Forests and Warfare in World History

J.R. McNeill
Georgetown University

For better and for worse, both woods and warfare are fundamental factors in human life, and have been for a very long time. Humankind evolved in park like savannas of East Africa, from hominid ancestors who had lived in forests. We, and they, have used woodlands, and to some extent have been shaped by woodland environments, for millions of years. Warfare, at least on small scales, also extends very far into the human past, and, to judge by the behavior of modern chimpanzees, probably occupied the energies and shortened the lives of our hominid ancestors too. So, in all likelihood, we and our forebears have been making war amid woodlands for at least a million years.[1]

War and warfare is one of the favorite historical topics and has attracted some of the best historians, from Thucydides onward. Forests, forestry, and deforestation also have a distinguished historiography, if rather smaller. Here I propose to explore some of the links and intersections between these two historical subjects.

Before I proceed, it may be helpful to explain some of the things that I am *not* trying to do. I will not argue that warfare has been of crucial importance in the history of forests generally, nor will I contend that forests have been a major influence upon military history generally. My goal is more modest: I will try to show that at certain

[1] For chimpanzee and hominid organized violence, see Franz De Waal, *Chimpanzee Politics: Power and Sex Among Apes* (Baltimore: Johns Hopkins University Press, 1998); for prehistoric warfare, Lawrence H. Keeley, *War Before Civilization* (New York: Oxford University Press, 1996).

times and places the links between military affairs and forests were significant, either for warfare or for forests, or for both. I also hope that some of the points of intersection between forest history and military history prove interesting and instructive, even when not of central importance for larger narratives.

In pursuing this theme I will range over some 30 centuries of history and venture around the world, from New Zealand and Japan to Britain and Brazil. This, then, is an excursion into world history as well, in which I hope to point out some large-scale patterns that transcend the borders and boundaries of particular eras and epochs, as well as of specific societies, states, and civilizations.

I will approach the subject from four different directions, but in every case will arrive at the links between forest history and military history. First I will consider forests as a source of war materiel. Second, I will turn to forests as a direct factor in how wars were fought. Third, I will treat the direct impacts of combat itself upon forests. And fourth, I will reflect upon the impacts upon forests of the business of preparation for war. Obviously these four approaches are closely connected to one another, and in practice will spill over into one another.

I. Forests and Woodlands as a Source of War Materiel

One of the characteristics of human beings is that we make war with weapons. Our limbs and teeth are unimposing, and have probably atrophied over evolutionary time

because our big brains allowed us to hunt and fight as a cooperative enterprise. Big brains also allowed us to fashion clubs, spears and other such instruments of violence. The earliest weapons—clubs, spears, slings, bows and arrows—typically required wood construction, even if the business end was made of sharpened stone or, at later times, of metal.

Metal weaponry, which is only a few thousand years old, required much more wood. Bronze weapons have existed for about 5,000 years, and iron ones for perhaps 3,400 years. Not only were the shafts of bronze-pointed spears made of wood, but the bronze required smelting, which normally involved a wood or charcoal flame, and the original mining of tin and copper (the ingredients of bronze) presumably sometimes required pit props. Cyprus, a major source of copper in the ancient Mediterranean, had lost most of its forests by 1200 BC, largely on account of copper smelting. Iron ores were comparatively abundant around the world, so iron weapons were usually cheaper than bronze ones, and by 2,800 years ago had become commonplace even among pastoral tribes in Eurasia and northern Africa. Iron weapons were also just as good bronze ones, and so wherever ironworking technology spread—which was very widely in the Old World by 500 B.C.—the production of iron weaponry placed an increasing pressure on wood supplies. In the African Great Lakes region, an early site of iron production, this would have made only the slightest difference to the spatial extent of forests, because they were abundant and in most locations their re-growth would have been rapid. In Egypt or Mesopotamia, where woodlands were scarce and military requirements sometimes heavy, the demands of smelters producing iron for weaponry might easily

have made a discernible difference to the extent of forest cover.[2] But one cannot know on just what scale because, although archeologists can draw inferences about production levels and charcoal use at various ancient smelter sites, it is beyond even their skill to discern the uses to which smelted metals were eventually put.

Warfare has always involved logistics and transport as well as weapons. The first animal-drawn carts and battle wagons appeared in Mesopotamia around 4,700 years ago. Made mainly of wood, they became a routine implement of warfare for sedentary societies throughout Eurasia. They carried supplies and, when arranged in a circle, served admirably as mobile defenses, especially against horsemen. Chariots, which allowed bowmen or even heavily armored warriors to move around a battlefield quickly, appeared around 4,100 years ago and also made their debut in Mesopotamia. They too were made chiefly of wood (surviving Egyptian examples used mainly elm, ash, and sycamore, all of which Egypt would have had to import).[3] They helped revolutionize war and society, bringing about a widespread transition in social organization toward warrior aristocracies of the sort limned by Homer in *The Iliad*. From Egypt and Britain in the West to China in the East, war chariots remained a powerful instrument of war for roughly 1,000 years wherever the requisite skills, horses, and wood could be brought together, and still found uses in technologically backward areas, such as Britain, as late as the early centuries A.D. Societies blessed with abundant grassland for horses, mines and woodland for weaponry and chariots were best situated to build and maintain the most

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[2] Almost all ancient Egyptian weaponry involved wood. See Ian Shaw, *Egyptian Warfare and Weapons* (Shire Publications: Princes Riseborough, UK, 1991), 31-44. For ancient Greece: Anthony Snodgrass, *Arms and Armour of the Greeks* (Ithaca: Cornell University Press, 1967).

[3] On the composition of Egyptian chariots, see http://www.reshafim.org.il/ad/egypt/timelines/topics/chariot.htm#rem2

formidable military machines in the era of chariot warfare. This helps explain the geopolitical success of societies based in North China, Iran, and Anatolia during the millennium ending around 500 B.C., although obviously many other matters besides ecological endowment were involved.

Chariot warfare came and went, but the use of wood in fortification continues to this day some 9,000 years after its debut. The earliest archeological record of fortifications is found in southwestern Asia, involving earthen and wooden works.[4] These two materials remained the basis of fortifications around the world until concrete in the 20th century, although stone walls figured prominently in settings as diverse as Bronze Age Mycenae (Greece) and 15th-century Inca Peru.

Probably most agricultural societies in world history built defensive fortifications of wood. I shall focus on only four, ancient Rome, Tokugawa Japan, imperial Russia, and Maori New Zealand. Their geographical and chronological spread gives some indication of how pervasive was the reliance upon wood for fortification prior to the last century.

The ancient Romans achieved lasting fame for their doggedness and skill in fortification. As their republic and then empire grew, they had every reason to construct extensive systems of defenses, most of which they did along the frontiers and in the conquered provinces (at least from the time of Augustus' consolidation of power 27 B.C.

