3 Multiple use forest management

3.1 LEGISLATION

The *Conservation and Land Management Act 1984* (the *CALM Act*) is the principal Act providing for multiple-use management of publicly-owned forested land in south-west Western Australia. Activities in these forest areas are also regulated by a range of other legislation.

CALM Act

The Act applies to State forest, timber reserves, national parks, conservation parks, nature reserves and any other landed vested in either the Lands and Forest Commission or the National Parks and Nature Conservation Authority.

On publicly-owned land the *CALM Act* stipulates only "necessary operations" shall take place in the absence of a management plan. For the preparation of a management plan the Act nominates the objectives for management of each tenure category thus providing increased levels of protection. The objectives for each tenure category are:

- State forest—conservation, recreation, timber production on a sustained yield basis, water catchment protection or other purpose prescribed by the regulations;
- national/conservation parks—fulfill the demand for recreation consistent with proper maintenance and protection of flora, fauna or cultural feature;
- nature reserve—maintain and restore the natural environment and to protect, care for and promote the study of flora and fauna and preserve any cultural feature.

Planning for multiple use of public land is achieved through the process set out in Part V of the *CALM Act*. Plans prepared under this part of the Act must comply with the management objectives set out in the Act, be for a maximum period of 10 years and be put out in draft form for public comment. The current plans for public land forests are the Forest Management Plan 1994-2003 and its precursors the Northern, Central and Southern Forest Region Management Plans published in 1987.

There is no legal requirement for planning forest management on private land unless it is enforced through conditions applied through formal approval of treatment of forest on protected catchments. A voluntary code of practice for timber plantations on private land provides guidelines on the contents of a management plan.

Forest Management Plan 1994-2003

In 1994, following public consideration of a draft, CALM published a 10-year plan for the south-west forests titled Forest Management Plan 1994-2003. This plan was designed to provide for multiple use of the forest within the framework of ecological sustainability. The plan incorporated the elements of two other documents published in draft form at the same time, the draft Nature Conservation Strategy and the joint CALM/Australian Heritage Commission study *National Estate Values in the Southern Forest Region of South-West Western Australia*.

The plan recognises the following key values required by the public from the forests:

- nature conservation;
- water;
- timber;
- recreation and tourism;
- community education and interpretation;
- natural and cultural heritage;
- minerals; and
- other products such as honey, wildflowers, seeds, grazing.

To provide for these values in an ecologically-sustainable way the plan enhances components of the following broad strategy:

- Establishment of a representative reserve system.
  Additions are proposed to the reserve system (tenures of national parks, conservation parks and nature reserves where disturbance to the forest is required to be minimal). This improves the representation of some vegetation complexes, incorporates representation of national estate values identified in the joint CALM/AHC study and protects a potential water storage site.
- The identification and protection through zoning of "special" areas within forest available for disturbing activities (tenures of State forest and timber reserve).
  Special areas include stream sides for water quality, nature conservation and recreation/tourism protection, rare ecotypes for nature conservation protection, travel routes and view-sheds for landscape protection, significant cultural sites and patches of mature forest distributed amongst regeneration for nature conservation. The plan improves protection of streams and includes new components of the biodiversity, such as ecotones, as protectable areas.
- Prescribing whole of forest structural goals for nature conservation and timber production.
- Prescribing a sustainable level of timber production.
- Setting priorities and procedures for the protection of the forests from pathogens, fire, weeds and pests.
- Developing and constantly updating codes of "best practice" for the implementation of strategies.

North, Central and Southern Forest Region Management Plans 1987

The North, Central and Southern Forest Region Management Plans were prepared according to the *CALM Act* and published in 1987. They covered the same south-west forest area as the Forest Management Plan 1994-2003. The provisions of the Forest Management Plan 1994-2003 replace the 1987 plan provisions for all State forest areas. However, the 1987 plans are current for all issues on State forest not covered by the 1994 plan (e.g. plantations) and any activity on national park, conservation park or nature reserves. The 1987 plans and the 1994 plan were assessed under the *Environmental Protection Act 1986* and are subject to Ministerial conditions.

Area plans

Area plans are produced within the framework of a regional plan where the issues in a particular area are too complex to deal with in sufficient detail in the regional plan. Typically these are the large national parks. Area plans in the south-west forests exist for: Lane Poole Reserve 1990-2000; Leeuwin-Naturaliste National Park 1989-1999; Shannon Park and D'Entrecasteaux National Park 1987-1997; Walpole-Nornalup National Park 1992-2002; Waroona Reservoir and Catchment area 1990-2000; Logue Brook Reservoir and Catchment area 1990-2000 and John Forrest National Park 1994-2004.

Other plans

Other lower level planning documents are produced such as:

- issue plans covering dieback protection; fire protection (Fire Control Working Plans for CALM districts); timber harvesting and regeneration (prepared for timber supply areas).
- operational plans covering matters such as feral animal control; noxious weed eradication; planting; road construction and maintenance.

Mining

The legislative framework covering the minerals industries can be divided into two sections:

- land access and the approvals processes that are required to be met prior to a project proceeding; and
- processes covering the operation of mining projects.

Land access

Access for mining on private land is governed by the *Mining Act 1978* which allows for the granting of mining tenements on private land after the consent of the owner has been attained. Tenements clearly specify the conditions under which the tenement holder must operate. On private land, owners have the rights to basic materials, such as sand and gravel, and do not require a *Mining Act* tenement for the removal and use of such material.

