THESIS

USES OF WOOD

IN

MILITARY OPERATIONS

Submitted by

Loren L. Stewart
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SCHOOL OF FORESTRY
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Introduction

This report on the connection of forestry to military operations, cannot be one of research, but only a retrospective one, looking into the past and studying its trends in connections to warfare in the different ages, paying especial attention to the recent trends so that the future may be predicted with some accuracy.

The report will start with the earliest man with his first implement of warfare, the club, going into the wars of the ancient countries of Greece, Persia, Rome, and others, showing the steady advancement in the use and importance of wood in warfare. From these countries the story will go into the times of the Crusades, during the dark ages, when everything stopped its forward progress and seemed to slide back a notch or two. Out of these times into the period of the Renaissance, The French Revolution and the great Napolonic Wars. From here into the modern age where everything had advanced tremendously. Through the times of the American Revolution, Civil War, Spanish American War and the World War. Here most of the story will be laid, because it is of the most importance to us. The uses of the forest products in the war will be discussed very thoroughly as well as the effects on Forest Industries.

From here I will try to predict a few of the important roles that forestry will play in case of another major war, which we all hope will not occur.
From the above introduction it seems that forestry is connected to military only during warfare. In summing up the story I will tell of a few uses of forestry outside of actual wartimes.

Just when wood began to be used by man is a thing that can only be guessed at. To place it in "remote antiquity" is eminently conservative. It is one of those lake-dwelling, cave-dwelling Cromagnon things, the measure of the age of which can only be put into figures in near-astronomical terms. Certain it is that wood was one of the first—if not the very first—material objects that man laid hold of in the beginning of his fight with nature. The first bow, the first canoe, the first man-made fire, the first rolling log with its hint of a wheel—there is a universe of conjectural material in all of them. And yet in the grace of 1932, man knows infinitely less about wood than about numberless other things—gold, iron, and copper, for instance—the very existence of which was only dimly apparent to him long ages after the first arrow flew. And so has it been down through the ages. Basic wood, the first rung of the ladder of our upward climb; the thing that in hundreds of ways has helped us win what we call our civilization, we have taken little thought of.
Fig. 107. Assyrian Soldiers of the Empire. (From the Palace Reliefs of Assurbanipal)

It was the valor of these stalwart archers and spearmen which made Assyria mistress of the East for about a century and a half (§§ 220–221)

Note. The headpiece shows an Assyrian king attacking a fortified city (ninth century B.C.). A century before the Empire the Assyrians had already developed powerful appliances for destroying a city wall. The city at the right is protected by walls of sun-dried brick like those of Samal (Fig. 97). The defending archers on the wall are trying to drive away a huge Assyrian battering-ram, mounted on six wheels, which has been rolled up to the wall from the left. It is an ancient "tank" with its front protected by metal armor plate. It carries a tower as high as the city wall, and Assyrian sharpshooters (archers) in the top of the tower are picking off the defenders of the wall. Within the tank unseen men work the heavy beam of the ram. It is capped with metal and is shown smashing a hole in the city wall, from which the bricks fall out. An observation tower with a metal-covered dome and holes for peeping out, shields the officer in command as he directs the operation of the machine. In the rear (at the left) is the Assyrian king shooting arrows into the hostile city. He uses a powerful bow, invented in Egypt, which will shoot an arrow with great force from 1000 to 1400 feet, and hence he can stand at a safe distance. This scene, carved on a slab of alabaster, is among the earliest Assyrian palace reliefs which have survived (§ 220), and hence the artist's childish representation of men as tall as city walls.
This chariot shows us what good woodwork the Bronze Age craftsmen could do with bronze tools. It is also an evidence of the far-reaching commerce of the Bronze Age; for it was transported across the Mediterranean to Egypt, where it was placed in a cliff-tomb, to be used by some wealthy Egyptian after death. There it has survived in perfect condition to our day. It is built of elm and ash, with bindings of birch fiber. The birch does not grow south of the Mediterranean, and hence the chariot must have been made on the north of the Mediterranean ($\S$ 329).