[4] On fortification, and weapons, in southwest Asia see Yigael Yadin, *The Art of Warfare in Biblical Lands* (New York: McGraw-Hill, 1963) 2 vols.

– 14 A.D.). They also tried to standardize construction procedures. Of course ecological conditions did not easily permit standardization: the available materials in Germany or Britain included abundant timber, whereas in Libya or Egypt timber was always rare and precious.

So it was on the European frontiers that the Romans built their forts of wood. After invading in 43 A.D., they built several hundred in Britain alone, most of them on a square plan, some of them, like Inchtuthil in Scotland, as much as 500 meters to a side and covering 20 hectares. A more typical fort in Roman Britain covered about 2 hectares, and was built in a larger clearing, usually about 5 hectares. One of the considerations in choosing a site was suitable timber supply. Structural timbers alone for an average-sized fort in Roman Britain required felling 6 to 12 hectares of mature forest.[5] And structural timbers in contact with the earth would rot and thus require replacement every 25 years or so. For about a century and half in northern Europe and for half a century along the Danube frontier, Roman authority rested on these wooden strongholds. A beautiful frieze on Trajan's column in Rome, depicting scenes from the campaigns late in the 1st century AD along the Danube, testifies to the importance of timber—mostly oaks in this case-- in Roman fortification of the early empire. By the time of Hadrian (reigned 117-38 AD), the Roman Army had come to the conclusion that it was in these lands for the long haul and began to rebuild its fortifications in stone. Soldiers and commanders may also have found the labor required to bring strong timbers ever longer distances to their existing forts more discouraging with each passing year.

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[5] Anne Johnson, *Roman Forts of the 1st and 2nd Centuries AD in Britain and the German Provinces* (New York: St. Martin's Press, 1983), 40.

These Roman forts of course represented only a small part of the significance of forests as sources of war materiel in Roman Europe. Rome's enemies had built wooden stockades and fortified villages well before Caesar and his legions set foot in Gaul or Britain. The Roman forces also built bridges, temporary roads, and siege towers out of wood, and of course they used wood for fuel in their encampments and forts, as did everyone else. For that matter, even after they began building their forts with stone, they needed plenty of timber for scaffolding and props. In Roman Europe, wood was a crucial component of military power, especially when combined with military engineering expertise of the sort Roman armies were justly renowned for. But despite all the felling and burning, because the Romans were few and the trees many, Northern and Danubian Europe retained most of its forest cover until medieval times. [6]

Fifteen centuries later at the other end of Eurasia, timber proved equally important in another pulse of fort building. In Japan the provincial magnates, the *daimyo,* began building forts in the 12th century. In the 16th century, guns and other factors encouraged the centralization of power, culminating in the Tokugawa Shogunate (1603-1868). The *daimyo* had to build large forts if they wished to remain independent. Between 1467 and 1590, they built about 200 large forts. Cost considerations and tradition dictated that these would be made of timber. The *daimyo* and their warriors (*samurai*) also built numerous stockades, palisades, and barricades of wood. By the 1550s some *daimyo*

[6] In addition to Johnson's book, some details of Roman use of wood in fortification can be gleaned from Russell Meiggs, *Trees and Timber in the Ancient Mediterranean World* (Oxford: At the Clarendon Press, 1982), ch. 6. Some details on medieval European wooden fortifications, siege towers and such are in Roland Bechmann, Des *arbres et des hommes: La forêt au moyen-âge* (Paris: Flammarion, 1984)

began regulating forests in order to preserve their dwindling timber supplies. However, their forest preservation efforts worked to the benefit of their chief enemy when a humble soldier, Toyotomi Hideyoshi (1536-98) and his successor Ieyasu Tokugawa (1542-1616) managed to consolidate power, centralize Japan, subordinate and impose peace on the fractious *daimyo*. This had the effect of unleashing a boom in construction, including military construction, because the consolidation of power involved projecting the image of authority as impressively as possible. Hideyoshi and Ieyasu built monumental castles, as well as lavish palaces and temples. Hideyoshi installed a system of timber-tribute that *daimyo* had to pay to him, and Ieyasu expanded that system and improved transport to ease the shipment of timber to his strongholds; with this system of supply, the Tokugawa shoguns could complete their castle-building program. Based on the work of Tokoro Mitsuo, Conrad Totman estimated that three good-sized castles consumed the timber from 2,750 hectares of prime woodland, and many times that if the timber came from ordinary forest.[7]

Meanwhile *daimyo* continued to build castles of wood, if more for display than for military purposes. Castle building continued into the 18th century, although its pace declined after 1620 or so. By the 1660s Japan's great virgin stands of timber were gone, and scarcity had become a problem throughout the country. Timber quality had declined, because the demands of construction (not merely for castles of course) had consumed

[7] Conrad Totman, *The Green Archipelago: Forestry in Pre-Industrial Japan* (Berkeley: University of California Press, 1989), 62.

timber faster than Japan's landscape could regrow it. Wood shortages prompted the Japanese state to focus on forest conservation and restoration from the mid-17th century.[8]

The Japanese case suggests that perhaps in the era of the Military Revolution states in general made greater demands upon forests. The Military Revolution, commonly dated to about 1450-1700, consisted of the use of gunpowder, especially in cannon; of heavier fortification; and of more bureaucratized, larger-scale militaries and states.[9] Even though the characteristic fortifications of the military revolution outside of Japan were made of earth and stone, everywhere they required timber during the construction phase. The larger scale of military operations in general meant more carts, wheels, gun-carriages, more ammunition boxes and powder barrels, more barracks, barricades, and palisades—and more ships (of which more below). The manufacture of gunpowder from saltpeter, for example, required fuelwood, about 15-20 tons of wood for each ton of saltpeter. In the Ottoman Empire, annual saltpeter production in the mid-17th century used as much fuel as a city of 100,000 to 200,000 people.[10] The military revolution took varying forms in different lands, but in general affected Eurasian and North African states from Japan in the east to Morocco and Britain in the west. Fielding a formidable military after 1450, on land as well as at sea, required not merely more money, men, horses, metallic ores, and saltpeter but more timber too. Indeed the

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[8] Totman, *Green Archipelago*, chapters 3 and 4. See also Michel Bur, *Le château* (Turnhout: Brepols, 1999) for material on Japanese castles.

[9] Geoffrey Parker, *The Military Revolution: Military Innovation and the Rise of the West, 1500-1800* (Cambridge: Cambridge University Press, 1996); J.R. McNeill and William H. McNeill, *The Human Web* (New York: Norton, 2003), 192-200.