The approvals required to explore and mine on Crown land and conservation areas depend on the type of conservation area. Current Western Australian Government policy is that exploration within all national parks and class A nature reserves can proceed only with the agreement of the Minister for the Environment and the Minister for Mines. If an important mineral deposit is discovered, then mining is permissible only if both Houses of Parliament agree following an environmental assessment by the Environmental Protection Authority. Mineral exploration and mining in other conservation reserves requires the approval of the Minister for the Environment. Under the *Mining Act*, the concurrence of the Minister for the Environment must be obtained before mining can proceed on other categories of land managed by CALM. These categories include State forests, timber reserves and other nature and conservation parks. CALM, however, establishes the land-management conditions for conservation reserves and State forests and the conditions that may be required for access by miners.

Petroleum exploration and development in the South-West Forest Region are regulated by the *Petroleum Act 1967*, which provides the framework for these activities on land, islands and internal waters in Western Australia. The *Schedule of Onshore Petroleum Exploration and Production Requirements 1991* (which is an attachment to the *Petroleum Act*), covers environmental and safety restrictions related to petroleum exploration and production.

Standard conditions have been developed to cover mineral exploration and mining in the different types of conservation reserves, State forests and other environmentally sensitive areas. Tenements issued under the *Mining Act* also have conditions attached which draw attention of the licensee to the provisions of other Acts including the *Environmental Protection Act 1986*, the *CALM Act 1984*, the *Wildlife Conservation Act 1950*, the *Bushfires Act 1954*, the *Country Areas Water Supply Act 1947*, the *Aboriginal Heritage Act 1972*, the *Town Planning and Development Act 1928* and the *Aboriginal Affairs Planning Authority Act 1972*.

In developing a project, companies are required to meet requirements stipulated by a number of statutes covering project development, mine operation and post-mining rehabilitation. Such requirements have been introduced to ensure that the interests of all parties—the developer, community and government—are considered. Each tenement application and project proposal is assessed in terms of its location, site characteristics, land-use and the likely impacts or effects which the proposed activities (e.g. mineral exploration, project development, mining, ore treatment and processing, transport, storage and shipping) could have on the immediate and adjacent natural and modified environments.

The major approval processes which a proponent needs to obtain before a project can proceed are stipulated under the following statutes:

- *Environmental Protection Act;*
- *Mining Act;*
- *Town Planning and Development Act;*
- *Land Act;*
- *Aboriginal Heritage Act;* and the
- *Aboriginal Affairs Planning Authority Act.*

The approval requirements for a given project may vary and not all approvals are required for all projects.

Legislative processes for the operation of mining projects

Once the necessary approvals have been obtained by the developer, the construction phase can begin and the mine can be brought into operation. As part of the environmental approval process, companies are required to submit an environmental management program (EMP) to the Department of Environmental Protection (DEP). This document specifies the management practices that will be adopted by the proponent to ensure that operations are maintained within acceptable environmental limits. The EMP requires approval by the Environmental Protection Authority prior to the start of project operations and on going monitoring of the project.

Mine operations must be carried out in accordance with the *Mining Act* and the *Mines Regulation Act 1946*, except for major mining developments which are carried out under State Agreement Acts.

As well as containing provisions covering the application, processing, approval and procedures for exploration and mining, the *Mining Act* contains provisions which cover the surrender of mining titles, conditions of access to public and private land, payment of royalties and settlement procedures for title disputes. The *Mines Regulation Act* covers occupational health and safety requirements for the mining sector.

State Agreement Acts

For large capital intensive projects involving the development of an extensive resource, the developer may choose to negotiate a State Agreement with the Government. The agreement must be ratified by Parliament and development proposals be approved before the project is brought into operation. Thereafter, the operations under the agreement are authorised by statute.

State Agreements bind both government and developer to specific responsibilities and set down the obligations of both parties throughout the life of a significant development project.

Western Australia has used State Agreements to foster its resource development. State Agreements are expressly intended to provide an additional level of security over the life of a major project and have played a significant role in the development of the State's mineral and energy resources. The agreements provide the maximum available certainty over land tenure (property rights) required for project development that can be granted under the relevant State law. A high degree of certainty regarding the constraints on the future operation and management of the project is assured because the agreement provisions can be changed only by mutual consent of the State and developer.

Benefits to the Government include a clear identification of developer and State obligations allowing the State to coordinate provisions of public infrastructure and facilities. Other benefits of State Agreement Acts are that they have the potential to increase the value-added component of minerals through further processing within Western Australia, as they commit developers to considering the establishment of secondary processing facilities, subject to commercial viability.

The main overall benefit to the developer of entering into a State Agreement is a reduction in sovereign risk. For example, a significant benefit to the developer is legislative protection, in that a State Agreement can override other government legislation (with the exception of the Environmental Protection Act and Commonwealth legislation). Other benefits include security of tenure and protection against any zoning action under any Act, regulations and by-laws which may adversely affect the operations of projects under the agreement.

On the other hand, State Agreements bind the developer to meet on-going requirements to ensure that the project is operated within social and environmentally acceptable levels and conditions.