Note. The above fragment of a wall-painting at Pompeii shows us a Roman warship, seemingly in battle, for the wreck of another warship is visible at the left. Notice the two steering oars at each side of the stern—a device found on Nile ships three thousand years earlier (Fig. 41). The rudder had not yet developed from these steering oars. The Romans ascribed their success, in spite of inexperience, against the Carthaginians to a new boarding grappler, which they invented and called a "crow" (corvus). It consisted of a heavy upright timber, which was made to fall over with the end on the enemy's rail, where an iron hook attached to the end of the "crow" grappled and held the opposing craft until the Romans could climb over into it. In the hand-to-hand fighting which followed, the sturdy Romans more than made up for their inexperience in seamanship.
Man is supposed to have come into being as a species some 4,000,000 years ago. The earliest man we know as a thinking being was about 100,000 years ago. We do not know much of his fight with nature and other animals until about 50,000 years later.

These figures do not mean much to us in this modern age. Through excavation and study many interesting things have been discovered about our early ancestors. Of these facts I will relate the things about his use of wood as a weapon.

The first wood weapon used by man in his defense or offense was the club. A limb broken from some tree or picked up somewhere. With this he could defend himself from beasts and other men and also get some of his food. Through some accident or such the spear was used. There wood played a very important role, it making the shaft upon which the stone head could be attached. This invention proved a wonderful weapon and greatly facilitated man in his protection.

About 15,000 B.C. came an invention which was to be used by the civilized nations as their most effective weapon in warfare until gunpowder was invented some 17,000 years later. This weapon was the bow and arrow. It put man entirely out of the animal class in his fights, yet the weapon consisted almost entirely of wood and was to the early man what the rifle is to us today. It made his killing power greater and let him keep a safe distance from his enemies. All this occurred along the coast of France and Germany.
Men on other portions of the earth may have been going through the same evolution, but it is here that the most reliable evidence is found.

From the coasts of France and Germany we go to Egypt where civilization progressed rapidly. The bow and arrow attained a high perfection here. An arrow could be discharged with great force, going from 1000 to 1400 feet. A good archer in modern times can very seldom shoot and arrow over this distance. The Assyrians used this Egyptian bow and arrow extensively in their battles. It was a very effective weapon, both as to accuracy and killing power.

About 900 B.C. or thereabouts the first battering ram was invented. A picture of this is shown on the following page. It consisted of a wooden structure covered with metal armor. The ram was a timber capped with some sort of metal.

There was no great improvement in weapons of war for a long time. The Athenians and Spartans both used the bow and arrow a great deal along with the spear and sword. Alexander used the bow extensively in his campaigns.

Up until this time wood played the most important role in warfare, being used for many purposes besides those that have been mentioned. For example, fuel as wood. Napoleon said, "An army lives on its stomach." Certainly wood is a most important article in cooking food. This pertains to
all wars at all times during history. More will be said about this later in the report.

During Caesar’s time and later when Rome was in power, wood took a secondary role in warfare. The bow and arrow was almost entirely eliminated and replaced by the sword. Battle tactics had changed from open fighting to the massed phalanx. Even though wood was secondary in battle it was primary in the movements and protection of troops. Bridges were built across streams, boats were built. Here wood played a most important part. Great floats were built by Rome to transport troops to northern Africa. One of these Roman ships is shown in the picture. During this time most of the timber was cut off the head waters of the Tiber River later causing disastrous floods around Rome.

It was also a practice of the Romans to build fortified camps out of wood: "It was the invariable practice of a Roman army when it halted to construct a square fortified camp, surrounded by a ridge of earth bearing a stockade of wooden posts driven into the crest of the ridge. This camp was descendant of the old prehistoric pile villages of northern Italy."

The Romans continued using the shield and sword until about 250 A.D. but by 450 A.D. the heavy shield and sword had completely given away to the lance, and bow and arrow.
This was caused mainly by the effect of the open warfare with the German tribes to the north. The bow and lance were the principle weapons of war from this time until the beginning of the 15th century. This idea can be seen from the following statement by Procopius, a Tueton.

