthy statistics as to wages. The average yearly earnings of all persons, from day laborers to presidents, is estimated at seven hundred dollars; but as not more than three-fourths of the people are actual workers, three-fourths of this amount, or five hundred and twenty-five dollars is taken as the average wage. [Pg 299]

From these figures the money value of a person under five years is given at ninety-five dollars; from five to ten years, at nine hundred and fifty dollars; from ten to twenty years at $2,000; from twenty to thirty at $4,000; thirty to fifty years at $4,000; fifty to eighty at $2,900 and over eighty at $700 or less. The average value of life at all ages is $2,900 and the 93,000,000 persons living in this country would be worth in earning power the vast sum of $270,000,000,000. This is probably a low estimate but is more than double all our other wealth combined.

Now let us see how much of this vital wealth is wasted. As the average death rate is at least eighteen out of each thousand, we have 1,500,000 as the number of deaths in the United States each year. Of these, forty-two per cent., or 630,000 are classed as preventable—so that a number equal to the entire population of the city of Boston die each year whose deaths are as unnecessary as is the waste of our forests by fire.

If some great plague should carry off all the people of Boston, not the people of the United States only, but of the whole world would be roused by the appalling calamity and every possible means would be employed to prevent other cities from sharing such a fate; but because these preventable deaths are not in one city, but are widely scattered, we have long remained indifferent to this terrible and needless waste. [Pg 300]

Then there are always 3,000,000 persons ill, 1,000,000 of whom are of working age. If, as before, we count only three-fourths of them as actual workers, we find a yearly direct loss from sickness of $500,000,000 in wages. The daily cost of nursing, doctor bills, and medicine is counted at one dollar and fifty cents, which makes for the 3,000,000 sick, a yearly cost for these items of more than $1,500,000,000. What should we think if nearly all of the people of the city of New York were constantly sick, and were spending for doctors, nurses, and medicine as much money as Congress appropriates to run every department of the government!

It is estimated that sickness and death cost the United States $3,000,000,000 annually, of which at least a third, probably one-half, is preventable. Is it not well worth while, then, from a money standpoint alone, to use every effort to conserve our national health? Conservation of health and life, going hand in hand with conservation of national resources, will give us not only a better America, but better, stronger, happier, more enlightened Americans. What a new world would be opened to us if we could have a nation with no sickness or suffering! That is the ideal, and everything that we can do toward realizing that ideal is a great step in human progress. [Pg 301]

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CHAPTER XIII

BEAUTY

America has another resource that differs from all the others, and yet is no less valuable to us as a nation, for it is upon natural beauty that we must depend to attract visitors and settlers from other countries, and also to develop love of country in our own people, and to arouse in them all the higher sentiments and ideals.

The love of romance and poetry is awakened only by the sight of beautiful objects, and that nation will produce the highest class of citizens which has most within it to kindle these lofty ideas. The savage cares only for the comfort of his body, but as civilization advances, man devotes more and more thought to those pleasures that come only through his mind and the cultivation of his tastes.

The United States is particularly fortunate in this respect, for here is everything to inspire a love of beauty. There is the beauty of changing seasons, of our wonderful autumn forest coloring, of rivers, mountains, lakes, sea, and shore.

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In addition to the beauty of our landscapes, which is everywhere to be found, there are many special beauties which are among the world's wonder-places, and which are visited yearly by thousands of sight-seers, and each year they attract a greater number of visitors from other lands. Some of the most remarkable of these are Niagara Falls, the Yosemite Valley, with its crowning glory, the Yosemite Falls, the Hetch-Hetchy Falls, Mammoth Cave, the Garden of the Gods, the Grand Cañon of the Colorado, the Agatized Forests of Arizona, Yellowstone Park, The Natural Bridge of Virginia, Great Salt Lake, and dozens of others, less wonderful, but scarcely less beautiful, and equal to the most talked-of beauties of Europe, such as the Palisades of the Hudson, Lake Champlain, the Shenandoah Valley, the Dalles of Oregon, Pike's Peak, Mount Rainier, Lookout Mountain, the Adirondacks, and the entire Rocky Mountain region.

To these must be added the relics of ancient civilization, the homes of the Cliff Dwellers, the work of the Mound Builders, and such fragments as still remain of the occupation in various times and places of certain Indian tribes, and of the Norsemen and the Spaniards.

All these are to be valued for their beauty or historic interest, and are also valuable as a source of wealth to the community.

