

The conservation value of defence training areas

Scientists from CSIRO have found that training areas used by the military for battle exercises provide refuges for many kinds of animals and plants. Whizzing mortars, exploding bombs, and raging tanks only temporarily disturb the peace. Native fauna and flora often prefer such havens to the public lands outside.

For example, some of the largest known populations of an endangered bird, the ground parrot, live within the Evans Head bombing range on the north coast of New South Wales and inside the Wide Bay training area in southern Queensland. An extremely rare primitive plant, *Bowenia serratifolia*, mainly occurs in pockets of the Shoalwater Bay training area on the Queensland coast. One of the few remaining virgin stands of tropical basaltic rain-forest grows at the Defence Department's Downey Creek trials area, near Tully in northern Queensland.

A number of training areas are now parts of national parks, and several are on the Register of the National Estate.

It's not that the men and women in khaki are becoming 'greenies' above all else. If military training calls for the bulldozing of a track through nearly impenetrable undergrowth, or demonstrating the ground-grazing effects of 500-lb bombs, they will do it. However, they take account of the area's conservation value and of its ability

to regenerate. And they carry out repairs if necessary.

Under contract to the Department of Defence, hydrologists, botanists, ecologists, soil scientists, agronomists, and geographers from the CSIRO Division of Water and Land Resources are providing scientific advice on how to keep the training areas in good shape.

Of course, it is in the Army's interests to look after these areas. It's no use trying to learn jungle warfare tactics in a country denuded of vegetation. Tanks have great difficulty making headway across erosion gullies. Artillery gunners find their targets just too easy when camouflaging vegetation has been lost.

Increased mechanization of the Army, and the introduction of longer-range

The map shows the locations of areas used for military training that CSIRO has studied in recent years. Some are controlled by the Defence Department; others are proclaimed for certain periods while manoeuvres take place.

Tracked vehicles, like this armoured personnel carrier, easily disturb loose soils.

weapons, have meant greater use of, and impact on, the training areas involved. Yet public pressure is against turning over more Crown land to the Army, as recent events in New South Wales showed.

The Army cannot destroy an area and move on. At present the Department of Defence controls more than 2 million hectares of land, both training areas and operational bases. Managing these sites so as to ensure, under heavy impact, long-term stability of their landscape and ecology presents a challenge. The Department spends about \$500 000 a year on research and advice from CSIRO.

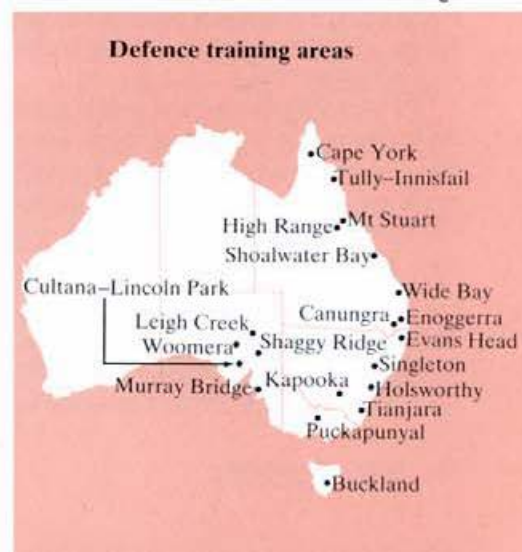
For its part, CSIRO finds that military areas provide a particularly useful field laboratory for environmental studies. Exclusion of the general public has advantages for such field experiments. And often the scientists can conduct experiments that are not possible in national parks (looking at the effect of regeneration after vehicle impact, for example).

Evans Head

In 1980 the RAAF's Evans Head bombing range on the northern New South Wales coast was incorporated into the Bundjalung National Park. At that time the Department of Defence requested CSIRO to provide an ecological assessment of the area.

Four scientists from the Division of Water and Land Resources, Dr Peter Heyligers, Dr Ken Myers, Mr Ralph Scott, and Dr Joe Walker, undertook this task, with the assistance of Mr Sandy Gilmore who was working on behalf of the New South Wales National Parks and Wildlife Service. They interpreted aerial photographs, compiled maps, and spent time in the field assessing the vegetation and animal life.

The bombing range, largely swamps and sand dunes, comprises a 10-sq.-km North Range and a similarly sized South Range. The RAAF ceased to use the North Range





for live bombing exercises in 1973, and made some progress in clearing unexploded ordnance before the magnitude of the task brought the project to a halt. The land here was swampy, and bombs penetrated several metres of mud. Slashing, burning, and excavating impact craters searching for these was creating as much disturbance as the original bombs had caused, even though rehabilitating the landscape was the aim. Instead, the target area has been left alone and proclaimed 'out of bounds' for an indefinite period.