"Men there are who call our modern soldiery mere bowmen and can praise only the troops of old, the shielded legionsaries who fought hand to hand with the foe. They lament that our ancient warlike courage has disappeared in these days and thereby show themselves to be mere ignorant civilians. They say that bowmen was from the earliest times a term of contempt, not remembering that the archers of Homers day—for of them they are thinking—were light troops without horse, lance shield, or defensive armor, who came on foot to the battle and skulked behind a comrades shield or took cover behind a stone. Such archers of course could neither defend themselves adequately nor set upon the enemy with confidence: they were mere fugitive hoverers on the edge of battle. Moreover they were such weak and unskilled shooters that they only drew the bowstring to the breast, so that the arrow flew aimlessly and probably did no harm. Now our horse-archers are very different men. They come to fight like men. They bear bow and sword, and for the most part a lance also, and a little shield slung on the shoulder, worked with a strap, not a handle. They are splendid riders, can shoot while galloping at full speed and keep up the arrow flight with equal ease whether they are advancing or retreating. They draw the
bow-cord not to the breast but to the face, or even to the right ear so that the missile flies so strong as always to inflict a deadly wound."

This shows the importance and effectiveness of the bow and arrow.

A defensive measure against cavalry which consisted almost entirely of wood came next. It was a system of beams with a projecting layer of spikes. When the horsemen were observed the beams were hastily placed in line before the front of the corps so as to form a continuous barrier.

Going on in history, we find the next important use of wood in military was the Visigoths use of the "Funda" and "Balista" which threw respectively stone balls and darts; they also used the ram in battering down walls and so forth. They used the fire arrows to great advantage in the reducing of a strong hold. From this we infer that the forts and strongholds were made largely of wood.

We now go to the British Isles where the Vikings and Norsemen were causing a great deal of destruction from their raids. They sailed from Norway and Sweden in wooden vessels and landed on the Isles, burning and carrying away a large amount of property. The Anglo-Saxon's principal weapon used against the Vikings was a short barbed spear. The shaft of it was made of Ash.

Going to France in about 900 A.D. we find fortified bridge-heads. "Much of this work was only wood work or palisading, not solid stone; but if properly held, it yet served its purpose." The famous tower at the bridge-head,
round which so much fighting raged during the great siege of Paris, by the Danes in 911, was only wood work.

The crossbow was the next important invention made of wood. "That hitherto unknown engine, the crossbow, is not a bow held in the left hand and bent by the right, but can only be spanned by the bearer stooping and placing both feet against it, while he strains at the chord with the full force of both arms. In the middle it has a semi-circular groove of the length of a long arrow, which reaches down to the middle of its stock; the missiles, which are of many and various kinds, are placed in the groove and propelled by the release chord. They pierce wood or any such obstacles, when they strike them." The Catalup was also developed at this time. It could hurl rocks several hundred feet, breaking down walls and fortifications. Another machine along the lines of a machine gun was developed. Several layers of arrows were placed in rows in a beam with holes through it. A plank was then drawn back and then let spring against the butts of the arrows, this sending them with great force at the enemy.

The long bow was developed in England about the year, 1275 A.D. It was an extremely powerful bow. At the siege of Abergavenny in 1277, the Welsh arrows penetrated an oak door four inches thick. A knight received an arrow, which went first through the skirts of his mail-shirt, then through his mail breeches, then through his thigh, from there through

SARACENIC TREBUCHETS (LATE THIRTEENTH CENTURY)

Illustrations from the "Jami-ul-Taitarik" of Raschid-ed-din (published in 1310). The inscription below the smaller trebuchets states that the machines can cast incendiary vessels as well as stones.
the wood of his saddle, and finally penetrated far into his horses' flank. The bows were neither made of horn, ash, nor yew, but of elm. Ugly, unfinished looking weapons, but astonishingly stiff, large, and strong, and equally capable of use for long or short shooting. It was through the use of this bow that the conquest of Ireland was made possible.

Gunpowder was the greatest invention of warfare ever known. The first use of gunpowder was in an instrument called a "madda." It is described as being a hollow cylindrical, wooden log, short like a mortar, and rather broader at the mouth than at the bottom. Thus, modern warfare's greatest weapon was developed from a wooden log.

Since the invention of the cannon, wood has become secondary in its use as a weapon, but nevertheless it is of the utmost importance in keeping an army in the field.

The passing of the bow and arrow, siege machinery, spears, crossbows, and catapults was very fast. About 200 years after gunpowder was first used the above weapons had almost completely passed out of the picture.