[10] Gabor Agoston, *Guns for the Sultan: Technology, Industry, and Military Power in the Ottoman Empire* (Cambridge: Cambridge University Press 2004 forthcoming).

simultaneous requirement of horses and timber increasingly rewarded states with a specific ecological profile, one that included both grasslands and forests.[11]

One of the states most strongly affected by the military revolution was Muscovy. The earliest towns and monasteries of medieval Muscovy had been fortified places, built of wood. The typical Slav village was surrounded by a wooden stockade. By the 15th and 16th centuries the tsars of Moscow were engaged both in centralizing and expanding their power. This included conquest and colonization of lands to the northwest and northeast of Moscow, and eventually in Siberia and what is now southern Russia and Ukraine. As with the Romans before them, Russian expansion required a permanent military presence among the subject populations, which implied a system of fortification in conquered provinces and along far-flung frontiers. So the Russian state embarked on a lengthy and intensive program of fort-building, using, for the most part, wood. Also like the Romans, the Russians preferred to build their wooden forts to a specified plan, although they had to adapt that plan to local circumstances. In the northern reaches and in most of Siberia, timber was cheap and plentiful. In the steppelands of the south it was not, but it could be found here and there, or if necessary transported via the Volga or the Don river systems. The Russians built a series of wooden fortifications at Astrakhan, on the Caspian Sea, with timber floated down the Volga.[12] As their empire expanded southward, the Russians sometimes dismantled wooden fortifications in central Russia

[11] For world environmental history in the early modern centuries, see John F. Richards, *The Unending Frontier* (Berkeley: University of California Press, 2003), a book which contains a goodly amount on military affairs.
[12] Alexander Opolovnikov and Yelena Opolovnikov, *The Wooden Architecture of Russia* (New York: Abrams, 1989), 90.

where they were no longer needed and shipped them south, where they were reassembled for frontier duty.

Russia continued to build wooden forts in eastern Siberia as late as the 1840s, long after the time when, in the western reaches of the empire (and throughout most of Eurasia) heavy cannon had made wooden fortification obsolete. The Russian logic of building with wood lay not only in its low cost, but in the fact that in Siberia their enemies lacked artillery and siege craft. But they were quick learners when it came to building timber forts. Russia's enemies in Siberia, the Yakuts for example, learned the arts of wooden fortification so well some of their forts could resist Russian field artillery in the 18th century.[13]

Among the most skilled architects of wooden fortifications were New Zealand's Maori. They are a Polynesian people, who originally settled New Zealand around 1300 AD (perhaps as early as 1000 AD). Upon arrival they found a heavily wooded landscape with excellent timber trees. After an initial period of adjustment, the land provided well for a few centuries, but resources had begun to seem scarce by the 16th century, encouraging conflict. By 1500 they had organized themselves in rival tribes and fought frequently. Every Maori settlement now required a *pa*, or fort, into which people could flee in the event of attack. Every chief, to call himself a chief, had to have a *pa*: it was necessary for prestige as well as defense. These had wooden palisades and storehouses to withstand prolonged sieges.

[13] These paragraphs rely on Opolovnikov and Opolovnikov, *Wooden Architecture of Russia*, 83-141.

After 1769, when Captain Cook arrived in New Zealand, followed in due course by whalers, missionaries, and settlers, politics and military affairs in New Zealand grew more complicated. In the 19th century, one of frequent warfare among the Maori as well as between Maori and the British Army (which was trying to make New Zealand safe for white settlement), chiefs built very elaborate *pa*, with tunnels, deep redoubts to withstand artillery barrages, all constructed of timber and earth. New Zealand has in all about 6,000 *pa* sites, most of them constructed in the 18th and 19th centuries.[14]

Neither the Maori *pa* nor the Muscovite fort had an impact on forests similar to the Japanese castle construction binge. Russia and New Zealand remained well-forested until after the middle of the 19th century, although patches were cleared around every fort and *pa*. If forest did not grow back, that was because open spaces and long views of approaching enemies made sense for defensive purposes. Moreover, in both cases forest clearance for agricultural purposes greatly exceeded that for strictly military ones, although it is true that, again in both cases, wooden fortification provided a measure of security that encouraged the extension of farming. Nonetheless, the abundant forests of Russia and New Zealand had a greater impact on war and fortification than war and fortification had upon the forests.

After the 19th century, other materials almost completely supplanted wood in fortification, because big guns firing explosive ordnance could make short work of timber

[14] See James Belich, *Making Peoples: A History of the New Zealanders from Polynesian Settlement to the End of the Nineteenth Century* (Honolulu: University of Hawaii Press, 1996); and Belich, *The New Zealand Wars and the Victorian Interpretation of Racial Conflict* (Auckland: Auckland University Press, 1986).

defenses. Scaffolding and props of course were still required to build in concrete, but a long era, in which fortification had relied heavily on forest timber, had come to a close.

Another ancient military use of wood, which also lasted through the 19th century, was for naval ships. The earliest archeological finds of ships devoted specifically to naval purposes—war galleys—date to roughly 2,800 years ago. Historians since Thucydides have often meditated upon the subject of naval timber supply. Thucydides himself had good reason to ponder it since as an Athenian commander in the Peloponnesian War he was held responsible for the loss of the Thracian port of Amphipolis, through which Athens had acquired part of its indispensable naval timber. (For this failure Thucydides earned a 20-year exile and the leisure to write his history.)

In the ancient Mediterranean world, good ship timber was often of the first importance. Pharaonic Egypt, which had scant ship timber of its own, frequently tried to exert control over the mountains of Lebanon and its cedar forests. An inscription reveals that cedar imports for ship construction (not necessarily for naval purposes) in Egypt date to at least 2600 BC.[15] Lebanon's tall cedars were famous throughout the ancient Mediterranean, and featured in some of the world's earliest literature, such as the Epic of Gilgamesh and the Bible. The seafaring Phoenicians derived much of their success and prominence as traders throughout the Mediterranean from their reliable access to high-quality ship timber in the mountains behind their cities of Byblos, Sidon, and Tyre. That

[15] Meiggs, *Trees and Timber*, 63. Or so Meiggs interprets the Egyptian terms. Some confusion surrounds the identification of tree species in ancient texts.

ship timber was a main reason, perhaps *the* main reason, why Egypt tried hard to prevent any other power from controlling the Lebanon.