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The money spent on tourist-travel in Europe is said to be more than half a billion dollars a year. This vast amount is spent because in Europe there is so much to delight the eye, because the cities are made beautiful with artistic buildings filled with art treasures, because historic places are carefully preserved, because the villages are neat and well-kept, and the intensive farming which is practised almost everywhere leaves no waste places to grow up with weeds, and lie neglected.

There are parts of Europe, of course, where this is not true, but they are not included in the line of tourist-travel, and in general it may be said that Europe is visited almost solely because of its beauty:—the natural beauty that man has preserved, the beauty that he has created, or the relics of past greatness.

Modern Greece would attract few visitors for its own sake. It is the ruins of a mighty past,—the Acropolis at Athens and the places made famous in mythology and literature draw thousands to its shores every year, and add greatly to the wealth and prosperity of the country.

The same thing is true of America wherever we have preserved and made beautiful our natural scenery. During three months in the summer, the New York Central Railroad derives about $200,000 in fares from its Niagara business alone. Since it became a state reservation in 1885, more than seventeen million persons have visited Niagara, and the amount of money that has been spent there at hotels, for carriages,

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automobiles, side-trips, souvenirs, etc., is almost beyond calculation.

In the Adirondack Park there is between $10,000,000 and $15,000,000 invested in hotels and cottages. The 15,000 clerks and helpers receive about $1,000,000 in wages, the railroads receive another $1,000,000 in fares, and hotel guests spend between $5,000,000 and $6,000,000. All of these advantages to the region are entirely apart from the practical uses of the forest.

These are examples which show the great amount of wealth which can come from preserving our natural beauties, and the same conditions exist everywhere, not only in the state and national parks, but wherever some beautiful spot has been set aside by a city, a railroad company, or some private enterprise. People flock to these resorts in large numbers for rest or recreation, and to satisfy their love for the beautiful, and the result is a gain in health and morals, more desire on the part of those who visit them to make their own surroundings beautiful, and at the same time a great gain in money value to the city or company that promotes such an enterprise.

Most of the larger cities of the United States have given particular attention to the subject of public parks during recent years. They are the breathing places for the dwellers in the city, often the only place where children can have fresh air and plenty of exercise, and the parks constitute one of the greatest attractions to draw summer visitors to the city. [Pg 306]

Nearly all steam and electric railway companies own some park or pleasure resort from which they derive a large income in fares, and many steamboat companies find their largest profit from their excursion boats.

All these facts show clearly that if we consider only the gain in money, it is altogether a wise policy to include natural beauty among our national resources, and to conserve it carefully, while if we look at it from the larger standpoint of preserving for future generations the same beauties that we enjoy, the need of such conservation is still more urgent.

In our future development the United States will largely be made over. We shall no longer have the same natural conditions that we have had in the early years of our history, and the physical appearance of the country will grow better or worse each generation.

It is possible for us to make America the most beautiful land the world has ever seen, for we have the natural beauty, and greater knowledge in setting about the work of building than has ever been possessed by any other nation during its time of greatest growth. [Pg 307]

We shall go far toward realizing our ideal of a beautiful America if we understand that the conservation of our resources means beauty, and that waste means ugliness. Proper conservation of our mineral resources will include the removal of the ugly, unsightly piles of culm, slag, and other refuse that lie about the mouth of the mines, and disfigure some of our most beautiful mountain scenery, for, as we have shown elsewhere, this should be used and not wasted. The proper use of coal would solve the smoke problem of cities, one of the worst foes of cleanliness and beauty, and the use of water-power would serve the same purpose. The complete utilization of our water resources that has been suggested would make all our waterways contribute greatly to the beauty and attractiveness of the landscape.

In conserving our forests we not only increase our timber supply, but add one of the greatest of all beauties, the trees which give variety and tone to every picture that our eyes rest upon. We shall have the shady roads, the long green hill-slopes, the quiet woodlands, the glory of autumn coloring, the delight of blossoming orchards.

Conservation of the soil, and utilization of every part of the land mean even more. Picture the contrast between a country where the hillsides are worn into gullies, where rocks are everywhere to be seen cropping above the barren soil, where the crops are scanty, the vegetation stunted; and one where every field yields a rich harvest, where the grain hangs heavy and golden, where every wayside nook holds a flower, where there are no neglected fence-corners, no piles of rubbish,—what we truly call "a smiling landscape." Lastly, in conserving health, we do more toward promoting personal beauty and advancing the standard of the race than in any other way. [Pg 308]

We should not be content, however, with the beauty that comes only from the conservation of our other resources, but should have a definite plan for the conservation of beauty as a valuable resource in itself.

The city of Washington should be made the center of this movement toward national beauty. There is now an organized effort on the part of those in charge of the erection of public buildings, to make Washington the most beautiful capital in the world, and a model for other cities.