About this time in history our own country was being explored and settled. This country went through many of the same steps that many of the European countries went through in their early development. Looking back into the early colonial days we find the Indians using the bow, making use of the fire-arrows we heard of in the earlier history. The settlers used stockades as defensive works to a large extent. The blockhouse is well known to everybody who has
read our early history. The Indians never developed any such siege machinery as in Europe but nevertheless they had the ram. A log handled by a few men. The woods afforded great protection to the troops on some of the early expeditions. Braddock's army was almost completely killed in a fight with the Indians in the French and Indian War, because he did not take advantage of the forest cover.

This new type of warfare was used with great success against the British in the American Revolution. The British were experienced in the open type of battle while the Americans took advantage of all forest cover possible. This was one of the big factors in helping win the war.

This type of tactics is now predominate in all nations, that is, keeping to cover at all times. Where trees do not afford enough cover trenches are used. Trenches were never used until the Revolution War.

Going back to Europe, we find England as early as 1650 beginning to feel the shortage of oak for ship hulls and tall trees suitable for masts. This was becoming very serious about 1700. England then started marking a great many trees in the colonies which were suitable and easily accessible, with the "broad arrow." Thus the beginning of the famous term. England also laid aside certain lands which had oak on them for use of the royal navy. During the Revolutionary War, England was in desperate need of the above articles. They finally secured amounts from Norway and Sweden and other countries. If England had not received these articles from these
these articles from these countries, they would have been at the complete mercy of some other country's navy. The oak found in England at that time was very susceptible to a dry rot, therefore replacements had to be made at frequent intervals. Forests and naval supremacy went hand in hand during this period of history.

Now to our own country: The early government set aside large areas of land along the coast of South Carolina and Georgia as naval reserves. The oak and pine on these areas to be used exclusively by the navy. One of the chief reasons that Florida was purchased was to secure the valuable oak which grew in that region.

We find wood the most important item in ship building until the Civil War when armor clad ships came into being. These ships have wholly replaced wooden ones for battle purposes, but for transport purposes the wooden ship is now and probably will remain in use for a long time.

A glance at the Civil War will show a more intensive use of forest cover for protection and also an increased use of the trench. Wood also played a most important part in the equipping of the army while in the field.

We now come to the World War. This phase of the report will be divided into several different headings. It is this war that we want to study closely so as to look as accurately as possible into the future.


In the advent of the war our countries every resource
was used in every way possible to win the victory. Our iron and wood supplies were the first to feel the awful drain. Troops had to be trained, thousands and millions of them. While in this training they had to be sheltered, transported, and equipped. Wood is the only answer to many of the problems during this period. Below is a list of some of the items used:

1. Temporary factories
2. Houses for civilian workers
3. Railroad requirements
4. Shipbuilding requirements
5. Sewage and water pipes
6. Road structures
7. Mess halls
8. Barracks
9. Latrines
10. Stables
11. Riding halls
12. Amusement halls
13. Water tanks
14. Walks

etc.

When the army gets into the field a great amount of equipment is required if it is to be mobile and operate with the utmost efficiency. Some of the equipment requires exacting specifications, both as to size and species. i.e. Gun stocks; must be of exact size and of walnut. Airplane stocks; must be perfect in texture and strength. Items of equipment made from wood are:

1. Combat wagons
2. Escort wagons
3. Motor vehicles bodies
4. Airoplanes stocks
5. Rifle and pistol stock
6. Field wire spools
7. Artillery wagon wheels
8. Cassions
9. Limbers
10. Surveying instruments
11. Ammunition and spare parts boxes
12. Crates
13. Litters
14. Light railway stock
15. Wood bullets (for new type blank machine gun ammunition)
16. Bayonet scabbards
17. Tent poles
18. Medical chests
19. Tools and tool handles
20. Pontoons
21. Prepared bridge material
22. Machine gun and automatic rifle parts
23. Artillery parts
24. Ramps
25. Barbed wire spools
26. Saddle trees, stirrups
27. Picket pins
28. Machine gun carts
29. Water carts
30. Trench mortar carts
31. Rolling kitchen bodies
32. Powder containers
33. Field desks and equipment
34. Signal equipment
35. Gun tompions

etc.
This partial list of wood equipment items shows the versatility of products of the forest.