Cedar, fir, and pine were the preferred ship timbers of the ancient Mediterranean. The Greek natural history author Theophrastus explained that triremes and other warships were made of mountain fir, because it is lightweight, allowing ships to be fast and maneuverable. Merchantmen were made of pine, which was more durable, while on the Syrian and Lebanon coast shipwrights used cedar because it was abundant. Keels required sturdy oak, because they had to withstand hauling.[16] Ship timbers existed in abundance on the Mediterranean's northern shores, so that for example when the Athenians responded to the threat from Persia in 482 BC they could build some 200 triremes in two years. In 406 BC, during the Peloponnesian War, Athens also built triremes quickly in a moment of crisis. The Roman Republic could do the same thing, on an even larger scale, when it suddenly needed a fleet in its wars with Carthage beginning in the third century B.C. In general, in the context of the ancient Mediterranean (for which the sources are far more eloquent than anywhere else in the world at that time), states rarely had trouble finding ship timber, and when difficulty arose it was a matter of supplies being interrupted for political reasons. The best timbers stood in Macedon, Thrace, Italy, the coastal mountains of Anatolia and Lebanon, and on Cyprus. Among states with any naval ambitions, diplomacy and strategy always included considerations of access to these provinces.[17]

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[16] Theophrastus, *Enquiry into plants* 5.7..1-3, quoted in Meiggs, *Trees and Timber*, 118.
[17] Meiggs, Trees and Timber, ch. 5; Lionel Casson, *Ships and Seafaring in Ancient Times* (Austin: University of Texas Press, 1994); Casson, *The Ancient Mariners: Seafarers and Sea Fighters of the Mediterranean in Ancient Times* (Princeton: Princeton University Press, 1991).

The great powers and maritime empires of the age of sail also had to ensure access to forested lands with good ship timber. By the 16th-19th centuries, naval vessels increasingly became cannon-platforms, built for strength more than for speed. This was especially so in the rough waters of the Atlantic; much less so in the Mediterranean, where swift galleys remained part of navies into the 18th century. Big ships-of-the-line required plenty of stout oak, including special crooked timbers (called knees or compass timbers), as well as pine and fir for masts and spars.

Although not primarily maritime states, great powers such as the Ottoman or Chinese empires needed navies to protect their interests. The Ottoman Empire from the early 16th century deployed a large navy in the eastern Mediterranean and required abundant ship timber from forests already much depleted. In the 17th century the forests from which it drew its naval timber stood as much as 50 kilometers inland, behind the coasts of the Black Sea, Sea of Marmara, and the northeastern Aegean. One of the constraints on Ottoman expansion into the Indian Ocean was the difficulty of arranging supplies of naval timber for the Basra shipyard, which had to import suitable wood from Anatolia down the Euphrates.[18] The Qing Dynasty in China during the 17th century, confronted with persistent piracy and raiding along its eastern coasts, found it necessary

[18] On naval timber in the Ottoman Empire, Idris Bostan, *Osmanlı Bahriye Teşkilâti: XVII. Yüzyilda Tersâne-I âmire* (Ankara: Türk Tarih Kurumu Basimevi, 1992), 102-21; and Salih Özbaru, "XVI yüzyilda Basra körfesi sahillerinde Osmanlilar," *Tarih Dergisi* 25(1971), 60.

to build up its navy. But it faced similar wood shortages and shocked observers by felling tall trees in graveyards, previously safe from military timber-cutting.[19]

The maritime empires of Venice, Genoa, the Dutch Republic, Spain, France, and Britain all faced a broadly similar problem. In medieval times Europe's forests had shrunk considerably, mainly because of agricultural expansion. This brought on the prospect of shortages of ship timber. The Venetians sought to conserve forests under their political control from at least the 14th century, with an eye toward maintaining supplies for the fleet. In particular, the Venetians worried about supplies of crooked oak, needed for knees in the construction of large vessels, and of beech for oars in their naval galleys. By 1550 they were thinking in terms of sustainable yield forestry, although it is not clear they ever practiced it. After 1569 they regularly counted the number of oak trees in Venetian territory and registered each oak's dimensions and characteristics. In the 17th century they often mounted raiding parties to venture into Ottoman territory in the Balkans to harvest a few good oaks. Venice took special pains with its forests, because it was unusually dependent on maritime prowess for its prosperity, and because the city itself needed oak for piles to serve as foundation for buildings and breakwaters. Venice was married to the sea, and thus tied to its timber supplies.[20]

The Dutch Republic also depended on seaborne success. But it had far less forest of its own than did Venice. Indeed, of all the European imperial powers, the Dutch had

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[19] Mark Elvin, *The Retreat of the Elephants: An Environmental History of China* (New Haven: Yale University Press, 2004), 44.

[20] Ruggiero Romano, "Aspetti economici degli armamenti navali veneziani nel secolo XVI," *Rivista Storica Italiana* 66(1954), 36-67; Karl Appuhn, "Inventing Nature: Forests, Forestry and State Power in Renaissance Venice," *Journal of Modern History*, 72(2000), 861-889.

the most unfavorable ratio of domestic forests to overseas ambitions. Their solution was to pay for logs and to keep a sufficient number of suppliers active that no single foreign power could deny the Dutch sawmills and shipyards the necessary quantities of timber. Until 1680 they relied chiefly on Norway, but increasingly they turned to German timber floated in great rafts down the Rhine, and to the vast forests of the Baltic region.[21] The Dutch East India Company, a quasi-statal entity that routinely engaged in war as well as trade, also built ships using teak in what is now Indonesia.[22]

The Atlantic powers Britain, France, Portugal, and Spain all needed navies to maintain their imperial might, and their navies in turn needed ship timber. In every case the state tried to protect forests, especially those with either old oak or tall, straight pines. And in every case the supply of appropriate timbers grew alarmingly scarce, requiring recourse to distant and uncertain sources such as the Baltic or overseas colonies. The British and French turned to North American forests in the 18th century for mast timber, and even to the Balkans, then mainly Ottoman territory, for hard oak. Britain also built naval ships in India. Portugal, like the Netherlands, had only small forests but large imperial ambitions. Its royal shipyards turned to Brazil for ship timber and on a lesser scale to India, where it had small outposts of empire. By the 18th century Portugal had built a naval shipyard in Brazil, which soon accounted for the majority of the tonnage in the Portuguese navy.[23]

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[21] Jan de Vries and Ad van der Woude, *The First Modern Economy: Success, Failure and Perseverance of the Dutch Economy, 1500-1815* (Cambridge: Cambridge University Press, 1997), 423-9.
[22] Peter Boomgaard, "The VOC Trade in Forest Products in the 17th Century." In: Richard Grove, Vinita Damadoran, and Satpal Sangwan eds., *Nature and the Orient: The Environmental History of South and Southeast Asia* (Delhi: Oxford University Press, 1998), 388-89.
[23] On Britain see Robert G. Albion, *Forests and Sea Power* (Cambridge, MA: Harvard University Press, 1926); Ian Friel, *The Good Ship: Ships, Shipbuilding and Technology in England, 1200-1520* (Baltimore:

