

# Fire Management in Commercial Plantations: A New Zealand Perspective

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## Abstract

The natural forests of New Zealand evolved in the absence of frequent wildfire until about 1400 to 1600 AD when Maori introduced the more methodical use of fire. This was followed by an extended period of burning associated with European settlement and land clearing. In 1874 the New Zealand Government introduced and subsequently improved legislation to control the use of fire and its impact on forests. Government ownership of large areas of plantation forests led to effective training and a career path for fire control activities. Land managers in New Zealand now view fire protection as part of management responsibilities, and have control of the complete process from fire planning to fire suppression.

Changes in State plantation ownership from the State to private companies started in 1987 and led to changes in many forest management practices, including fire protection. The absence of a proven economic benefit through incomplete data led to a number of owners reducing fire protection expenditure, and this increased stakeholder concern.

A need for an independent assessment of plantation fire management systems led to a comprehensive survey of New Zealand plantation owners in 2004. The results from the survey were compared to the last reported (1986) analysis of fire protection costs. The costs of plantation protection and pre-suppression activities have reduced on a per hectare basis in the 20 years since that report. Nevertheless, the area of forest burnt has declined since 1990. Information from the survey will be useful as a benchmark for plantation companies, and to contribute to the debate on the role of the plantation forestry sector in the future structure of New Zealand's fire and emergency management services.

New Zealand plantation owners continue to support national publicity programmes, the international mutual support agreement, and the joint Australia/New Zealand bushfire research programme. In future, New Zealand plantation managers should improve data collection systems and reliability for recording key data on plantations lost through wild fires, as part of the Kyoto Agreement and other carbon trading ventures. Valuing the benefits of protecting indigenous biodiversity and the provision of recreation opportunities will also be a challenge as part of defining the economic benefit of fire protection.

## Introduction: Fire in New Zealand's natural history

There is evidence from carbon records of occasional landscape fires in New Zealand from 40,000 years B.P. (Burrows and others 1993). In the Canterbury region, fires occurred between glacial periods, and after 1,800 years B.P. the climate dried and more frequent natural fires removed tall woody vegetation and allowed tussock grasslands to expand in area (Burrows and Russell 1990). Similar patterns of disturbance by pre- and post-Polynesian fire after 6,000 years B.P. are recorded in records from the Wanganui (Russell 1988) and Far North (Enright and others 1988)

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areas of New Zealand. Despite such early occurrences of fire, New Zealand native ecosystems consist of species that are not specifically adapted to fire (McGlone and Webb 1981). However, it is evident that throughout the period after 6,000 yr B.P., fire has in some areas combined to a greater or lesser extent with the effects of climatic fluctuations (and associated glacial activity, drought and frost) and tectonic activity (Cowan and McGlone 1991) to influence the distribution of some plant species and communities. Polynesian burning in the last 1,000 years further removed tall woody vegetation and this process was continued following European settlement (Wardle 1985), when fire was a primary agent for land clearing and some large wildfires caused extensive damage to forest and rural environments of New Zealand.

New Zealand now experiences around 4,000 vegetation wildfires each year that burn around 7,500 ha of rural lands (NRFA statistics), including grasslands, shrublands, indigenous and exotic (i.e. plantation) forests. As such, it doesn't have as severe a fire climate as many other parts of the world, but strong winds, high temperatures, low humidity and seasonal drought still combine to produce dangerous fire weather situations (Pearce and others 2003). More detailed descriptions of the New Zealand fire environment are provided elsewhere (Fogarty and Pearce 1995, Pearce and Majorhazi 2003, Gould 2006). Only 1-2 percent of fires in New Zealand are started by natural causes (i.e. lightning). Most rural fires are caused by people, through escaped land clearing burns (both permitted and unauthorised) and a steadily increasing number of malicious fires.

## Importance of New Zealand's Commercial Plantations

Establishment of exotic conifer plantations in New Zealand began over a century ago (Cooper 1980, Familton 1990) in response to the rapid depletion of New Zealand's natural lowland forests, mostly by burning.