2. The Strategic Importance of Forests and Wood Products.

"Woods are an ornament in peace and a fortification in war," wrote Cicero some 2000 years ago. This holds true in modern warfare.

The tactical value of growing timber for the protection from enemy observation of troop concentrations is beyond computation. It means secrecy of operations as well as actual physical protection.

The attack on the St. Mihiel Salient was an excellent example of how troops can be concentrated in the immediate vicinity of the enemy, with absolute secrecy, where protection from enemy observation is adequate. Nearly one million troops were concentrated on this front, within easy range of hostile artillery, during the few days just preceding the initiation of the offensive, but movements were so conducted that the enemy did not suspect anything until the night preceding the assault.

Woods are of equal tactical value in defensive operations as shown by the German defensive measures in the Belleau Woods, the Argonne Forest and others. Had our army been on the defensive these woods would have been of as great value to us as they were to our enemy, and the terrible price we were required to pay for their capture would have been theirs to bear.

In tactical operation of troops in the theatre of oper-
ation troops must be moved from place to place. Road conditions are usually bad near the front which makes the transportation problem very serious. Other problems such as this must be overcome near the line of action. Following is a partial list of those articles, used to aid, protect, or comfort troops in the face of the enemy, which usually must be made by the troops themselves from timber resources of the immediate vicinity.

1. Fascines
2. Hurdles
3. Gabions
4. Timber revetment material
5. Duck Boards
6. Rifle racks
7. Ammunition recess lining
8. Grenade containers
9. Dugout timbers
10. Grenade protection frames
11. Wire entanglement posts
12. Abatis
14. Palisades
15. Temporary bridge material
16. Rafts
17. Gun emplacement timbers
18. Bomb proofs
19. Road and trail material
20. Culverts
21. Drains
### War Dept.

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<th>Rnd Prod</th>
<th>Fuel</th>
<th>Totals</th>
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<td>Year</td>
<td>1,238,086 Steres.</td>
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**TOTALS:**
- Sawn Prod: 3,451,719,557 Bm.
- Rnd Prod: 3,044,317 Pieces.
- Fuel: 1,238,086 Steres.
Fire wood is an absolute essential in the proper care of troops. The amount consumed by an Army is tremendous. In the forward areas troops must secure their own fuel wood and sometimes this gets to be a serious problem.

In the chart accompanying, the report shows the production of firewood, by months.

3. Forest Losses Due to the War

The total area of the French forests situated in the fighting zone and in the regions which were long occupied by the enemy or subject to his fire, has been estimated at 1,482,600 acres. It is estimated that it would take 720,000,000 saplings and 1,851,000 pounds of seed per year for 10 years to reforest the area destroyed.

$800,000,000 is the general estimate of the war losses and loss in reproduction value of the destroyed forests of France. It is estimated that 16,960,000,000 has been felled during the war. Nin-tenths of this timber was used for military purposes. In addition, military operations have destroyed 2,544,000,000 board feet, while the Germans confiscated 2,968,000,000 board feet. The total estimated drain on the French forests is therefore some 22,472,000 000 board feet. It would take France fully one hundred years to fully recuperate from these forest losses, for the reproductive capacity of the French forests has been reduced about 424,000,000 board feet per year over a very long period. Devastated forests in France cannot be put
to agricultural uses because the soil is of such a quality that under French economic conditions the forest crop is the most profitable one that will grow upon the land assigned for forest production.

France is now carrying on a very intensive reforesting campaign, trying to balance her forest budget. We are shipping great amounts of seed to this country at the present.

It is roughly estimated that England, Scotland, and Wales cut about 17,000,000 tons of green timber for war purposes in the three years, 1916, 1917, and 1918. This amount is about twenty times the average annual pre-war fellings. This, however, is only part of loss since the woods had to be slaughtered irrespective of the interests of silviculture in order to keep the collieries and national industries supplied with the necessary timber. This often entailed cutting out suitable sizes for pit-wood and other requirements, and ruining the entire future of the woods. Here is a picture of very poor management on the part of the government toward forests. It is now a different story in England. They have recognized the importance of wood in the plan of national defense, and are engaged on a reforestation movement.