Spain also had great imperial ambitions from the 16th century but a limited supply of suitable forest. The first great fleet in Spanish history was the famous armada of 1588, sent unsuccessfully to defeat England. Its 300,000 tons of shipping required about 6 million cubic meters of timber, oak and pine in equal proportions.[24] By the late 16th century European warships has become large, heavy cannon platforms, built to withstand enemy fire more than to evade it. They were as large as any wooden ships ever built, as much as 2,000 tons burden; a French king had a tennis court installed in one. While Spain did not run out of forest in maintaining an oceanic navy, it eventually did run low on oak and pine in accessible locations. In response, from the early 18th century, Spain, like its imperial rivals and allies, turned to forests elsewhere, in Italy, in the Balkans, and especially in its overseas empire. An 18th-century ship-of-the-line required 4,000 mature oaks.[25] Over the course of the 18th century, during which Spain fielded what was usually the third-largest navy in the world, about 35% of its naval shipbuilding took place in Cuba. Cuban cedar lasted well in tropical Atlantic waters which contained shipworm, *teredo navalis* (actually not a worm but a bivalve mollusk), that bored into and weakened ship timbers. Indeed Cuba became the most important colony in the Spanish empire

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Johns Hopkins University Press, 199), especially 46-52; Patricia Crimmin, '"A Great Object with Us to Procure This Timber': The Royal navy's Search for Ship Timber in the Eastern Mediterranean and Southern Russia, 1803-1815" *International Journal of Maritime History*, 4(1987); on France, Paul Bamford*, Forests and French Sea Power* (Toronto: University of Toronto Press, 1956); Andrée Corvol, *L'homme et l'arbre sous l'ancien régime* (Paris: Economica, 1984); on Portugal, Shawn Miller, *Fruitless Trees: Portuguese Conservation and Brazil's Colonial Timber* (Stanford: Stanford University Press, 2000).

[24] Roland Bechmann, *Trees and Man: The Forest in the Middle Ages* (New York: Pargon House, 1990), 169. Using ratios from Rolf Peter Sieferle, *The Subterranean Forest: Energy Systems and the Industrial Revolution* (Cambridge: White Horse Press, 2001), 112, this volume of wood was equivalent to the annual growth of some 1.2 million hectares of forest., a little more than 2% of the national territory of Spain.

[25] For ship construction details, see Brian Lavery, *The Ship of the Line. Vol. II. Design, Construction and Fittings* (London: Conway Maritime Press, 1984); and Jean Boudriot, *Le vaisseau de 74 canons: Traité pratique de l'art navale* (Grenoble: Editions Quatre seigneurs, 1973) 2 vols.

because of its forests, for without them the Spanish navy could not have defended the rest of the far-flung empire.[26]

Navies depended on wood for more than naval timber. They also needed iron, for various fittings of the vessels themselves, and for their cannon. Until the 1760s, when English ironmasters began to make good iron using coal as fuel, iron smelting required wood charcoal. To make a ton of wrought iron with European technologies before 1760 required 50 cubic meters of wood, the annual growth of about 10 hectares of northern European forest.[27] The great expansion of the navies of Britain, France, and Spain the in 18th century required the casting of tens of thousands of cannon, which helped keep the woodsmen busy cutting fuelwood. Part of the reason Sweden and Russia developed an internationally competitive iron industry, which included among its customers the navies of the Atlantic powers, was that the Baltic region's abundant forests made fuel far cheaper than in Atlantic Europe.

For millennia the world's navies had depended on the world's forests, and a reliable supply of good naval timber, as well as iron, was a strategic requirement for all but landlocked states. From the middle of the 19th century, however, warships increasingly came to be made of metal, and the metals smelted with coal. The long association of naval power and forests came to a close rather quickly. Navies still used

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[26] See José Merino Navarro, *La armada española en el siglo XVIII* (Madrid: Fundación Universitaria Española, 1981); Erich Bauer Manderscheid*, Los montes de España en la historia* (Madrid: Ministerio de Agricultura, 1980).

[27] Rolf Peter Sieferle, *The Subterranean Forest: Energy Systems and the Industrial Revolution* (Cambridge UK: The White Horse Press, 2001), 112. Abraham Darby pioneered the relevant technical advance in 1709 or 1710, but it became widespread in the English iron industry only in the 1760s.

wood – the PT-boats made famous by John F. Kennedy's misadventure in World War II were made chiefly of plywood – but they did not need it to project force on the high seas.

By the end of the 19th century wood had lost some of its strategic significance as a source of war materiel, but by no means all. Military construction, whether of fortifications or ships, still used timber. In a protracted war of attrition, such as WWI, timber supplies could again become of strategic significance. In Great Britain for example, which had come to rely almost completely upon North American and Baltic forests in the late 19th century, U-boat warfare interrupted supplies in 1915. Britain's own woodlands were scant and not managed for timber production. But the military needed timber for trenches, barracks, telegraph poles at the front, and the munitions industry and coal mines needed plenty more. In 1916-18 Britain felled half of its productive forests to meet the needs of the war.[28] Similar urgency inspired similar assaults on forests in other combatant countries. Roughly the same thing happened in WWII. Japan, for example, felled 15% of its forests 1941-45, and clear-cut 50 square miles a week by 1945.[29] Yet although enormous amounts of timber were used in these war efforts, something important had changed that diminished the significance of timber and forests for war. Modern militaries used plenty of wood, but they did not absolutely need it the way navies had in the age of wooden ships, or the way charioteers had before them. Modern militaries used wood because they could, because it was cheaper than

[28] A. Joshua West, "Forests and National Security: British and American Forest Policy in the Wake of World War I," *Environmental History* 8(2003), 274-5.
[29] William Tsutsui, "Landscapes in the Dark Valley: Toward an Environmental History of Wartime Japan," *Environmental History* 8(2003), 299-300.

alternatives, because it is ideal for quick construction. But they could have fought without it, because their weapons, and their fuel, increasingly came from other sources.

II. Forests in War-Fighting

Forests, as opposed to wood, have always been and still remain important strategic and tactical assets or liabilities in combat. There are at least three ways in which the presence of forests affected the ways in which wars or battles were fought. The first two, both applicable mainly on the tactical level, are obvious enough: forests served as an obstacle to movement, especially of cavalry and artillery, and provided concealment or cover, especially to infantry or irregular forces. The third way is not so obvious: dense forests affected the way in which societies conceived of war, prepared for it, and practiced it.