The South Range continues as a target for inert bombs, rockets, and helicopter gunship fire, despite its national park status.

Notwithstanding the considerable disturbance inflicted on the area, one of the largest concentrations of ground parrots (*Pezoporus wallicus*) on the northern coast of New South Wales was found in the target area of the disused North Range. This contrasts with the low numbers found in similar habitat to the north (Broadwater National Park) and to the south (Yuraygir National Park).

Indeed, ground parrot numbers are falling rapidly, and in Dr Myers' estimation its populations in Defence areas form most of the significant ones on the eastern coast. (The bird also occurs in good numbers in parts of Victoria and in south-western Tasmania. The ground parrot is not rare, but certainly threatened.)

Dr Myers cites exclusion of people as the main reason. He thinks that too-frequent fire — caused accidentally or intentionally by people — has destroyed its habitat elsewhere. Although controlled burning is used at Evans Head, a resident ranger

maintains wide fire-breaks to help keep wildfire out.

The ground parrot requires a wet heath habitat, which is fire-sensitive. The birds breed well at Evans Head because their nests are relatively safe from fire as well as from those who would collect their eggs. Range managers shoot intruding feral animals.

The range was 'absolutely seething' with ground parrots.

Dr Myers also finds that the shutting up of Evans Head has had other benefits. Swamps have not been drained as they have been in other coastal regions, a boon to ground parrots and many water birds, and allowing melaleucas and banksias to flourish. Honey-eaters in particular feed and multiply among the wet coastal heath. Other bird species that enjoy the conditions there include the drongo, rose robin, varied triller, and jabiru.

The ground parrot thrives inside the Evans Head bombing range and the Tianjara and Wide Bay training areas.

Tianjara

The Tianjara training area near Nowra, on the coast south of Sydney, was incorporated into the Morton National Park several years ago and is now on the Register of the National Estate. It includes an impressive array of tiered sandstone cliffs, and its contrasting landscape constantly attracts the interest of naturalists, although they'd best stay away from areas that may harbour unexploded ordnance. The environment ranges from dry low heaths on rock platforms to tall open forests on deep humic soils. Rainforest can also be found in sheltered gullies.

At the time of the area's elevation to national park status, the Department of Defence requested CSIRO to undertake a survey of it. The survey had two aims: to examine its environment in terms of geomorphology, soils, vegetation, and fauna, and to see what effect 40 years of Army training had had. Training still continues in the area.

The complexity of the landscape, the many types of habitat (wet and dry, exposed and sheltered), and the rugged gorges and steep cliffs made reconnaissance difficult, but an interim report was published in 1983 and a more detailed version is in press.

The fauna study assessed the presence and numbers of all vertebrates except fish. Dr Myers, Mr Richard Thackway, and Mr Viv Read did most of this work, using a variety of sampling techniques.

As the highlight of the study, they confirmed that the ground parrot is widely distributed throughout the heathlands of the area. And they found the highest numbers of these birds where wet and dry heath formed a mosaic.

Ground parrots are shy, and seldom seen during the day. However, they call regularly at dusk and dawn, and the researchers



This shy bird, *Emblema bella* (the beautiful firetail finch), finds refuge inside the Tianjara training area.

The result of forest clearing at Puckapunyal. Raised water tables make the ground wet and boggy.

counted the birds by using a line of listening posts.

Bountiful numbers of the beautiful firetail finch were also counted, a bird that is fast disappearing under the impact of agriculture.

The surveyors found the richest fauna at the headwaters of the main streams, where there is permanent water. They suggest that these areas should remain free of heavy vehicles, and be kept as conservation areas.

But, comparing the training area with similar environments outside, the CSIRO group concluded that Army training has not had a significant impact on fauna, other than to increase habitat for frogs (shell holes fill with water after rain). More serious has been the impact of fire and, to a lesser extent, past logging.

The effect of fire can be seen everywhere. It keeps much of the heathlands low and sparse, and maintains much of the forest and woodland dry and open. Dr Myers blames too-frequent fire for the low diversity of arboreal and ground-dwelling mammals. Many mammals that ought to be there were absent or very rare. Similarly, earlier ornithologists had seen the birds that need dense habitat (like the eastern bristle bird), but these are not common now.