The importance of State Agreements in the context of the Western Australian RFA has been recognised in the Scoping Agreement signed by the Prime Minister and Premier. Under clause 2 in the Preamble, it is stated that:

"The Commonwealth and Western Australia recognise that this agreement, and any RFA negotiated, cannot impose on a party any obligation that is inconsistent with a law of the Commonwealth or of Western Australia where that law is binding upon that party."

The Agreement Acts and statutes administered by the Department of Resources Development relevant to minerals projects operating within the RFA area are listed below.

Alumina/bauxite
- *Alumina Refinery (Worsley) Agreement Act 1973*;
- *Alumina Refinery (Wagerup) Agreement Act* and *Acts Amendment Act 1978*;
- *Alumina Refinery Agreement Act 1961*; and
- *Alumina Refinery (Pinjarra) Agreement Act 1969*.

Coal
- *Collie Coal (Griffin) Agreement Act 1979*; and
- *Collie Coal (Western Collieries) Agreement Act 1979*.

Mineral sands
- *Mineral Sands (Beenup) Agreement Act 1995*.

While a State Agreement clearly does not "freeze" the rights and obligations of the State and of companies for the duration of a project, with its explicit requirement for effective negotiation with the company over any proposed changes, it does represent a significant strengthening of property rights available to the company and a reduction in investment risk. This is likely to be a major reason why most companies contemplating major long-term investment in resource development in the State seek to establish such an agreement.

3.2 IMPLEMENTING MULTIPLE USE MANAGEMENT

Minerals

Mining and mineral processing is the most economically significant industry in the RFA area generating some $2.68 billion in revenue and more than 8000 jobs in 1995-96. The main minerals mined are bauxite in the northern jarrah forest, coal at Collie, gold at Boddington, mineral sands on the coastal plain southern coastal plain and tin-tantalum-lithium and spodumene-lithium at Greenbushes. These operations clear and rehabilitate approximately 600 hectares per annum.

As discussed previously, many of the mining operations are covered by State Agreement Acts. Such Acts require the companies to submit mining and rehabilitation plans. As an example, there are two significant committees involved in management of bauxite mining.

The Mining and Management Program Liaison Group (MMPLG) was set up as a result of the Ministerial conditions of 11 August 1995, for the production increase for the Wagerup alumina refinery. It is chaired by the Department of Resources Development and comprises representatives of State government agencies whose areas of responsibility are affected by Alcoa's mining operations. The agencies are CALM, Department of Minerals and Energy, Water and Rivers Commission, Water Corporation and Department of Environmental Protection. Alcoa and the MMPLG prepare and implement plans to manage the impacts of mining operations on the local community in consultation with the affected local government authorities. The MMPLG also reviews mining plans and manages issues relating to Alcoa's mining operations and coordinates environmental auditing of Alcoa's mining and management program.

The Mining Operations Group (MOG) undertakes liaison on operational issues with staff at Alcoa's three mine sites. The MOG comprises representatives from Alcoa and those government agencies with a direct interest in the day to day operations of the mines. These include CALM, Water and Rivers Commission, Water Corporation and the Department of Minerals and Energy. The primary task of MOG has been to evaluate Alcoa's advance forest clearing applications for the three mine sites. Clearing applications are evaluated according to forest management strategies that the MOG has developed from the five and 25-year mining plans.

Heritage

There is no stand-alone plan for natural heritage, for which a strategy is incorporated into the Forest Management Plan 1993-2004. This strategy is based on the 1992 Memorandum of Understanding between CALM and the Australian Heritage Commission that was developed following a joint CALM/AHC inventory of national estate values in the Southern Forest Region. The major element of protection for these values is their adequate representation in the reserve system. Planning to protect natural heritage values within areas disturbed for other uses is based on guidelines produced in the joint study and built into planning for those activities, particularly timber harvesting and road making. Planning and operational guidelines designed to minimise impacts on national estate values which are sensitive to timber production operations include ensuring that regeneration of the forest emulates the original structure, mix and relationship of forest types and care to avoid soil compaction, erosion and stream siltation. Where the location of cultural sites is known they are protected from disturbance activities that may affect the cultural values present.

Recreation and tourism

Most active recreational pursuits such as horse riding, mountain-bike riding and motor sports are facilitated in State forest. Recreation and tourism are typically excluded from nature reserves, unless there are special reasons such as a prior history of recreation. Draft area management plans include details of CALM's intentions and provide an opportunity for public comment. Once the plan has been approved there is some public consultation during the design and implementation phase. Sometimes plans showing proposed developments are displayed at recreation sites and comments invited. Proposed developments on harnessed water-supply catchments are submitted to the Water and Rivers Commission for endorsement. The intention to establish new sites or modify existing sites is advertised in local newspapers. Highlights are often reported in CALM's annual reports.

CALM's *Recreation and Tourism Strategy 1996-2000, People in CALM places* requires each recreation opportunity and each developed tourism site to be evaluated to determine its compatibility with CALM's

conservation objectives. Acceptable levels of environmental change that can be sustained within a given ecosystem need to be identified. Procedures followed are:

- evaluating recreation and tourism opportunities in terms of their compatibility with conservation and other management objectives—recreation sites are selected, designed and developed according to procedures in CALM's Recreation Operations Manual;
- establishing management guidelines that take into account conservation objectives;
- training CALM staff and tour operators;
- assessing and planning activities and facilities to minimise their impacts on nature conservation values;
- implementing new developments according to approved management plans; and
- identifying acceptable limits of environmental change that can be sustained in a given ecosystem and taking action when these levels are in danger of being exceeded.