Forests, especially dense ones, inhibited the free movement of armies from the earliest times onward. Caesar's legions complained of the dark woods of Gaul, and worked hard to build roads through them to ease transport. Clausewitz in Chapter 21 of his famous military manual *On War,* explained how field commanders might make use of forests, and how above all they should, when on the defensive stay clear of thick forests so as not to fight "like a blind man against one with his eyesight." Clever commanders could exploit forest barriers to offset enemy advantages in numbers or firepower. General Robert E. Lee did just this at Chancellorsville in early May of 1863, one of the many battles of the American Civil War fought in northern Virginia. Outnumbered nearly 2 to 1 by the Army of the Potomac under Gen Joseph Hooker, Lee divided his

forces, gambling that Hooker would not venture out of the dense woods locally known as The Wilderness. Hooker, having forgotten his Clausewitz, obliged. Unaware of the scale and meaning of Lee's movements, he allowed Lee's right arm, Gen. Stonewall Jackson, to achieve a surprise attack on the weakest part of the Union front. Lee relied on the forests to inhibit his opponent's movement, and his information, in what is often termed his greatest victory.[30]

Relying on forests to stymie enemy movements was always a risky gamble. While it worked for Lee it did not save France from German invasion in 1940. In the 1930s, the French had invested heavily in fortifications along the Franco-German border (the Maginot Line) and expected an eventual German attack along a broad front, along the lines of what had happened in the previous German invasion in 1914. The French Army had arranged its defenses in anticipation of war on the theory that the Wermacht would not be able to penetrate the Ardennes forest in Belgium in strength. Indeed the French Army was influential enough in the Third Republic to mandate forest preservation on the northeastern frontiers of France in order to improve its defenses.[31] Marshall Pétain, the prestigious French hero of World War I, claimed the Ardennes forest would prove impenetrable, as indeed it would have to an army advancing along a broad front. But the Germans instead drove armored units right through the Ardennes, along paved roads, quickly punctured the French line, ignoring the state-of-the-art defenses of the Maginot Line, and soon defeated France in June of 1940.

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[30] Hooker lost 17,000 men at Chancellorsville, and Lee 14,000, but Lee lost a much larger proportion of his army. Details in James McPherson, *Atlas of the Civil War* (New York: Macmillan, 1994).

[31] Jean-Paul Amat, "Le rôle stratégique de la forêt, 1871-1914: Exemples dans les forêts de Lorraine," *Revue historique des armies* 1(1993), 62-9.

Forests routinely served to provide concealment to armies, a great equalizer for weaker forces. Gauls and Germans used the thick forests of northern Europe to hide from Caesar's legions and to ambush them when opportunities arose. Guerillas and brigands everywhere sought the shelter of forests from the superior power of their enemies. In modern warfare, forests provided cover against enemy air power. Serbian guerillas in World War II were able to occupy several German divisions with the help of the forests of central Yugoslavia. In Vietnam in the 1950s and 1960s, Vietnamese forces achieved a mobility under forest canopies that their French and American enemies would otherwise easily have denied them through air power. The history of resistance to great powers by tribal peoples, whether in southwestern China during the Ming dynasty (1360-1644) or in British Kenya in the 20th century, is replete with examples of attempts, sometimes successful, sometimes not, to use forests to neutralize superior strength.[32]

The presence of dense forests also affected the way armies trained for war and fought wars. When muskets became the prevalent infantry weapon in Europe in the 17th to 19th centuries, armies unfailingly drilled their soldiers on parade grounds, and taught them to fire in organized volleys. This worked efficiently in open terrain, and had the added benefit of increasing group cohesion among the troops.[33] But in forested landscapes, drill and volleys made little sense. West African armies, although often well equipped with muskets, never adopted drill or volley tactics. Nor did Amerindian forces,

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[32] A number of Chinese examples appear in Mark Elvin, *The Retreat of the Elephants: An Environmental History of China* (New Haven: Yale University Press, 2004).

[33] See the arguments along these lines in William H. McNeill, *The Pursuit of Power* (Chicago: University of Chicago Press, 1982); and McNeill, *Keeping Together in Time: Dance and Drill in Human History* (Cambridge MA: Harvard University Press, 1995).

even in those rare instances when they had plentiful muskets.[34] Thickly forested landscapes lent themselves to guerilla tactics, and militated against the use of formal infantry maneuvers, not to mention reliance upon artillery and cavalry, which were very difficult to deploy in such terrain. On one occasion in 1741, West African armies of Akyem and Asante assigned some 10,000 men the task of cutting trees to make space for a full-scale battle (won by Asante). More often, dense secondary-growth forest with its tangled undergrowth prevented large armies fighting decisive battles, so West African warfare was a matter of smaller units mounting ambushes along narrow forest paths.[35]

III. The Impact of Combat on Forests

Deliberate environmental warfare has a long pedigree. Scorched earth tactics, poisoned wells and the like are almost as old as war itself. In the Book of Judges Samson is credited with tying burning torches to the tails of jackals and ushering them into the fields of the Philistines to set their crops alight. General William Sherman recommended exterminating the bison as a means to destroy the military power of the Plains Indians, for the bison was, as he put it, "the Indians' commissary."[36]

War's environmental collateral damage often included the forests in particular. The ancient Assyrians, like many more recent armies, deliberately burned the woodlands of their enemies. Armies often caused forest fires entirely by accident as well. Indeed

[34] On West African armies, see Robert S. Smith, *Warfare and Diplomacy in Pre-colonial West Africa* (London: Methuen, 1976).
[35] John Thornton, *Warfare in Atlantic Africa, 1500-1800* (London: University College London Press, 1999), 58-9, 71.
[36] This was not the main reason behind the near-extinction of the bison however. See Andrew Isenberg, *The Destruction of the Bison* (New York: Cambridge University Press, 2000).

the Roman writer of the 1st century B.C. Lucretius listed armies among his three reasons behind forest fires (hunting parties and lightning were the others).[37] For most of human history, war could not do much damage to forests except where burning was possible. In the more humid forests of northern Europe where fires were rare, for example, prolonged warfare, as in the Hundred Years War or the Thirty Years War, could lead to the spontaneous resurgence of forests because it reduced population, and thus both the area under the plow and fuelwood demand.[38] With the development of explosive ordnance in the 19th century, the accidental impact of combat on forests became more severe. It reached its apogee in the prolonged bombardment of stationary positions during the First World War. Years of trench warfare at places such as Verdun or Ypres were locally devastating to the forests of France and Belgium.[39]

The most destructive campaigns were probably those launched against guerrilla warriors, for whom the forest was a vital tactical resource. Hence forest clearance offered potentially decisive advantages to armies engaged in counter-insurgencies or other forms of anti-guerilla war. Roman legions burned forests deliberately when conquering and pacifying Gaul and Britain. Imperial China pursued the same strategy in its southern and southwestern expansion. For example in the Ming and Qing dynasties, the Chinese military tried to make the province of Guizhou safe for ethnic Han Chinese, which required the defeat and dispossession of a formidable ethnic minority, the Miao

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[37] Lucretius, *De rerum natura* 5.1241ff.

[38] See René Cintre, *Les Marches de Bretagne au Moyen Age: économie, guerre et société en pays de frontière, XIV-XV siècles* (Pornichet: Editions Pierre, 1992, 119-27. Henry Makowski and Bernhard Buderath,. *Die Natur dem Menschen untertan: Ökologie im Spiegel der Landschaftsmalerei* (Munich: Kindler, 1983). See also Georges Duby, *Rural Economy and Country Life in the Medieval West* (Columbia: University of South Carolina Press, 1968), 296-8, 302.