Military areas provide a particularly useful field laboratory for environmental studies.

Fire sweeps into Tianjara from grazing areas outside, and Dr Myers would like to see fire-breaks established and rangers equipped to suppress its almost yearly occurrence.

Puckapunyal

The armoured corps training area at Puckapunyal in central Victoria provides a prime example of how country suffering erosion problems can be turned around.

In 1970 the landscape at Puckapunyal had deteriorated to the extent that, in winter, 60% of the Range had become 'no-go' areas, as the Army calls untrafficable country. Even Centurion tanks were becoming bogged. Silt was washing off into local streams, and threatening the purity of water in Goulburn Weir.



As a previous *Ecos* article has pointed out, the Army wasn't entirely to blame. Excessive farm clearing and timber-getting, overgrazing, rabbit infestations, and early mining activities had all contributed to the severe sheet, tunnel, and gully erosion. Battle manoeuvres aggravated the problem: tanks and other tracked vehicles are not kind to the soil, nor are explosions from guns and bombs.

Eroded areas produced increased water run-off, and this gave rise to waterlogging and bogging on the lower flats.

Repair was the first priority, and CSIRO took charge of general planning and technical supervision of the whole project. At the time, it was the largest rehabilitation project ever attempted in Australia, and involved a number of CSIRO Divisions and several State and Commonwealth departments. Most of the field work was carried out by the Soil Conservation Authority of Victoria. Workmen have graded at least 4000 ha of grossly disturbed land, ripped up erosion tunnels through about 300 ha, and bulldozed some 300 km of erosion gullies.

Revegetation involved sowing pasture on more than 20 000 ha, and planting more than 370 000 trees on some 1000 ha. 'Pucka' carries a large sheep flock to help reduce the fire risk in summer and stop scrub from taking over the grass cover. These sheep belong to a grazier who has the grazing rights under stringent conditions.

Experience has shown that the general approach taken to fix Puckapunyal was the right one. Soil stability and the capacity of the surface to withstand heavy punishment continue to improve as the introduced pasture and trees develop an effective ground cover.



Using a neutron moisture meter to measure the water content of Puckapunyal soil.

That's quite an achievement when you consider that heavy use of the Range continued during the whole revegetation program.

As revegetation nears completion, management of the Range becomes increasingly important. Questions such as the optimum stocking rate and level of fertilizer application need answering, and it is expected that CSIRO will continue to be involved with the Puckapunyal Pasture Advisory Committee in the formulation of detailed management strategies and operational decisions.

Puckapunyal revisited

Now that the erosion damage has been repaired, a recent major study has sought to find out why the area is so susceptible to waterlogging. Problems of salinization have arisen too, and salinity measurements of Majors Creek (flowing through Puckapunyal) have revealed an average salt content of 600 p.p.m., with values up to 8000 p.p.m. at times.

It has been known for some time that one cause has been the removal of native forest, which leads to waterlogging and salting of the flats that the water drains onto. Hydrologist Dr Gordon Burch of the Division of Water and Land Resources wanted to find out which areas contributed most to the problem, so that replanting could be done in the right areas.

A new dimension to the question has been added by the Army's acquisition of State Forest adjacent to the established Range. This nearly doubles the training area (from 217 to 424 sq. km), alleviating



The Wide Bay training area sometimes receives a heavy beating.

much of the pressure on the original landscape. It will make it possible to use different sections in rotation, allowing damaged ones to recover.

Although the new West Range has already been partially cleared (it has about 75% tree cover), additional clearing will be needed to make it suitable for Army training. Dr Burch is trying to identify areas where such clearing (and replanting to pasture) will have the smallest hydrological effect. To use the land without considering its hydrology would result in a situation similar to Puckapunyal in the 1960s.

Dr Burch and his colleagues have spent nearly 3 years studying the local hydrology. He selected two representative catchments for detailed study: one in cleared grassland, the other in a forested area. Each was equipped with a flume to record run-offs and with piezometers (wells that allow the height of the water table to be measured). A variant of this is the 'well-permeater', used to gauge the permeability of the soil to water at different depths.

Additional data came from soil surveys, and from a rainfall simulator. This piece of equipment, mounted on a trailer, sprinkles a metered amount of 'rain' on a selected test site. The scientists measure the run-off from the site, which allows them to calculate the infiltration capacity of the soil.

Dr Burch found that a substantially greater run-off occurred from the grassland than from the forest. Indeed, peak flows were often 1000 times higher over grassland, and frequently the forest had no run-off at all after rain. The erosion potential of grassland is therefore very much greater.