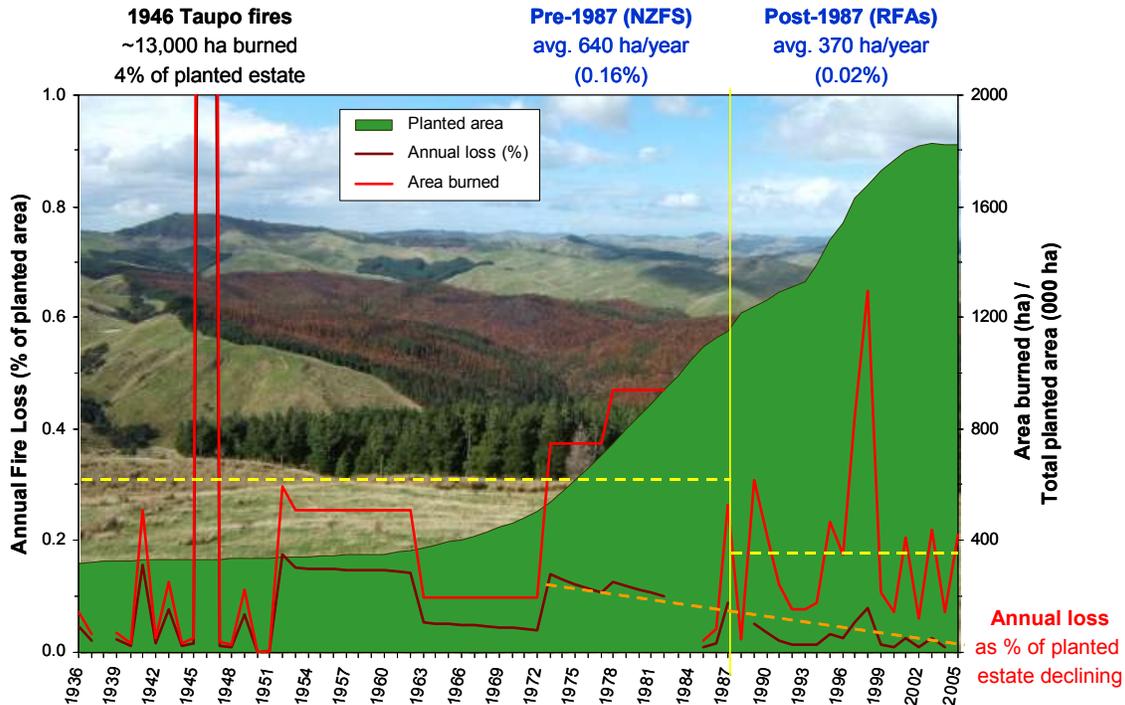
The area of plantation forests currently amounts to about 1.81M hectares or roughly about 7 percent of the country's land mass (NZFOA 2006), with radiata pine (*Pinus radiata*) comprising nearly 90 percent of this total. These plantation forests have formed the basis of important forest-based industries, as well as providing a range of social and environmental benefits.

Safeguarding these areas from wildfires was a major concern of the former New Zealand Forest Service and forest industry almost from the first plantings. Many advances in fire control technology and management have occurred over the intervening years (Cooper 1980).

Due to the value of the asset being protected, fire has always been an important consideration for New Zealand plantation managers. During the last 60-70 years, fires have resulted in over 40 000 ha of exotic plantation forest being burned, with an annual loss of around 570 ha (or 0.12 percent of the planted estate) (see Fig. 1, after Cameron and others 2007). The average annual loss over the last decade (to 2005) is somewhat lower (about 440 ha/annum or 0.03 percent of the plantation estate), but current plantation fire statistics are unreliable due to poor reporting and confidentiality issues.

As part of an analysis of the plantation fire situation in Australia, Rawson (2006) obtained plantation fire statistics for New Zealand and included the following comment: Cameron (*pers. comm.*) also believes that "*the plantation forestry sector in New Zealand has a small and declining loss from wildfire, but the statistics mask the*

*potential for extreme fire weather conditions to contribute to or escalate a major plantation fire incident. The sector also needs to maintain or improve its current levels of skill and interest in rural fire training and rural fire management for such a state to continue."*



**Figure 1.** New Zealand plantation fires losses, expressed as area burned (ha) and percentage of the planted estate (000's ha). Losses during the NZ Forest Service era (pre-1987) are contrasted with the post-1987 period where fire protection is provided by Rural Fire Authorities (RFAs) (after Cameron and others 2007).