Water

The main organisations involved are the Water and Rivers Commission (for long-term planning), Water Corporation (for existing and proposed water supplies) and CALM for CALM-managed lands. Close liaison is maintained between these organisations.

The Water and Rivers Commission aims to maximise the social, economic and environmental benefits to the community to ensure the availability and quality of water resources for present and future generations. The Commission allocates water resources, taking into account environmental and social aspects.

Regional water resource reviews and development plans are the primary means of providing guidance in the development of the State's water resources. These plans assess water supply and demand and identify possible environmental, social and cultural constraints. Plans are to be prepared for the 10 regions in the State; three had been prepared to 30 June 1996, including plans for the Bunbury-Collie region and Albany-Denmark region. A draft plan for the Busselton-Walpole region has been prepared. Water allocation management plans are the primary means of providing a framework for water allocation. The planning process involved provides for future needs to be considered. The plans provide public information and are subject to public participation.

The Water Corporation is required to act in accordance with prudent commercial principles and endeavour to make a profit, but considers potential effects on the natural environment of existing and proposed water supply developments. New developments are subject to EPA processes, including public participation when required.

CALM management plans set out requirements for catchment protection, water production and water quality maintenance where water is a management issue. The requirements of the Forest Management Plan 1994-2003 include:

- reserves of undisturbed vegetation to be retained on every river and stream on CALM land;
- restrictions on the proportion of forest which may be harvested in forest areas with saline ground-water tables;
- cooperative planning procedures with the Water Corporation to ensure potential water resource development sites are set aside for the future use and benefit of the community;
- continued work with the Water Corporation and other relevant agencies to reverse stream salinity by soundly-planned reforestation.

Timber production

The sustainable yield of products from the jarrah and karri forests was calculated based on a number of factors, including allowance for existing and proposed reserves and achieving forest structural goals.

On 16 August 1993, the Minister for the Environment made a determination of the annual sustainable timber resource available for allocation. The determination applies from 1 January 1994 until 31 December 2003. In summary, the Minister set an average annual harvest of 214 000m^3 of first grade karri saw logs and 203 000m^3 of other logs; 490 000m^3 of jarrah first and second grade saw logs and 559 000m^3 of marri logs. CALM contracts for the annual sale of log timber up to the allowable cut. Almost all of these sale contracts for sawlogs expire on 31 December 2003. Further details are provided in the Forest Management Plan 1994-2003.

Harvesting plans integrate multiple-use requirements such as:
- timber industry log requirements (size, quality, volume, haulage distance);
- visual resource management requirements;
- protection of research and inventory plots;
- dieback disease requirements;
- fire protection;
- regeneration requirements;
- heritage requirements;
- Aboriginal, archaeological, historical sites;
- catchment protection (salinity, sedimentation, siltation, turbidity);
- water production;
- honey production requirements (apiary sites);
- nature conservation requirements, including rare and endangered species;
- recreation and tourism;
- neighbours amenity requirements;
- public safety, including road safety;
- mining;
- public utilities including telephone, electricity; and
- education, interpretation of forest environments.

Harvesting plans aim to maintain productive capacity by various means such as harvesting mature and senescent, damaged or under-stocked forest and other forest growing at well below potential growth rates; thinning overstocked stands to promote growth on retained trees; and salvaging damaged or diseased trees that would otherwise be lost. Harvesting and regeneration plans aim to minimise the time between harvesting and regeneration and to rehabilitate areas as soon as practical to bring them back into production. Silviculture aims to retain the same species that were present before harvesting.

Nature conservation

The conservation objective in the Forest Management Plan 1994-2003 is:

"*To maintain biological diversity at the genetic, species and ecosystem level in the forest, with special emphasis on the protection and conservation of threatened, rare and uncommon taxa and communities.*"

Broad objectives include to:
- seek security of tenure for all forested areas considered to have value for nature and resource conservation, and oppose alienation of reserved land;
- establish a representative reserve system;
- incorporate measures that sustain biological diversity in forests managed for multiple purposes; and
- prepare wildlife management programs for selected taxa and identify, locate and seek to conserve threatened or endangered flora, fauna and communities in the forest.

Other products

Honey production

All apiary sites on pubic land are registered by CALM with an annual lease fee being imposed to cover administration and associated costs. Beekeeping is considered to be compatible with most other land uses in State forests, although site selection is critical and is coordinated so that factors such as the risk of dieback spread are considered. Apiary sites are positioned approximately three kilometres apart and each beekeeper is allowed to hold eight public land sites for every 100 hives owned. Beekeeping is allowed in national parks for those already licensed, however, a moratorium prohibits new sites being established until research on the impact of honeybees on flora is completed.

Wildflowers, blossom and seeds

Native flora and other vegetation declared as flora under the *Wildlife Conservation Act* are protected on all land within Western Australia. CALM regulates the bush picking sector of the floriculture industry and administers a licence system to ensure that harvesting from crown land does not pose a threat to flora conservation. Conditions are applied to all licences which specify quotas, permissible area, time frame and preferred access.

Grazing

The Forest Management Plan foreshadows the phasing out of sheep and cattle grazing in native forest areas over the next 30 years. The minor advantage of reduced fire hazard from grazing is considered to be offset by the degradation of nature conservation values.