About 13,000,000,000 board feet of timber was felled in the United states for military purposes, and most of this came from the Pacific Northwest. Especially Spruce and Douglas Fir. This cut was calculated only in board feet. An enormous intangible loss occurred along with this cut. These losses occurred in: Inefficiency of
operations, disorganization of the industry, private interests trying to make huge profits, and transportation not well directed.

Almost a 100% of this loss could have been avoided by a little forethought and preparation. But it seems as though the Americans are a "happy-go-lucky people," thinking that God will take care of our "common defense."

We are now in the aftermath of a period of overproduction, and the lumber industry is as hard hit as any of them. This condition is partially caused by an overcapitalization made possible by the great profits made during the war. This condition could have easily have been avoided in the lumber industry if the government had had forest reserves as recommended in the conclusion. The government could have supplied its own needs from its own forests, that way private interests would not have made such enormous profits. Just as soon as the war demand was over the government could have dropped its production and the lumber industry would resume its normal rate of production.

4. Forest Research During the War

"The war was a great factor in bringing out the uses of wood," as stated by Earle H. Clapp.

The activities of the Forest Service, first and last, dwelt with practically every use of wood in modern warfare, aircraft, both heavier and lighter than air, and for both land and sea, wooden ships, military vehicles, boxes and crates, containers, packers, lumber and structural timber, offensive and defensive gas warfare, grain alcohol, acetate
of lime, pulp for explosives, hardwood distillation for various purposes, wood limbs, fiber board, wooden pipe, implement handles, rosin for shrapnels, and naval stores products. The number of individual tests amounted at the end of the war, to no less than 300,000 and covered 130 American species.

The dry kiln received its first real recognition as a real factor in the lumber industry during the war. So from the research standpoint the war adds a great deal to the lumber industry, pushing the work many, many times faster than would ordinarily have been the case.

American Forests, March, 1919,

"A force of nearly 400 employes of the U. S. Forests Products Laboratory is working in cooperation with the University of Wisconsin, on research work with reconstruction.

The laboratories war time achievements are unique in that practically all of them can be turned effectively to uses of peace. More than 300 kinds of the type developed by the laboratory in various parts of the country, which were used in drying airplane material, gunstocks, and vehicle parts, for use of the government in war, can now be turned to account in the pursuit of peaceful occupations."

Uses of Wood by the War and Navy Departments During Peace

The army and navy use several million board feet of wood every year, in such ways as:

1. Summer camps

The ROTC and CMTC summer camps demand a great deal of lumber in building the floors of tents, the
temporary mess halls, latrines, supply houses, sidewalks, etc. The National Rifle matches held at Camp Perry every year demand large quantities of lumber, for about the same reason as given above.

2. Targets

The navy and coast artillery use targets mounted on wooden frames, the large number of these used runs the number of board feet up to a sizeable figure.

3. Material

The army and navy both use lumber for material, such as gun stocks, tripods for surveying instruments, wagons, and many other uses.

4. Army Engineers

The army engineers use large amounts of wood in their construction work. Such as the construction of the Panama Canal, flood control work on the Mississippi, and many other peace-time activities.

5. Firewood

Large amounts of cord wood are sold to the army each year to be used for heating purposes.

Conclusion

From the above report it can be seen that wood is an absolute necessity in the success of military operations. There is no doubt but what wood will be just as important, if not more so, in any future operations, as it was in the last major war.

With this in mind I want to make some recommenda-
tions as to creating a Military Forest Reserve which would eliminate many of the faults which existed in the last war. These points were stressed earlier in the report.

The features that must be observed in these reserves are:

1. Securing proper species.
2. Strategic requirements.
3. Production of full war requirements.
4. Accessibility.

A bureau should be set up in the War Department which would cooperate with the Forest Service in the handling of these reserves. The reserves should be cut by and used for the army and navy only. During peace times these areas could be cut by special forestry units. This would serve two purposes. The reserves could be made self sustaining and a special army unit would be trained in the production of wood in the case of an emergency. By taking this step our national defense would be greatly improved and a supply of war material would be readily available.