The principal causes of fires in plantation forests are arson, escaped burns (both permitted and non-permitted), vehicles and campfires (Cameron and others 2007). Within plantation areas, forestry operations and spontaneous combustion are also major causes. Outside of forests, railways are significant causes of fire. In fact, fires originating outside of forests on adjacent land present considerable (and, in many cases, the predominant) risk to production forests, with up to twice as many fires and six times the area burnt reported outside of forest areas as within forests (Cameron and others 2007). Reporting of fires is principally by the public or forestry staff/contractors, with very few fires now reported by forest lookouts or ground and aerial patrols.

Despite the general perception that New Zealand's fire climate is not as severe as other parts of the world due to its maritime position, periods of high and extreme fire danger do occur in many parts of the country each year (Pearce and others 2003).

Historical fire events have demonstrated that these periods of high regional fire danger coincide with a source of ignition about once a decade resulting in major plantation fires (Pearce and Alexander 1994, Pearce and others 2000). The 1945/46

fire season was the worst on record, with the 1946 Taupo fires burning about 13,000 hectares of planted forest out of a total of over 30,000 hectares of forest burned; Canterbury also experienced major plantation fires in 1955, 1973, 1976 and 1988. However, since 1955 only one plantation fire (Hira in 1981) has burned over 500 hectares of plantation forest (Pearce and Alexander 1994, Pearce and others 2000). This is due to a number of reasons, particularly improvements in fire management.

## **New Zealand's rural fire legislation**

As early as 1857 a Gazette Notice warned about the dangers of fire, and there were major forest fires during the early 1870's. The first Forests Act in 1874 included some fire control measures; these were expanded in the 1885 Forests Act after the large Puhipuhi fires of 1881. The Act was amended in 1908 to further strengthen fire control regulations. Following the large Raetahi fires in 1918, the 1921 Forests Act established the fire district organisation around State Forests; this was amended in 1925 to extend that principle to private forest areas over 80 hectares.

Major changes in legislation have typically been associated with significant fire seasons or fire events. The first piece of legislation dedicated wholly to rural fire (the Forest and Rural Fires Act, 1947) was passed in reaction to the fires that devastated 240,000 hectares of forest and rural lands in the central North Island in 1946. This Act extended the concept of rural fire authorities outside the State, and brought in the concept of restricted fire seasons, specialised officers and specific regulations. After the Balmoral forest fire of 1955, another Forest and Rural Fires Act (1955) brought all aspects of rural fire legislation together for the first time under Forest Service responsibility. This Act covered the three types of Rural Fire Authorities (County or Local Government, Soil Conservation and Rural Fire Districts established for the protection of private plantation forests). The State was also responsible for crown lands, national parks and scenic reserves.

The current legislation was enacted in 1977, with the accompanying regulations in 1979. The NZ Forest Service administered that Act, and had a well organised and well funded system to protect its forests and neighbouring rural lands, including the smaller private forests. It had specialist staff, specialized equipment and an organisational culture of treating fire protection as an integral part of forest management. When the Forest Service was disbanded in 1987 there was a hiatus as the new entities created attempted to find and establish their respective roles in the new environment. There were obviously some difficulties in doing so. The new Ministry of Forestry became responsible for the administration of the Act, whilst people and equipment were split between the new State entities – the Department of Conservation and the Forestry Corporation.

In 1990, following a fire-prone summer of 1988/89, Hensley (1990) reviewed the state of the rural fire sector and his report led to an Amendment of the 1975 Fire Service Act. The Fire Service Commission, in addition to its role of a national urban fire service under the Fire Service Act 1975, was given a new role as the National Rural Fire Authority. This new role saw the Commission being responsible for a national coordination of rural fire and ensuring the effective and efficient functioning of localised Rural Fire Authorities.

The new changes also led to Regional Rural Fire Committees covering the whole country to ensure effective regional co-ordination of rural fire authorities.

Forest owners and New Zealand Fire Service representatives are included as members of these committees.

The role of the National Rural Fire Authority was to:

- Co-ordinate all matters relating to national rural fire control;
- Develop, publish, and audit national standards and assess the performance of Rural Fire Authorities;
- Co-ordinate the operation of a national rural fire weather index and co-ordinate a national regional system of rural fire hazard prediction and warnings;
- Promote and encourage research in matters relating to rural fire control; Promote and encourage the training and education of persons engaged in rural fire control; and
- Make available grants or other assistance to Rural Fire Authorities.