Forest Management Plan 1994–2003

The manipulation of forest stands to achieve a forest structure and composition consistent with nominated management objectives is the science of silviculture.

The Forest Management Plan 1994-2003 sets the silvicultural policy for CALM-managed land. At the whole of forest level it defines four disturbance classes for the jarrah forest and specifies a structural goal for each. For the karri forest, it sets a goal for the percentage representation of the mature/senescent, immature, juvenile and establishment stages of stand development. (See below for each species.)

Within these whole of forest structural goals silvicultural policy is based on the stand condition and its interaction with the ecological characteristics of the forest.

Jarrah

Structural goals have been set for each of four categories of disturbance recognised in the jarrah forest. These categories range from minimal disturbance (e.g. conservation reserves) to high disturbance (e.g. forest areas subject to mining). Forest available for timber harvesting is predominantly within the moderate disturbance category where the structural goal for the term of the plan is to convert no more than 1% of the forest to the establishment phase each year. In time, this will provide for about 40% of the forest in this disturbance category to be dominated by trees in the mature and senescent stages of development, about 40% by immature, about 15% by juvenile and about 5% by establishment stages of development.

Timber harvesting operations in the jarrah forest may be linked to a variety of silvicultural objectives. Where there is a predominance of vigorously-growing trees, the stand is thinned. Where this is not the case, stands are harvested with the object of promoting regeneration. This is achieved either by harvesting in a way that will release existing lignotubers to grow unimpeded into saplings; or, where there are insufficient lignotubers as determined by pre-harvesting surveys, by harvesting to create a shelterwood under which seedlings can establish. Within a particular area of forest the proportion that is harvested to each of these objectives, and the degree of intermixing, vary according to the existing stand structure and condition.

In many areas the desired silvicultural objective is largely achieved by the harvesting operation itself. A proportion of the remainder is completed by silvicultural-tending operations one or two years after harvesting. In forest types that are regarded as marginal for long-term production harvesting may be done by selective cutting.

Marri occurs together with jarrah in varying proportions throughout the main jarrah forest range, and is more abundant in the southern forests. Relationships between forest composition and site characteristics have been described by Havel (1975) and Strelein (1988). Western Australian blackbutt occurs in association with jarrah and marri on moist sites throughout the jarrah forest, while wandoo is generally confined to the lower rainfall eastern forests and along the Darling scarp. Both these species have been harvested on a significant scale in the past, but constitute only a small proportion of the timber removed in current jarrah forest harvesting operations. Existing silvicultural prescriptions cater adequately for the requirements of Western Australian blackbutt, and a specific prescription has been prepared for treemarking and regeneration of wandoo (CALM 1989a).

Karri

The overall silvicultural goal for the karri forest is to maintain a sequence of age classes which ensures that about 40% of the forest consists of trees in mature and senescent stages of development (CALM 1994). In order to achieve this goal, management in forests subject to timber harvesting seeks to maintain the preceding stages of development in sufficient proportions to sustain the mature and senescent stages in perpetuity. Silvicultural strategies vary according to the structure and age of the existing forest.

Patches of even-aged and vigorously-growing karri forest that are greater than two hectares in area are identified for thinning. Once these patches have attained a top height of 30 metres and are old enough to yield saleable products they are thinned to an appropriate density by commercial harvesting.

Mature forests and forests of mixed structure created by past logging activities are harvested using a clearfelling system. Logging slash is burnt at high intensity in autumn to create a receptive seedbed and to remove fuel that would otherwise be a hazard for the regenerating stand. Regeneration following harvesting is achieved within the following year or two by means of seed trees retained temporarily on the site, by planting with nursery-raised karri seedlings, or by broadcast seeding. The seed tree method is used wherever possible in order to use on-site seed and minimise the cost of regeneration operations. Planting is used when the seed crop is inadequate. Broadcast seeding is employed only to a limited extent because of the high cost of karri seed, and the inconsistent results obtained using this technique. Regeneration surveys are conducted to ensure the stocking meets success targets.

Marri occurs in association with karri and may be the more abundant species on some sites, particularly in lower rainfall areas on the margins of the karri forest range. Marri regenerates readily from seed and ground coppice following fire or logging disturbance, and no silvicultural intervention is normally required to maintain the marri component of mixed karri/marri stands.

Fire management

Fire is a naturally-occurring disturbance factor in south-west ecosystems, to which most of the flora and fauna are generally well adapted. The bushfire hazard in the south-west of Western Australia is as potentially severe as anywhere in Australia and although fire is a natural and necessary element, it can also be an agent of death and destruction for human assets and values.

CALM is responsible for all fire management on State forest, timber reserves, national parks, conservation parks and nature reserves. Although other government departments are responsible for other Crown land tenures, fire management is often effected through interagency agreements with CALM. Fire management on private land is the responsibility of the landowner but local government and the Bush Fires Board have a role in controlling and coordinating their efforts.

Fire management strategies employed in the south-west forests include the use of prescribed fire, fire detection, direct fire suppression, public education and law enforcement.