He also found that topography accounted for very little of the difference. Of much more importance is the ability of the soil to store and transmit water. Clearing has the

effect of reducing the permeability of the soil in the critical subsurface layer (10–40 cm) by nearly one-half, and even more in low-lying areas.

If it loses its capacity to transmit water, then not only is run-off greater, but the soil stays wetter for longer and waterlogging problems (such as bogging) are greatly enhanced.

Dr Burch is employing a computer model of soil hydrology, devised by his colleague Dr Emmett O'Loughlin, to extend his findings to the entire Puckapunyal Range and to pin-point sensitive areas. The model indicates that — to minimize waterlogging and secondary salinization — in general, depression areas should not be cleared. Vehicles should keep away from them too. Crests and upper slopes would appear to provide the best clear corridors for vehicle movement.

Over the whole range care is being taken to preserve the grass trees (*Xanthorrhoea australis*) because their presence is unusual in this part of Victoria. The area abounds in wildlife, although no systematic study has been done on this aspect. Dr Ken Myers and colleagues from the Division are hoping to conduct wildlife surveys of all Defence Department establishments in the near future.

Gauging tank impact

Another major consideration at Puckapunyal is gauging how much beating the land can take before it needs rest or restoration. Among the continuing problems, tanks inflict considerable damage on the pasture, especially when the soil is wet, and that damage frequently requires expensive repairs.

Scientists from CSIRO have been carrying out so-called 'trafficability' trials at Puckapunyal for a number of years, and Dr Mike Braunack of the Division is now in charge of this work. The experiments are

designed to gauge the ability of soils to withstand various degrees of armoured vehicle impact, and to assess the best ways of minimizing damage and making repairs.

Recently, a 20-ha trial zone has been pegged out, and Dr Braunack intends to measure the impact on bare and grassy areas of an armoured vehicle travelling in straight lines, and cornering.

A heavy tank turning at battle speed is a formidable engine of destruction, as the turn is executed by stopping one of its crawler tracks. Aptly, it bears the name 'pivot' or 'screw' turn.

Dr Braunack has already conducted similar trials at Woomera, S.A., and at Shoalwater Bay, Qld. His hope is that he can correlate the degree of damage with soil measurements in the laboratory. He has built apparatus that tests a soil sample's resistance to shear while it is undergoing repetitive impacts, which simulate the forces imposed by a tank.

Work so far, in the field and in the laboratory, has confirmed that repetitive impact can reduce the strength of dry soil from Woomera and Shoalwater Bay.

This explains why, under dry conditions, one or two vehicles may get through, but those following find the going increasingly difficult. Corroboration of the deleterious effects of multiple passes of heavy tracked vehicles comes from the observations of Divisional colleagues Mr Peter Reece and Dr Andy Gillison.

How much beating can the land take before it needs rest or restoration?

For a number of years Mr Reece has been environmental consultant when Army exercises are planned. He surveys the area before the exercise, and recommends which environmentally sensitive sections should be avoided. Afterwards, he gauges the impact, and ascertains whether repairs are needed.

After surveying many exercise sites in a number of States, Mr Reece confirms that light damage over a large area is preferable to heavy damage on a smaller one. Time will usually heal the former (it may take 10 years in arid country), but erosion can too easily take hold in the latter, and repairs are likely to be necessary.

Dr Gillison has done a lot of work at Wide Bay, Qld, mainly as a plant ecologist (which we will look at later). However, he has also done trafficability trials there with

armoured personnel carriers, and reached similar conclusions.

Wide Bay

The Wide Bay training ground lies next to Fraser Island and Cooloola; indeed, it forms the northernmost extension of the Cooloola sand mass. Its 20 000 ha takes in a coastal system of leached sands and marsh areas generally referred to as 'wallum'.

The shallow sandy, acid soils are very low in nutrients, and overlies heavy clay. Drainage is therefore slow, the water table is consistently close to the surface, and bogs and marshes are common. The result is a fragile-looking system that appears very susceptible to erosion.

After rain, particularly, when the water table is highest, vehicles become bogged easily and damage the landscape. Yet the area has been intensively used by artillery regiments and infantry battalions employing armoured vehicles. Although rather small for tank manoeuvres (Shoalwater Bay would be better), it has been used almost continuously because of its proximity to Brisbane.

Considerable damage has been done in some areas, where restoration is likely to take up to 15 years. Restoration of native vegetation is difficult because many wallum plants are susceptible to damage by the fertilizers that are usually used to speed the healing of scarred soil. For this reason, some introduced pasture species are used for revegetation.