The position of National Rural Fire Officer was established to administer the Forest and Rural Fires Act, enhance coordination of rural fire authorities, establish and audit a national rural fire management Code of Practice, and administer the Rural Fire Fighting Fund.

New Zealand's early legislation could thus be seen as reactive, responding to systems failures revealed by significant fires. The most recent legislation is regarded by some as prescriptive and perhaps out of step with the way other more recent legislation has been written, and there is now a realization that there may be a need to change it, with a review of the Regulations having recently been completed and a legislative review signalled (DIA 2004).

Nevertheless, significant improvements have been made to the governance of the rural fire sector since 1990, and there have also been improvements and efficiencies in the way rural fire districts have evolved and operate. In the 10 years prior to 1990 the yearly average area lost by wildfire in New Zealand was 13,300 hectares. Since 1990 the 20 year average area lost from wildfire is 6,200 hectares. This reduction of area burnt has been due in part to the establishment of national standard and national funding grants being made available to Rural Fire Authorities which are subject to them meeting national standards.

Cost recovery is permitted under the legislation. Rural fire managers have been able to recover costs from those responsible for wildfires, either for the ignition or for owning the land from which a fire spread. One notable example, the 1973 Mohaka Fire, resulted from a farmer's non-permitted fire near the forest's boundary and illustrated that stern legal action would be taken in such cases (the individual was found guilty in civil court and required to pay all costs) (Pearce and Alexander 1994).

### ***Fire management in State Forests – Pre 1987***

The NZ Forest Service developed and maintained a high level of rural fire management expertise within its ranks. Being part of sometimes isolated rural communities meant that Forest Service staff provided a focal point and assumed many roles, with rural firefighting being just one. Most able-bodied people who worked for the department were trained in aspects of firefighting. There were career opportunities and progression within that particular discipline. Some participants remain available to the fire management industry in New Zealand today. As well as

protecting State Forest land (which included both natural and plantation forests), Forest Service staff took responsibility for firefighting in neighbouring private forests and other rural lands. As such, the NZ Forest Service formed a de facto national rural fire organisation, and allowed other land management agencies such as Local Government territorial authorities (who still had the fire control responsibility for private lands under legislation) to renege on their responsibilities.

As government accounting systems improved through the 1960s and 1970s, costs were identified with increasing sophistication. The advent of spreadsheets and computers enabled detailed analyses to be conducted relatively quickly and management systems were progressively introduced. Although increasing attention was being paid to costs, little attention was paid to gathering data to analyse the economic benefit of various fire protection regimes (Cooper and Ashley-Jones 1987). This situation still remains current today (Cameron and others 2007).

### ***Fire management in commercial forests – Post 1987***

Under changes made to legislation in 1977 and 1990, rural fire management is the responsibility of Rural Fire Authorities (RFAs), which may be the Department of Conservation (DoC), the Ministry of Defence, a Territorial Local Authority (TLA) or a specially-created Rural Fire District administered by a Committee made up of rural land owners, particularly forest owners.

Currently, many forest owners choose to insure their forests against loss from fire, with the majority of policies covering damage to tree stock as well as firefighting costs. However, in some cases, forest owners choose to “self-insure” by maintaining a fire protection capability that includes trained personnel and fire suppression equipment. Private and corporate plantation owners also have the option of choosing to rely on the local fire authority (usually a Territorial Local Authority) to provide fire protection services, or to establish and manage their own Rural Fire District to provide their own fire protection.

The key differences from the NZ Forest Service era include a lack of career paths for fire managers within one agency (apart from limited opportunities in DoC), few controlled burns being undertaken as part of forestry land preparation, improved farming practices creating fewer problem boundaries and better burn plans, better communications with cell phones, better road networks, and the increased availability of skilled aircraft operators (especially helicopters).