The federal government should set aside as national parks all of our greatest natural wonders, as Yellowstone Park is now held.

The states should follow the same line and set apart in the same way those objects of lesser interest, either natural or historic, which are to be found in every state—those that are not of sufficient importance to merit national recognition, but that will add interest to the state as a place for tourists to visit. [Pg 309]

Few states are visited in this way more than is Massachusetts, and it is largely because not only the state, but the various communities have preserved historical places, buildings and objects so carefully, have erected monuments to commemorate them; and have thrown these various objects of interest open to the public free of charge. These communities in turn have gained the original expenditure many times over from the money spent by the steady stream of visitors.

There has been a great movement toward the beautifying of cities and villages in the past few years. Besides the good work done by park boards in cities there has been a great improvement in the matter of cleaner streets, better sidewalks, the planting of more shade trees, and a far greater attention to the beautifying of private grounds. The adorning of front yards and porches with vines and flowers is increasing enormously every year.

Many causes have been at work to produce this result: the broadening influence of travel, which brings people in touch with what is being done in other places to promote public beauty, the work of schools, newspaper and magazine articles, and more time and money to spend on luxuries,—even the post-card, which makes a souvenir view of every spot of local beauty or interest; but probably no other one agency has produced such good results in public beauty as has the woman's club which has taken up this line of work. [Pg 310]

The "cleaning-up" movement, with a public house-cleaning day twice a year when all refuse is carted away, and streets, alleys and back-yards cleaned, had its origin in this way. The care and beautifying of cemeteries is another branch of the work.

In many places, flower and vegetable seeds are distributed free or at a nominal cost among the school children, prizes are offered for the best garden, the largest vegetables, the most attractive back-yard, the best arranged flower-bed, and other good results; the work is examined by a committee, and the prizes awarded at the end of the season either by the club or by merchants who have become interested in the contest.

This provides the children wholesome outdoor work and exercise throughout the summer, and promotes a pleasant rivalry among them, besides increasing their knowledge of plants, and the results have been found to be far-reaching, for not only the pupils, but their parents as well, are interested in neater, more orderly methods of living, and in beautifying their homes. [Pg 311]

In the movement for public beauty, as in all other progress, it is the work of individuals that counts most. Every house that is built with a thought for its beauty, every home, farm-building and fence kept in good repair, every neat back-yard and flower-surrounded home has its part in making America more beautiful, and this influence in countless homes is certain to count in the making of better citizens.

A country where beauty meets the eye at every turn will invite the tourist and the home-seeker, will be deeply loved by its own people, and will be an inspiration to poetry and art. It rests largely with the people of to-day to decide whether we shall make of our own land such an ideal place. [Pg 312]

CHAPTER XIV

IN CONCLUSION

No one can read the record of facts presented in this book without being impressed by two things: (1) How these resources depend on one another and that proper care of one results in the saving of another, and, (2) the fact that every one of our most valued resources is decreasing so rapidly that its end is in sight, even though far in the distance. When the end comes we know that it will mean the end of progress for our country in that direction.

It is also plain that the great, in fact the only, reason for this scarcity lies not in use but in waste. And lastly we see that there is yet time to prevent serious shortage in most directions if we set about a general system of good management and thrift.

In the meantime we are sure to have higher prices, for the supply is growing less and the demand greater for almost every material. In many lines, unless something be done to check this shortage, prices will rise so high that only the rich can afford what are now considered the necessities of life, and the lives of the poorer classes will become like those of the peasants of Europe:—a scanty living on the plainest food, poor homes, hard work, less opportunity to develop mind and body. [Pg 313]

Let us sum up how the various resources may be used to conserve one another.

The soil is saved from erosion by the planting of forests, and by the storing of the flood waters of rivers. Waste land is made fertile by proper control of the rivers through drainage, storage and irrigation. Farm crops and also the forests are increased in value by insect control.

The insects are largely kept in check by encouraging the nesting and increase of certain birds. Birds play a large part in the conservation of the crops, by destroying insects, weeds, and small mammals. The birds themselves are sheltered and thrive only where trees are abundant.

The grazing lands are conserved by proper forest control, and the supply of animal food depends largely on the grazing lands.

Fisheries are dependent on proper care of the waters, which in turn depend on forest control, and on proper care of the by-products of factories.

Coal is conserved by the use of lower-grade fuels, by using waste from the forests, and by substituting water-power.

Gas and oil will also be saved by the greater use of water-power. [Pg 314]

Coal-mining is made safer to human life and much saving in coal is effected by the use of mine-timbers, which involves the planting of forests. Forests regulate to a great extent the stream-flow of rivers.