Dr Gillison and colleagues have examined the damage Wide Bay has suffered, and conducted experiments that gauge the impact inflicted on soil (with various water contents) by different types of military vehicles. He has provided the Army with recommendations for repair and for ways to reduce the impact of tracked vehicles.

Basically, he has suggested that no armoured vehicles train at Wide Bay during

A trafficability trial at Wide Bay.



the wet season (January to May), and that at any time only small exercises be staged. Since the water content of the soil is the crucial factor, he has provisionally recommended that all tracked vehicles should stay put for 3 days following rainfall of more than 50 mm.

Surprisingly, he has found that under dry conditions the wallum is remarkably resilient. 'If you want an area that can take a considerable beating, then the wallum, in the dry, is it,' says Dr Gillison, although he expects a number of ecologists may not completely agree. However, he stands by the evidence of controlled impact experiments that has converted him to this view. His botanical survey of the area, with Mr Laurie Adams of the Herbarium Australiense, showed only two or three exotics compared with more than 200 native species, despite the considerable disturbance to the vegetation.

With Dr Baden Williams and Mr Jock Robertson, of the Division, Dr Gillison has recently been involved in trying to devise a more accurate indicator of soil moisture (and the soil's suitability for tank traffic) than that given by the '3-day' rule. Dr Williams is testing a 'go-no-go' indicator, which basically consists of a bore-hole in which a graduated pointer floats on the water table. Army people can read off the pointer position, and tell whether manoeuvres can proceed. Accurate calibration of the indicator will require another season, but the system, simple though it is, seems to be working well.

Another good indicator of 'going' conditions found by Dr Gillison is the occurrence of a conspicuous plant at Wide Bay, *Banksia robur*. The plant requires damp conditions, so any driver of a heavy vehicle who sights clumps of it had better steer clear. Trials with 5-tonne trucks have confirmed the validity of this indicator: whenever the trucks were driven into *B. robur* country, they became bogged!

On the botanical side, Dr Gillison has taken a considerable interest in the area because some of the *Callitris* scrubs and thickets are related to a 'dry rainforest' type that at one time dominated much of the northern half of inland Australia on low-nutrient soils. Outside national parks and defence establishments, 'dry' scrubs of this kind, and wallum, are under threat from human settlement.

Isolated stands of *Callitris columellaris*, containing superb specimens, can be found

Dr Gillison has found that if vehicles venture into areas of Wide Bay where *Banksia robur* grows, they are likely to damage the soil and get bogged.

in remote areas of the Wide Bay range. Elsewhere, the best specimens of this tree have commonly been logged.

Some parts of the range appear to be suffering from dieback, as if attacked by *Phytophthora cinnamomi*. However, no trace of this fungus has been found in examination of soil samples, and Dr Gillison thinks that too-frequent fire may be to blame.

Dr Williams is also applying Dr O'Loughlin's hydrology model, mentioned earlier, to understand the behaviour of the water table and locate susceptible areas.

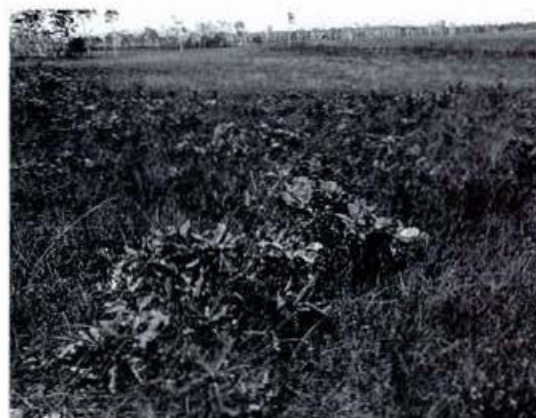
Although Wide Bay had the potential to become severely degraded, good management has averted this. The impact of vehicles within the area remains high, but from their impact and revegetation trials, the Divisional scientists consider that they now have the management prescriptions to maintain the landscape more-or-less in balance; a conclusion providing considerable relief to the Army.

Wide Bay is another area for which a proper wildlife survey has yet to be done. However, Mr Henry Nix of the Division conducted a bird survey there in 1981 and found a high diversity of bird species in all major habitats. The range was 'absolutely seething' with ground parrots: their density was the highest he had ever recorded.