The average area burnt annually by rural wildfires for the period since the disestablishment of the NZ Forest Service has declined, and over the last 10 years has reduced by over 50percent compared to the previous decade. During the Forest Service era to 1987, at least one major forest fire (500+ ha) occurred nationally about once each decade (Pearce and others 2000), and the average annual plantation loss was ~640 ha (or 0.16 percent of the total planted estate) (Cameron and others 2007; see Fig. 1). Since 1987, there has been on average about one major plantation fire (100+ ha) every 2-3 years, and the average annual plantation loss over the last decade is lower at about 440 ha (or 0.03 percent).

There is some evidence that the average annual loss is declining as a result of the significant reduction in forestry burning off, combined with improved farming practices on forest boundaries, improved communications, and increased attention paid to predicting weather conditions and the management of incidents. The annual

plantation loss as a percentage of total planted estate has also declined as a result of the growing forest area (*fig. 1*).

However, given the decline in the fuel reduction burning across New Zealand and the potential increase in fuel loadings in the hill and high country areas, the experiences in other countries indicates that this increase in fuel loading may in future decades become a potential problem and result in greater land areas being destroyed by wildfires, and place commercial forests at greater risk from external fires.

## **The NZ Forest Owners Association fire research project**

In 2005, the NZ Forest Owners Association (NZFOA) carried out a survey of its members in an attempt to gain a better understanding of the nature and extent of rural fire control activities undertaken by New Zealand plantation forest owners (Cameron and others 2007). The survey formed part of a broader project that included:

- summarising the equity of current funding and resources provided by the forestry sector,
- determining the average annual relative investment per hectare by forestry companies in regard to rural fire, relative to that undertaken at the end of the NZ Forest Service era,
- determining the relative threat that rural fire presents to forest owners, in terms of cost per hectare spent vs. potential value per hectare lost to fire in New Zealand, and
- comparison of this threat/loss with other losses such as wind and forest health.

Results from the survey also provided insights into issues such as forest insurance and risk management strategies, as well as forest owner fire prevention and preparedness activities and expenditure.

### ***Contribution of forest owners to fire management***

The survey responses, which covered about two thirds of the total forest estate and a range of small and large forest owners from all parts of the country, showed that forest owners spend in the order of \$8M to \$10M per annum on fire protection for the 1.8M ha plantation forestry estate, with by far the majority on fire administration, prevention and preparedness as opposed to firefighting and damages. While this amount includes suppression costs for the majority of minor fire events, it excludes firefighting costs and damages for major fires (200+ ha) of which there have been several in New Zealand in the last few seasons where suppression costs exceeded \$1M in each case.

This compares with about \$6-8M per year for Local Government, \$9-10M per year for the Department of Conservation, about \$4M per year for Defence and about \$3M per year for the National Rural Fire Authority. Study results have also shown that forest owners contribute a huge amount to the rural fire sector in terms of manpower and equipment, providing the equivalent of some 60 full-time positions in fire control and more than 1600 trained staff, contractors and volunteers, as well as more than 130 firefighting vehicles. The forestry sector is also a major financial contributor to national activities, such as the National Fire Prevention Campaign and

Rural Fire Research, and through in-kind (time/personnel) activities such as national working groups/committees, national and regional Incident Management Teams and international fire-fighter deployments.

Local Government authorities are legislatively responsible for around 60 percent of New Zealand's land area, the Department of Conservation approximately 30 percent and Defence less than 2 percent, compared with forestry at 7 percent. Based on the total area being protected, the forestry sector is therefore providing above-average levels of protection, which can be attributed to the value of the asset being protected.

### ***Comparison of fire prevention expenditures***

Fire prevention expenditures during the NZ Forest Service era (1984/85) varied for districts based on fire "hazard" (i.e. fire danger) (Cooper and Ashley-Jones 1987) and, in general, were higher in NZ Forest Service districts than fire protection costs for private forestry companies at that time (Cameron 2006).

The NZFOA survey was used to obtain details of plantation forestry fire protection expenditures for comparison with values for the NZ Forest Service period, and covered fire organisation, fire administration, fire prevention, pre-suppression and suppression activity costs (Cameron and others 2007). Survey results were used to express current fire protection costs on a \$/ha basis (based on both the total forest estate being protected and the net stocked area of forest), and to analyse these costs by forest size, region, forest ownership and Rural Fire Authority type.