"In the depth of the wood the country has its heart." This should never be forgotten.
Bibliography:

1. A History Of The Art Of War In The Middle Ages------
   Charles Oman
2. Forestry Instructions------ J. D. Guthrie
3. American Forestry
4. Governmental Development of Forestry------Cameron
5. Thesis------Sereno E. Brett

Submitted by:
Loren L. Stewart
B.S. Logging Engineering.
Uses of the different trees:
Scotch Pine—The major product will be sawn into standard sizes including standard gauge railroad ties, utilizing cord wood limbs and other parts not suitable for other purposes. Other products on special orders.
Fir—The major product will be sawn into standard sizes, including standard gauge railroad ties, utilizing for cord limbs and other parts not suitable for other purposes. Other products on special orders.
Spruce—The major product will be sawn into standard sizes including standard gauge railroad ties, secondary products, road plank, cord wood from tops and limbs; other products on special orders.
Hardwood Forest produce: Artillery plank
Road plank
Bridge timbers
Ties
Fuel
Softwood Forest produce: Lumber
Railroad Ties
Pole or pile operations produce:
Piles
Pit props
Poles
Wire entanglement stakes

The conversion factor used was:
One cubic meter equals 200 feet B. M. (the actual average was 210, but the yield varies with the size of the timber, under-running in small stuff and over-running
in the larger sizes.
RECAPULATION OF DAMAGES CAUSED BY THE WAR
TO FRENCH AGRICULTURE

1. Direct damages (material and Certain).

<table>
<thead>
<tr>
<th>Category of damages</th>
<th>Value, 1914, (in millions of frs.)</th>
<th>Value of Re-constitution, 1919 (in millions of frs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture not including rural construction and the deficit of production</td>
<td>7,221</td>
<td>14,349</td>
</tr>
<tr>
<td>752*</td>
<td>1,463*</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>68</td>
<td></td>
</tr>
<tr>
<td>46</td>
<td>46</td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>162</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>8,135</td>
<td>16,108</td>
</tr>
</tbody>
</table>

2. Indirect Damages

<table>
<thead>
<tr>
<th>Category</th>
<th>Value, 1914</th>
<th>Value of Re-constitution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>4,016</td>
<td>4,016</td>
</tr>
<tr>
<td>Forests</td>
<td>200*</td>
<td>200*</td>
</tr>
<tr>
<td>Hunting</td>
<td>17</td>
<td>17</td>
</tr>
<tr>
<td>Fishing</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Irrigation</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Agriculture credit</td>
<td>11</td>
<td>12</td>
</tr>
<tr>
<td>Breeding stud</td>
<td>Y 2</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>4,281</td>
<td>4,283</td>
</tr>
</tbody>
</table>

Total of direct and indirect damages | 12,416 | 20,391 |
TO THE OFFICERS AND SOLDIERS OF THE 20TH ENGINEERS
AND ATTACHED SERVICE TROOPS

On November 25, 1917, the first board was cut in France by American Forestry Troops at a little French mill in the Jura Mountains. At the same time, another detachment was getting out 50 foot piling in the Landes on escort wagons drawn by hand. The total cut during December, 1917, was 321,000 board feet of lumber and 12,000 railroad ties.

When the armistice was signed on November 11, 1918, the 20th Engineers were operating 81 American Sawmills and producing 2,000,000 feet of lumber and round products every working day. Up to December 1st we have cut a total of 272,500,000 feet of lumber, including 2,728,000 railroad ties, together with 38,000 pieces of piling, 2,739,000 poles of all sizes and 892,000 steres of fuelwood.