[39] See Andreé Corvol and Jean-Paul Amat, eds., *Forêt et guerre* (Paris: L'Harmattan, 1994).

(also known as the Hmong). The mountainous and forested terrain made operations dangerous for the Chinese, by affording the Miao cover for ambushes. After long years of heavy losses, the Chinese concluded that to win they needed to change the environment, to cut and burn off the forest and drive roads throughout Guizhou. It took about two centuries to pacify the province, and indeed not until after 1854 did the Miao fully acquiesce in their fate.[40]

Imperial Russia adopted the same expedients in response to persistent guerrilla resistance to its expansion in the North Caucasus, a century-long process that began in the 1760s. Chechens and other Turkic and Islamic populations proved formidable enemies for the Russian Army as long as they had forests and mountains in which to take refuge. The Russians could do nothing about the mountains, but did their best to reduce the forests. They cleared broad margins along their military roads to prevent ambushes. For major roads they cleared swathes as wide as the distance of two cannon shots. Regiments spent a month or two of the year cutting forests, not only along roads but wherever they imagined Chechens or others might take advantage of them. Naturally the Chechens energetically resisted. Their leader Shamil, who organized especially successful guerrilla campaigns c. 1834-59, even instituted strict forest preservation rules, keenly aware of the military value of forest cover. Tolstoi's short story "The Wood

[40] Mark Elvin, *The Retreat of the Elephants: An Environmental History of China* (New Haven: Yale University Press, 2004), 216-32. Elvin (227) terms the Chinese policy in Guizhou as "eco-war." A more detailed treatment is Claudine Lombard-Salmon, *Un exemple d'acculturation chinoise: La province du Gui Zhou au XVIIIe siècle* (Paris: Ecole Française d'Extrême-Orient, 1972).

Felling," based on his own experiences as an officer in the North Caucasus in 1852-53, sketches the Russian pre-emptive ecological warfare policy.[41]

In the 20th century anti-guerrilla forest clearance grew more efficient with the introduction of aerial bombing. Incendiary bombing of forests made its debut in the early 1920s in the context of French efforts to defeat an anti-colonial struggle for independence in northern Morocco, the Rif War (1921-26). The aerial use of napalm began in the final stages of the Greek Civil War (1944-49), in which a communist insurgency used the forests of the northern mountains as its redoubt. Both sides burned forests for tactical advantage, but the Greek nationalists, with napalm and American help, did it more widely, trying to minimize the forest cover that afforded refuge to their enemies. The Americans employed this approach on a much larger scale in Vietnam (mainly 1965-73), clearing about 22,000 km2 of forests, amounting to 23% of the forest area of the country as of 1973.[42]

It is well to remember, of course, that the deforestation brought on by warfare may be either temporary or durable, depending on both natural conditions and postwar patterns of land use. In Britain, the fellings of 1916-18 had regenerated fifty years later. In Vietnam, much of the wartime deforestation has given way to new growth, although in some places to imperata grass (a particularly useless form of vegetation from the human

[41] Details in Thomas Barrett, *At the Edge of Empire: The Terek Cossacks and the North Caucasus Frontier, 1700-1860* (Boulder: Westview, 1999), 59-67.
[42] Rodolphe De Koninck, *Deforestation in Viet Nam* (Ottawa: International Development Research Centre, 1999), 12. This area would have amounted to only 15% of Vietnam's 1943 forest area. Some of the clearing done by the Americans was by mechanical means or defoliants such as Agent Orange. On the Rif War and the Greek Civil War, see J.R. McNeill, *The Mountains of the Mediterranean World: An Environmental History* (New York: Cambridge University Press, 1992).

point of view). In Mediterranean lands prone to high rates of soil erosion, such as northern Morocco, and to a lesser extent northern Greece, the loss of forest cover generally led to accelerated soil loss, and less propitious conditions for forest recovery. More often, the destruction of mountain forest gave way to scrub vegetation (garrigue and maquis) that under the pressure of grazing animals has not yet returned to tall forest.

IV. The Impact of Preparing for War Upon Forests

In all probability, the impact upon forests of the business of preparing for war far outweighed the impacts of combat itself. This is because societies have more often prepared for war than gone to war, and because preparation often lasted longer, remained more constant, and thus had more ongoing effects. Not all of these effects, however, were destructive of forests; some preserved them.

First I will consider efforts to maximize military preparedness that resulted in changes to forests. I have already treated the role of forests as a source of naval timber and war materiel generally, a significant part of this story. Another large part is what might be called strategic clearances. States concerned about possible guerrilla action sometimes opted for a doctrine of environmental pre-emption, changing the landscape and its population to suit their geopolitical interests. A favorite approach was to reward military veterans with frontier land in the hopes that they would then clear it, farm it, populate it (or re-populate it), and thereby secure it politically and raise its revenue-producing capacities. The Roman, Chinese, and Ottoman empires all pursued this policy at various times. So did the Russians in the 18th and 19th centuries when they settled

Cossacks and Russians in the North Caucasus region in an effort to defeat and displace the local Turkic Muslim populations. The British Empire employed it as late as the 1920s in so-called soldier settlement schemes, which accelerated forest clearance in Canada, Australia, and New Zealand.

A variation on the theme was the policy of the Brazilian military governments toward Amazonia between 1965 and 1985. While the generals in charge had many motives in promoting Amazonian settlement, prominent among them was the perceived necessity to secure and thus to "Brazilianize" the rainforest borders of the country. Indigenous Amazonians were not sufficiently Brazilian in this analysis, so settlers from elsewhere in the country were recruited with the slogan of 'land without men for men without land.' This, in its own way, was an imperial settlement policy, which like those of the Romans, Ottomans, Russians, Chinese and others led to widespread forest clearance as an intentional component of a peacetime military program. Since 1965 some 10-15% of Brazilian Amazonian forests have disappeared through cutting, burning, and subsequent settlement.

In addition to inspiring policies of frontier settlement in forest zones, anxieties about military vulnerability and ambitions for military dominance have also provoked large-scale programs of infrastructure construction. Some of this took place in forested landscapes and therefore required some measure of forest removal. All of it involved timber in at least modest quantities. Railroad building is perhaps the most important example.