Prescribed fire

The controlled application of fire in Western Australia's native forests serves three important functions:
- to assist in achieving rapid regeneration of the forest following harvesting—different fire intensities are required to achieve the different silvicultural objectives;
- to provide strategic protection to life, property and forest values (including established regeneration) from damaging high intensity wildfire through the use of fuel reduction burns; and
- to maintain and enhance fire-adapted flora communities and fauna habitats and recycle nutrients within the forest ecosystem.

Fires are generally categorised as being of low (litter fires of less than 350 kW/m), moderate (understorey vegetation fires of 350-2000 kW/m) or high intensity (defoliating canopy fires of more than 2000 kW/m).

Silvicultural use
Low, moderate and high intensity prescribed fire is an important silvicultural tool in south-west forests.

Low intensity fire is used to remove the flash fuels from jarrah harvesting debris and "burn back" the above-ground stem of the lignotubers without damaging the below-ground component of the lignotuber. This will stimulate the lignotuber to form a dynamic shoot that will progress to the sapling and pole stages.

Moderate intensity fire is used to establish regeneration in jarrah forest through natural seed fall from retained trees and subsequent germination and development of seedlings on the resulting ash bed.

High intensity fire is used in karri forest to remove most of the harvesting debris, create an ashbed and induce seedfall from the seed trees if they have been retained. Removing harvesting debris reduces the future fire hazard as well as the potential for lower-bole damage to developing regeneration in later prescribed burning.

Fire is excluded from regenerated stands until such time as future crop trees can withstand a low intensity fire. This may be 10 to 15 years in jarrah and 15 to 20 years in karri. CALM (1997c) provides a more detailed discussion of the silvicultural application of fire in the jarrah forest.

Fuel reduction burning
The most effective means of minimising the damaging effects of wildfires is to reduce available fuel levels with prescribed fire. Low intensity fire is used to maintain low fuel buffers adjacent to areas with high life and property values such as townsites, plantations and farming communities. A network of low fuel areas is also maintained within large forest blocks to stop the run of high intensity fires. In the drier forest the buffers are designed with an acceptable loss of about 2000 to 4000 hectares, whereas in the karri forest it is 1500 to 2000 hectares.

Wildlife management
Prescribed fire is used for particular wildlife management purposes. For example it is incorporated into the Perup Nature Reserve fire plan to regenerate heartleaf poison thickets used by woylies and tammar wallabies for cover. Fire is also excluded from some areas in order to maintain habitat for particular species.

Fire planning

The integration of the use of prescribed fire with the detection, suppression and education strategies occurs in the planning phase. The principal planning tool is a risk evaluation system called the Wildfire Threat Analysis (WTA). The WTA provides a framework for evaluating the values at risk, the risk of an ignition occurring, the suppression response available and the headfire behaviour potential. All of these factors are mapped and overlain to provide the planner with the information needed to integrate and optimise the fire management strategy.

CALM regions and districts maintain master burning plans that are updated each year and from which an annual burning plan is produced. The annual burning plan is discussed with local government and Bush Fires Board officers to allow integration of private land fire management with that for public land. Districts also prepare an annual fire control working plan that sets out their resource levels, fire detection requirements and standing orders.

Where an area management plan exists, such as that for Walpole-Nornalup National Park, specific fire management requirements to meet the objectives for the area will be set out over and above the broad strategic fire requirements.

Weeds, pests and diseases management

Threats include:
- fungal diseases such as dieback due to Phytophthora cinnamomi, wood rots, stem and branch cankers, leaf spots;
- insect pests include jarrah leaf miner, gumleaf skeletoniser and bullseye borer;
- feral animals; and
- invasive weeds.

Feral animals

CALM's fox control program "Western Shield" is in place in the forest area. Control measures for pigs, goats, rabbits and cats also occur in various areas, under annual programs in CALM regions and districts. Some eradication programs occur on private property and the Agriculture Protection Board targets feral animals of economic importance on other Crown land.

The priorities for feral animal control on forested lands managed by CALM are:
- Priority 1—protection of rare and vulnerable animals, especially where risk of native species extinction exists;
- Priority 2—the progressive eradication of feral animals from selected offshore islands;
- Priority 3—protection of other important habitats and high value ecosystems subject to significant environmental degradation;
- Priority 4—control of feral animals adjacent to private property, around areas subject to regular public use, in harnessed catchments and in disease risk areas;
- Priority 5—remainder of CALM lands.

Feral animal control is covered in CALM management plans. Draft management plans include details of CALM's intentions and provide an opportunity for public comment. Once the plan has been approved there is typically little public consultation during the implementation phase. Highlights are often reported in CALM's annual reports.

Disease control

Over the past 25 years a detailed dieback control strategy has been developed and implemented in south-west forests. This involves policy, research, planning (including disease location and impact mapping), community education, liaison, field management, silviculture, control of access and monitoring. The principal research and operational findings are that:

- the fungus spreads in contaminated soil carried as a result of human activities;
- spread can be reduced if stringent hygiene is practised;
- the forest has markedly varying degrees of susceptibility to the disease; and
- the high density of *Banksia grandis*, which is highly susceptible to the fungus, is a major factor contributing to disease spread and intensification.

Disease control is usually covered as a topic in CALM management plans. Draft management plans include details of CALM's intentions and provide an opportunity for public comment.

Weeds

Numerous weeds are present on CALM land, including weeds declared under the provisions of the *Agriculture and Related Resources Protection Act*, e.g. blackberries, and other weeds such as veldt grass. CALM's objective is to prevent the accidental introduction of weeds, control declared weeds and control non-declared "environmental" weeds on its lands.