Recent reports from the various depots and construction projects of the A.E.F. show that the Army was, at the time of the conclusion of the Armistice, well supplied with lumber. When ties were called for in large quantities to support the advance of our troops at St. Mihiel and in the Argonne, they were ready. At practically every
dock project, deliveries of piling and lumber were well ahead of construction. In other words, the Forestry troops have made good on the work for which they were brought to France. Notwithstanding the difficulties in obtaining equipment and transportation, notwithstanding the enormous increase in the size of the A.E.F. and the work which it undertook over the original estimates, the Army has been given lumber which it needed, and the suspension of hostilities find us with a substantial surplus which will be used for the restoration of France. This is an achievement in which every man in the Forestry Troops may well take pride, for every one of you have had a share in it. Your part in winning the war has been as important as that of any other troops in the A.E.F. Your loyalty and enthusiasm has been put to a hard test. You wanted to get to the front but could not; you have had to put in long hours of the hardest kind of work, month after month, without glory or excitement, and without the special forms of recognition given to Combat Troops. The Medical Officers have told us that the Forestry Troops were being worked too hard, but the only answer has been a steadily increasing cut of lumber from month to month. You have failed in no task that has been assigned to you. You have gotten more out of sawmills than had ever been dreamed of by mill operators at home. Time and again, in spite of difficulties such
as lumbermen never contended with before, you have exceeded our expectations. Your record as members of the A.E.F. will be a source of pride and satisfaction to you as you return to civil life. It will be your recompense for the sacrifices which many of you have made to come to France.

J. A. Woodruff
Colonel Engineers.
AMERICAN COMMISSION TO NEGOTIATE PEACE  
WAR DAMAGES IN ALLIED COUNTRIES  
53 Avenue Montaigne, Paris.  

January 16th, 1919  

FINAL REPORT ON FORESTRY DAMAGE

1. Classification of Forest Damage for which justifiable claims can be made.

A. Physical Damage
   1. Resulting from active military operations eg, shell fire
   2. Resulting from cutting by Germans
   3. Resulting from overcutting by allied armies in zone of active operations.
   4. Damage to roads maintained by Forest Service.
   5. Loss of timber cut and on ground August 1, 1914.
   6. Damage to sawmills and equipment.
   7. In (1) and (2) timber may be either totally or partially destroyed, in (3) timber can be only partially damaged. The possible factors of damage in any case may be as follows:

   (a) Timber totally destroyed.
      (1) Mature timber the measure of damage for which would be the sale value.
      (2) Immature timber the measure of damage for which would be the replacement value or expectation value.
      (3) Cost of restoring forest conditions when under normal conditions there would have been no expense.
      (4) Loss in increment till forest conditions re-established.
      (5) Loss in interest on sale value from moment of destruction till payment is made.
      (6) Loss in productivity due to soil damage.

   (b) Timber damage
      (1) Loss in productivity until forest conditions restored.
      (2) Any costs connected with restoration of forest conditions, such as planting, cutting back stumps, removal of borden limbs and etc.

B. Indirect Damage

Indirect damage to lumber industry due to lack of supply or raw material due to lack of profits through inability to operate due to loss of customers for product and general disturbance to business.
I. Physical Damages

1st-Damages to immovable property

1. Standing timber
2. Soil (destruction apart from standing timber with the productive capacity for timber upon 200,000 hectares.

The damage is represented-

a. By the expenses of reforestation, leveling and etc.

b. By the check on forest vegetation from the moment of destruction until the moment of reconstruction, that is to say on an average of seven years.

3. Highways, boundaries, etc.

Total

2nd-Damage to movable Property

1. Timber cut and trimmed but remaining upon the ground, 1st of August, 1914-

<table>
<thead>
<tr>
<th>Item</th>
<th>1914 Value</th>
<th>Coefficient of Destruction</th>
<th>Total Loss after the Application of the Coefficient of Increase</th>
<th>Cost of Reconstruction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st of August, 1914</td>
<td>200,000</td>
<td>50</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>1st of August, 1914</td>
<td>200,000</td>
<td>42</td>
<td>42</td>
<td>63</td>
</tr>
<tr>
<td>Total</td>
<td>717</td>
<td>1</td>
<td>717</td>
<td>1413</td>
</tr>
</tbody>
</table>

II INDIRECT DAMAGES

1. Loss resulting, from the point of view of National wealth, from reduction in the production timber during a period of from 40-80 years, inconveniences resulting from the increase in imports, loss to local labor, etc.

GENERAL TOTALS

3% compounded—Standard figure used in French calculation.

Hectare equals 2.47 acres.
NORTHERN FRANCE—A BATTLE-SCARRED AREA, AS IT APPEARS TODAY

A scene at sunset on the National road between Soissons and Chavignis, at one time the very center in the turmoil of battle. These skeletons—mute and pathetic witnesses—are all that remain of the once magnificent avenue of trees which lined the road.