Current costs for forest owners varied greatly in terms of both total annual expenditure and \$/ha being protected. Results showed that for forest ownership size, total fire protection costs (on a \$/ha basis) were greater for small forest owners (i.e. less than 5,000 ha) and lowest for very large owners (greater than 50,000 ha), due to fire organization and administration costs as well as fire prevention and pre-suppression costs being greater. Suppression costs were also greatest for small (and medium) owners, and damage costs highest for medium-sized (5000-20,000 ha) owners. For ownership type, Local Government owned forests had the greatest overall protection costs, due to having the highest fire administration costs; however, this was likely as a result of total fire authority costs (i.e., associated with fire protection in other grassland and shrubland areas) being spread across just the forest area. Forest Partnerships (with high fire administration costs) and Central Government (with high fire suppression costs and damages) ownership types had the next highest costs, while Individuals and Public Companies had the lowest overall costs due to their smaller forest holdings, less personnel and suppression equipment, and reduced prevention activities. Fire protection costs by Rural Fire Authority (RFA) type showed that forest areas under TLA administration have the highest overall costs, due to having the highest fire administration costs; however, again, this is likely the result of total RFA costs being applied to just the forest area. Rural Fire Districts (RFDs), either original or enlarged, are the next most expensive rural fire administrative structure, with enlarged RFDs having the highest fire organization and pre-suppression costs.

These expenditures obtained from the survey were tested against the perceptions from a number of experienced rural fire managers, and from this it is clear that current fire protection costs are higher than those during the 1960s and 1970s, and similar or lower than those during the 1980s and 1990s. However, there are some

differences in what is included within cost categories for the various eras, and historic cost data has not been adjusted for inflation.

### ***Relative risk from fire compared with other forest threats***

In terms of relative risk, forest owners were asked to rank both fire and wind against each other and against health threats to forests (both currently established and potential/not yet established). The result was that foresters ranked the risk from non-established pathogens and insects higher than wind, with fire, other abiotic and established pathogens and insects ranked in descending order (Cameron and others 2007). Fire was qualitatively ranked a lower threat than wind, and this is supported by loss information (Pearce and others 2000, Moore 2006). Despite more widespread damage and significant economic losses, current established forest health issues (Bulman 2004) were ranked well below wind, fire and other abiotic threats to forests.

### **The future**

Issues facing commercial forest managers that will impact on future rural fire management in New Zealand include:

Significant changes in the forestry estate as a result of land conversion from forestry to dairying and urban sub-division, due to lower international log prices and high local land values, resulting in consolidation of forestry from plains to foothills;

Potential for increases in threat from fire to forestry as a result of projected climate change. A recent study (Pearce and others 2005) suggests this could result in significant increases in fire climate severity in future, with the number of days of VH+E Forest fire danger increasing by more than 20 days (over 50 percent) in some parts of the country by 2080;

Review of fire legislation, and fire management structures and responsibilities, with potential for significant changes. It is possible that forest and rural fire suppression services could be transferred to an urban fire and rescue service, and separated from fire prevention and other land management activities (Cheney 2004). This could dramatically influence forest owners' choices as to whether they rely on external agencies for suppression services, or opt to carry-out their own fire protection cover;

Poor forest fire reporting systems and statistics. New Zealand plantation managers need to improve data collection systems and reliability for recording key data on plantation losses through wild fires, as part of the Kyoto Agreement and other carbon trading ventures;

Valuing the benefits of protecting indigenous biodiversity and recreation opportunities will also be a challenge as part of defining the economic benefit of fire protection.

### **Conclusions**

Since exotic forests were first established in New Zealand, plantation forestry has formed a significant part of the country's economy and its rural fire management. The value of the forest assets is such that fire protection has always formed an integral part of forest fire management.

A project conducted by the NZ Forest Owners Association compared rural fire management in commercial plantations in 2004/05 with the NZ Forest Service era. That project presents estimates of the relative contributions of the major players to rural fire management in New Zealand and demonstrates that, due to the high value of the asset being protected, forest owners contribute well beyond the level expected from the area being protected. The study also presented details of forest owners' expenditures for various fire management activities, and illustrated significant differences depending on forest size, region, ownership and Rural Fire Authority type.

Study results and associated statistics also show that the risk of fire to plantation forests has declined since the NZ Forest Service era as a result of a number of factors including improved fire management. However, there are several significant issues presently facing forest owners in New Zealand that could change this outcome for the future.

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