Each CALM district is required to survey and record the location and extent of weed infestations. A weed control plan is then developed at a regional and district level in liaison with the Agriculture Protection Board (APB) and implemented within the constraints of funds available. Resource limitations preclude the treatment of all known weed infestations.

The priorities for forest weed control are:

- Priority 1—areas of highest value from a conservation, recreation, production or protection aspect;
- Priority 2—small new infestations, particularly in headwaters of streams;
- Priority 3—large infestations adjacent to private property and likely to affect it;
- Priority 4—remainder of CALM land.

Weed control is usually standard practice when establishing tree plantations.

Insect control

There are three insects currently of concern in Western Australia's native forests: jarrah leafminer, gumleaf skeletoniser and bullseye borer. Despite extensive research into jarrah leafminer by CSIRO and CALM, no practical control measures have been found. A similar situation exists for gumleaf skeletoniser and the bullseye borer. Control of insect attack in native vegetation is usually not practical except in small areas such as some parks, and no formal planning is undertaken. Insect control is often practised if required when establishing tree crops on cleared land. One insect not present in native forests but of concern for pine plantations is sirex wood wasp.

Codes, manuals and guidelines

CALM has a range of codes, manuals and guidelines to control the implementation of management practices. The most significant are:

Timber Harvesting in Western Australia (1996)

This document currently includes the Code of Harvesting Practice and the Manual of Harvesting Specifications. The Code of Harvesting Practice was subsequently issued separately in 1997 following revisions of the occupational health and safety section. The code sets out broad requirements for felling, extraction, roading, loading and delivery, environmental protection, recording and safety. The manual on the other hand is more specific in setting responsibilities and standards in planning, roading, silviculture, coupe management, environmental protection, log specification and administration.

There is no legislative requirement for the provisions in either document, however, both documents are included as schedules to harvesting contracts so that their provisions become enforceable through the contract.

Code of Practice for Timber Plantations in Western Australia (1997)

This document is a joint production by CALM and the Western Australian chapter of the Australian Forest Growers and is intended to apply to private and public plantations. It provides guidelines on all aspects of plantation establishment and management. CALM is committed to compliance with the code, but its adoption is voluntary for private property owners.

Silviculture guidelines

Guidelines have been produced for silvicultural practices for all species. Guidelines or manuals also exist for many other activities that promote or protect multiple use management in forests. These include fire management, recreation operations, apiary management and wildflower harvesting.

3.3 FOREST RESEARCH

CALM's Science and Information Division (SID) undertakes forest research on public land. Its role is "to provide up-to-date and scientifically-sound information to uphold effective conservation and land management in Western Australia". SID consists of three research groups:

- Bio-resources group—concerned with the inventory of systematic, biological and ecological information on the biota and documentation of the landscape characteristics and ecological communities of the State;
- Bio-conservation group—focuses on the processes which are diminishing or degrading the State's bio-resources and how these processes can be managed effectively so the resources are conserved;
- Sustainable Resources group—researches the management and use of species from which natural products are derived, including plantations.

The groups interact extensively and work with staff in other parts of CALM. There is also considerable interaction with scientists in the CSIRO and universities and with scientists in other government departments and authorities.

Bio-resources and Bio-conservation

Current research areas include:

- development of the departmental monitoring program;
- development of guidelines for monitoring Australia's wetlands of international importance;
- community conservation of the Walpole-Nornalup National Park;
- community conservation of the Lake Muir complex;
- conservation biology of locally-endemic eucalypts;
- radio tracking of translocated noisy scrub-bird;
- conservation biology of rare and threatened flora;
- seed biology, seed bank dynamics and long-term germ plasm storage of Western Australia's flora, particularly rare flora;
- control and ecology of the red fox in Western Australia;
- the development of micro-satellite probes to investigate the social organisation of foxes;
- quenda translocation methods;
- factors affecting establishment in the numbat reintroduction program;
- recovery plan for the chuditch;
- population surveys, conservation status and area-based wildlife management programs;
- ecology and conservation of Western Australian pythons;
- conservation biology of vulnerable frogs;
- control and management of *Phytophthora megasperma* in national parks and nature reserves;
- effects of three fire regimes on ground-dwelling invertebrates in the jarrah forest;
- effects of spring and autumn prescribed burns on small vertebrates in the jarrah forest;
- control of jarrah leafminer;
- effects of fire and logging on jarrah forest vegetation;
- fire danger and fire behaviour in south-west forests;
- jarrah growth on dieback sites;
- biological and chemical control of *Armillaria* in karri regrowth stands;
- monitoring of gumleaf skeletoniser attack on jarrah;
- effects of logging and fire on birds of the jarrah forest;
- *Phytophthora cinnamomi* impact in the northern jarrah forest;

- effect of logging and burning on fauna hollows in jarrah and marri;
- dieback-resistant jarrah;
- fire technique for germinating brown boronia;
- fire history and impact of *Phytophthora* in jarrah forests;

Recent projects (1992-1995) include:
- long-term data on diversity and composition of small vertebrate and invertebrate communities in mallee and woodlands in south-west;
- data on resilience to disturbance in relation to climate, fire, drought, etc. in determining structure and composition of faunal communities;
- recovery plans for woylie, tammar, Purdie's donkey orchid;
- research plan for ground parrot;
- wildlife management program for rare and threatened flora in metropolitan area, Albany districts, other southern districts;
- development of a fire response database;
- *Phytophthora* spp. research, including control with phosphonate;
- other forest diseases research;
- susceptibility of *Pinus radiata* to *P. cinnamomi*;
- bullseye borer research;
- fire behaviour and fire impact model for jarrah forests;
- site hazard rating for impact of *P. cinnamomi* in northern jarrah forest;
- jarrah leafminer studies;
- effects of different fire regimes on jarrah forest understorey;
- age to first flowering after fire and month of peak flowering of jarrah forest species.