Beauty can only be conserved by the planting of trees, by keeping the waters pure and clear, by using waste products so that there will be no unsightly piles of refuse.

Health depends, among other things, on pure water, air unpolluted by coal smoke and poisonous gases which should be used as factory by-products.

And lastly, the life, happiness, and prosperity of man is conserved by all of these things.

The first step in this system of conservation must be education on this subject, education not only of the children but of the men and women also, on the need and methods of saving. There would be no danger of a scarcity of coal if manufacturers all knew the value and economy of electric water-power or low-grade fuels, and of smoke-consuming devices. There is no reason why insect destruction should cost the nation so dearly if the birds were protected, and a few simple methods of prevention understood. All the various water problems could be met and solved if one general plan were adopted and carried out, and so all along the line.

We have taken note of the great natural wastes: how two-thirds of the wood cut is wasted, and how insects and fire destroy the standing timber; how the soil is washed down into the valleys, taking the best from the farms; how we are steadily robbing the [Pg 315]

soil of its most necessary elements; how our waters are unused and we pay for this non-use by the use of other resources that we can ill afford to spare; how millions of acres of land which might be profitably farmed lie useless for lack of water and other millions are useless because they are covered with water. Consumers pay high freight rates and the railroads are so overcrowded that they are unable to care for all the business, while the rivers, the cheapest of all carriers, flow idly to the sea.

We have seen how one-fourth of the coal is left in the mines, and how small a part of that which is mined is actually turned into heat, how gas is allowed to escape unchecked into the air. And greatest and most serious of all, the useless waste of human life and health.

But there are scores of other wastes and extravagances that all growing boys and girls should think of, so that when they enter active life, they may do their part to prevent them.

It is going to be necessary to learn to economize in every department of life as all the European peoples do. We must learn, in this new country, to do things more with the [Pg 316] idea of the future in mind. In all European cities, there are hundreds of houses that have lasted many centuries, but there are few houses in America that are built in an enduring way. This building up and tearing down taxes not one, but many, resources heavily. As the housewife learns that a good kettle that costs a dollar and lasts five years is cheaper than a poor one which costs fifty cents but will wear out in one year, so people must learn the lesson that in building poor light houses of wood which will last a comparatively short time, they are really paying the higher price; that in putting in poor roads, cheap bridges, badly-constructed public buildings, that cost less heavily in the first place but that will need to be renewed in a few years, they are really paying much more than if these had been substantially built in the beginning.

The fire loss of the United States amounts to over half a million dollars a day, and all insurance men agree that most of this might be prevented.

The remedies are to build fewer wooden houses, especially in crowded districts, to exercise greater care in the building and management of chimneys, greater care in electric wiring, and general watchfulness in handling matches and lighted cigars.

For the forest fires which mean so much to all of us the remedy lies in forest patrol. The amount usually set aside for fighting fires was not allowed by some states in 1910, [Pg 317] and the fires which cost hundreds of millions of property and many lives were the result.

Much of the most fertile land in our country is used for raising tobacco, and grains that are made into alcoholic liquors. As these can never be considered necessities it is well to think to what better uses the land might be put.

The yearly bill of the United States for pleasure is gigantic, and a large proportion of the pleasure tends to lower rather than raise the standard of American life and morals.

The greatest of all wastes is the waste of time and labor. The waste of time by drunkenness, by poor work that must be done over, and by idleness, makes a large item of loss in every line of business.

Proper education will teach every child to work neatly and with perfect accuracy, will teach eye, hand and brain, will teach the value and pleasure of work, careful management and economy and a regard for the general good.

A study of the great facts of our national possibilities that have been gathered together in this book should arouse in the heart of every American, old and young, the feeling that here is a work for every hand and every brain, not only to save, but to use wisely; to develop all the possibilities of our great resources no less than to conserve [Pg 318] them. In searching for new by-products or machinery for checking the waste and adding to the usefulness of these resources there is a field for invention that will not only bring wealth to the inventor, but prosperity and length of life to the nation.

THE END

FOOTNOTES:

[A] Department of Agriculture bulletins are free unless a price is indicated, and may be obtained by application to The Department of Agriculture. Washington, D. C. Postage is free in the United States. These bulletins contain the latest scientific information and result of research work by the government.

[B] All Bureau and Commission reports are free.

[C] Some of the Yearbooks of the Dept. of Agriculture contain very instructive reports on Insects and on Birds. Reprints on various subjects have been made from them which are available in pamphlet form, or the entire Yearbook may be had in many cases.

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