The first railroads, in Britain, were built for commercial reasons alone. But within 15 years of the opening of the first line in Britain in 1829, states had begun to see the military potential of railroads and in cases such as Prussia quickly set to constructing rail networks with strategic considerations in mind. Imperial Russia too built its rail system with an eye to military requirements, and the great trans-Siberian railroad, begun in the 1890s, served as the necessary link by which Russia could assert its power in northeast Asia (which it did with some success after the disaster of the Russo-Japanese war in 1904-5). The trans-Siberian passed through landscapes of both steppe and forest. It, like all railroads until the late 20th century, used wooden sleepers (cross-ties) which until the development of wood preservatives (from the 1920s) had to be replaced every few years. Russian locomotives also often used wood in their boilers. By 1920 Russia had more railroad track than any country in the world except the USA (Germany was third). The railroad in America was sometimes called the iron horse, but in Russia (as in America) it was a wood-based system. Elsewhere in the world railroads were often built for military purposes as well, although in every case, even the Prussian and Russian, a mixture of motives and justifications lay behind railroad building, in which military preparedness was only a part.[43]

Less directly, road building for military purposes also affected the world's forests. Roads, like railroads, change patterns of settlement and land use by reducing transport costs. Hence they encouraged new logging frontiers, new agricultural frontiers, new

[43] On the trans-Siberian railroad see Steven G. Marks, *Road to Power: The Trans-Siberian Railroad and the Colonization of Asian Russia, 1850-1917* (Ithaca: Cornell University Press, 1991).

mining frontiers, all of which normally had an impact on forests. The great majority of roads were built for peaceful purposes of commerce, but there have been many major exceptions. The famous road systems of the Roman and Inca Empires, each tens of thousands of kilometers cumulatively, were built in large part for military purposes. More recently, the American interstate system, begun in the 1950s, also had military considerations behind it, and indeed was sold to Congress as vital to national security.[44]

Settlement and infrastructure schemes normally helped reduce forest cover, but other military initiatives had the reverse effect, albeit on smaller scales. Timber reserves created and maintained for the purpose of assuring supplies of naval timber existed from the 14th century, as noted above. Unofficial forest preserves also resulted from the creation of restricted military zones. For example, states uneasily sharing militarized borders often created no-go zones along their frontier. By keeping people out military authorities quite accidentally created de facto nature preserves. The DMZ, although not intended as such, is much the largest nature preserve on the Korean peninsula. The tense and militarized zone along the border of the Soviet Union and Iran during the Cold War was another accidental nature preserve; satellite imagery showed a broad belt of forest amid a larger landscape of pasture and arable. In the deeper past, it seems that the frontier between Christian and Muslim powers in medieval Spain was often a park-like expanse of cork oak woodland. On a larger scale, in the 17th-19th centuries the Qing dynasty in China tried, and in large part succeeded, in keeping much of Manchuria – an

[44] Interestingly, another such system, the German autobahns, begun in the 1930s under Hitler, apparently did not have military motives behind it, despite frequent claims to the contrary by scholars (including myself). See the new work by Thomas Zeller, *Straße, Bahn, Panorama. Verkehrswege und Landschaftsveränderung in Deutschland 1930 bis 1990* (Frankfurt/New York: Campus, 2002).

area equivalent to France and Spain put together – as forest. The Qing intentionally prevented peasant settlement and other land uses in order to keep potential enemies at a distance, to retain space for military maneuvers, and to preserve hunting grounds (useful in part because hunting allegedly kept the Qing dynasts in fighting trim).[45]

Border zones were not the only form of de facto forest preserve inspired by military priorities. In South and Southeast Asia until the 17th century, powerful princes needed war elephants. Elephants would not breed in captivity, so to maintain a supply of war elephants a prince needed to have access to wild elephant populations, lest he be dependent upon his neighbors and potential rivals for what was the cutting edge of military technology. Wild elephant populations existed only in forest zones, so prudent princes went to lengths to preserve forests as elephant habitat. And because elephants need large expanses of terrain, this necessarily involved sizeable areas. Kautilya, the Machiavelli of the Mauryan Empire who served as advisor to Chandragupta (reigned c. 321-297 BC), in his book *Arthashastra* explicitly advised rulers to preserve forests in order to maintain a reserve of elephants.[46]

More recently, militaries have created firing ranges, restricted zones in which artillery and infantry units hone their skills. Curious as it may seem, such areas often served, like border zones, as de facto forest and nature preserves. In Puerto Rico for

[45] The Manchurian case is treated in Patrick Caffrey, "The Forests of Northeast China, 1600-1953: Environment, Politics, and Society," Ph.D. thesis, Georgetown University, 2002.
[46] States that relied on cavalry had to take care to preserve reliable access to horses, which although they will breed in captivity nonetheless are best raised on grasslands. Until 1921 the British in India purposely maintained grassland on which to raise cavalry mounts. Imran Ali, *The Punjab Under Imperialism, 1885-1947* (Princeton, Princeton University Press, 1988).

example, the Culebra National Wildlife Refuge was a naval gunnery and bombing range before 1975. Intermittent artillery barrages and bombardment proved less destructive of vegetation and wildlife than ordinary peacetime activities in Puerto Rico, so that seabirds, turtles, and forest survived better there than elsewhere on the island. The same was true on many of the training grounds, proving grounds, and large bases kept by the world's great powers in the 20th and 21st centuries.[47] In these cases, and many more, the simple fact that military considerations prevented the quotidian economic activities of ordinary citizens was enough to preserve forests, or woodlands, that otherwise would likely have disappeared, conforming to the patterns of surrounding landscapes and land use.

V. Conclusion

The history of co-existence between humankind and forests is as complex as it is long. The largest human impacts upon forests normally were results of quests for the land underneath forests or for the timber and fuelwood in them. Sometimes these quests acquired a special urgency in time of war, or times in which the prospect of war was much on people's minds. Sometimes war interrupted these quests, interfering with agricultural settlement and thereby preserving forests. And sometimes the presence of forests influenced the ways in which armies fought.

Today the world's forests, in broad terms, are shrinking in the tropics but growing in temperate latitudes. The rhythms of war and peace have lost some of their significance for forests, because wood has slipped well down the list of strategic materials. Settlement patterns and timber markets, normally more important for forests than war, have become

[47] On Culebra, see Philippe Hein, Between Aldabra and Nauru," in W. Beller, P. D'Ayala, and P. Hein, eds., *Sustainable Development and Environmental Management on Small Islands* (Paris: UNESCO, 1990), 71-2.

even more so. The age of chariots and wooden ships is long behind us. Warfare today seems so high-tech as not to require wood as materiel, and in the landscapes of Iraq had little impact upon forests because there were none in combat zones. But in fact linkages between warfare and forests still persist. Guerrilla campaigns continue in a dozen settings, with guerrillas hiding in the forests and their enemies trying to deny them cover. Refugees displaced by war in Angola or northern Pakistan still consume fuelwood. Military cliques in Burma, Thailand, and until recently Indonesia finance themselves with (illegal) logging operations. And the next big war might take place in landscapes entirely different from those of Iraq, making forests once again a factor in war fighting, and war once more a factor in the fate of forests.