Sustainable Resources

Silviculture

Silvicultural research conducted since the 1930s has contributed to a substantial body of knowledge about the regeneration, development and management of karri forest stands. This research has been reviewed in detail by Breidahl and Hewett (1995), and current developments have been described by McCaw and Rayner (1995). Detailed silvicultural specifications are available for all harvesting and regeneration operations carried out in karri forest (CALM 1990a, 1992a, 1995b, 1997a, b)

There is a long history of silvicultural research in the jarrah forest dating back to the early years of organised forest management in the 1920s. Abbott and Loneragan (1986) reviewed a large body of published and unpublished research on the ecology and silviculture of jarrah, and Stoneman et al. (1989) discussed the silviculture of jarrah and the application of silvicultural systems to meet various land use objectives. Detailed silvicultural specifications are available for all harvesting operations carried out in jarrah forest (CALM 1989a, b, c, 1995a, 1997c, d)

Current Sustainable Resources research projects include:
- increasing productivity of karri regrowth stands by thinning and fertilising;
- spacing effects on development and form of regrowth karri;
- regeneration of jarrah in southern jarrah forest;
- improving seedling nursery techniques;
- seed orchard management for the supply of superior *Eucalyptus* globulus seed;
- development of vegetative multiplication techniques for *E. globulus* clonal forestry;
- pine tree breeding;
- *E. globulus* tree breeding;
- marri family provenance trial (including kino-free marri);
- inoculation of *Pinus radiata* seedlings with different mycorrhizal fungi;
- performance of *E. globulus*, planted on farms, in relation to soil and site attributes;
- determining the cause of death of *E. globulus* grown on shallow soils on the Darling plateau;
- prediction of silvicultural requirements (ripping, mounding, fertilisation) for specific sites before trees are planted;
- early rotation nutrition of *Pinus radiata* on ex-pasture land on the south coast of Western Australia;
- pine timber belts.

Recent research projects (1992-1995) include:
- evaluation of the success of in-fill planting of karri seedlings;
- compared growth performance of seedlings raised using a variety of nursery techniques;
- thinning/fertiliser experiment in karri regrowth;
- study of factors affecting emergence, mortality and growth of jarrah from seed in the northern jarrah forest;
- thinning and fertilising of jarrah pole stands;
- development of computer program to help set commercial wildflower picking quotas;
- permanent plots to provide data on effects of legumes, season of germination and ash on survival and growth of brown boronia.;
- study on herbicides used for thinning jarrah and marri;
- whole-farm planning to determine optimum placement of pine plantation on farms;
- modified blue gum planting designs to minimise salt damage and drought deaths;
- soil survey and land evaluation systems for different tree crops on farms;
- fertiliser response trials for *E. globulus*.

Other organisations such as CSIRO, Alcoa of Australia Ltd and universities have undertaken some research in related topics. Many research projects are currently taking place at an international, national and State level. These will help understanding of the relative importance of greenhouse gases and particular sources and sinks. Of particular interest has been the work conducted by the Climate Impact Group of the CSIRO on the regional implications of the greenhouse effect for Western Australia. CSIRO Forestry Group staff based at Floreat conducted some research on nutrient cycles and carbon flows in jarrah and karri forest in the 1970s, 1980s and 1990s.

3.4 MONITORING, REVIEW AND REPORTING

Major reviews of management systems of CALM and other agencies occur at irregular and often long intervals, frequently during restructuring exercises, e.g. the amalgamation of the Forests Department, National Parks Authority and part of the Fisheries and Wildlife Department to form CALM in 1985. Minor reviews occur much more frequently. Some sections of CALM, including the CALM Corporate Executive, have annual seminars, which present an opportunity to consider performance and discuss possible changes. Some of CALM's manuals and guidelines are reviewed fairly regularly and revised every few years. The timber harvesting manual has been kept reasonably up to date, in recent years.

Continuous improvement

While there is no specific policy within CALM to have continuous improvement there is a corporate efficiency and effectiveness objective. Numerous improvements have been introduced in recent years and many are documented in CALM's annual reports. For example, in the 1996-97 report (CALM 1997e) there was information on:
- developments in the State salinity strategy;
- extensions to the Western Shield feral animal control program;
- introduction of a new Threatened Species Scientific Committee to provide advice on flora and fauna requiring special protection;
- revision of the priority flora list (includes declared rare flora);
- trials of aerial fire-fighting techniques;
- distribution of information on CALM programs through the Internet;
- trials of techniques for use of the dieback-inhibiting chemical, phosphite;
- amendments to the gazetted list of specially protected fauna; and
- preparation of interim recovery plans for taxa classified as critically endangered.