Shoalwater Bay

The Shoalwater Bay training area is on the Register of the National Estate, and is the biggest (274 000 ha) largely undisturbed area on the east coast south of Cooktown. Military use has had only minimal impact because of its large size.

Its great variety of habitats provides one reason for its scientific interest. It lies where the coast, the Great Divide, and the Tropic of Capricorn intersect. It contains communities of rainforests, mangroves, saltmarshes, fresh-water swamps, high sand dune heaths and shrublands, woodlands, and eucalypt forests. A rare primitive plant *Bowenia serratifolia*, mid way between a





Dr Tunstall is measuring the water quality of some catchment areas within the Shoalwater Bay training area. It might provide a good indicator of environmental damage by military vehicles.

fern and a flowering plant, only occurs in isolated pockets within the range and adjacent State forest.

The Division of Water and Land Resources has studied the area closely for more than a decade, and various aspects are still continuing. An early study (in 1972) pointed to its richness in plant and animal life. About one-third of Australia's bird, mammal, and reptile species can be found within it.

Mr Nix was particularly impressed during his wildlife survey at that time. The bird population was magnificent, and data from his survey of it have been incorporated into the recent *Atlas of Australian Birds*.

Mr Nix received the impression that the wildlife was very much richer inside the area than outside, and he has seen the same contrast at all the training areas he has studied. He cites the exclusion of people (and the pets that accompany them and go feral) as the main reason. Grazing animals are kept out, and the effect on the vegetation is obvious to see. However, to verify this impression scientifically will be one of the aims of future surveys.

Parts of Shoalwater Bay subjected to disturbance, including those where grazing and intensive logging went on a decade and more ago, appear to have regenerated well.

Dr Brian Tunstall and Mr Jim Edwards, of the Division, are now looking at whether water quality can provide a useful indicator of the extent of environmental damage that military vehicles cause, and the time it takes to recover. To assess the impact that vegetation and soil sustain in this way, they have instrumented 15 catchments, taking in 100 ha, so that water quality and quantity can be gauged. The idea is to stage controlled runs of vehicles through a catchment and see what effect these have on the water collected at the gauging station.

One tool Dr Tunstall is finding of great use for his plant ecology studies is Landsat. He is using Landsat images of the area, which comprise image elements (pixels) 80 m square in four different spectral bands. He has found that he can reliably recognize the dominant plant communities by means of their spectral signatures.

The interesting aspect now is to investigate how particular communities tend to be



The rare primitive plant *Bowenia serratifolia*, halfway between a fern and a flowering plant, occurs mainly in pockets of the Shoalwater Bay training area.

Tracks made by a Leopard tank in sandy soil. 'Screw' turns can cause a lot of damage.

found next to certain others, a study which involves looking at the 'taxonomy' of adjacent pixels. Dr Tunstall has already recognized patterns in the sequence of pixels starting at the coast and moving inland. Pixels in another series vary with altitude, and his hope is that disturbance such as fire and impact by vehicles will show up in a similar way.

Cape York

Dr Peter Laut of the Division is looking at different ways of mapping areas on the Cape York Peninsula to give a quick indication of whether or not a particular area is trafficable. As well as conventional maps and aerial photographs, he is using Landsat images to help. He hopes the final data for individual 5- x 5-km grid cells can be stored on a microcomputer for instant use by strategists.

Cobar

Dr Laut and colleagues have been doing a similar exercise for the Cobar region in New South Wales, except that the condition and fragility of the landscape was the factor of interest. While plans for an Army exercise area here have been dropped, the Division has continued the Cobar work, as it will provide useful information on land management. The Western Lands Commission controls land to the west of Cobar, and it will be of considerable value to know how the state of the land there differs from that left in private hands to the east.

Tully-Innisfail

The Defence Department runs its Tropical Trials Establishment and Field Force Battle School on 14 000 ha of rainforest country between Tully and Innisfail in northern Queensland. It includes the unique Downey Creek rainforest, which represents most of the few remaining stands of tropical wet lowland rainforest on basalt in Australia. The rainforest is probably closer to some complex equatorial types than any other on the Australian mainland. The Downey Creek stand has been listed as part of the National Estate.

Because of their scientific interest, 1000 hectares have been set aside and will remain totally undisturbed. That may be just in time, since rainforest logging has begun at Lower Downey Creek.

The military impact at Downey Creek is light because it is mostly used for weathering and performance tests on Defence equipment. In the Jarra Creek sector, sol-



diers undergo training in tropical warfare at the Battle School. Because they largely move on foot and use sites in rotation, damage to the rainforest is light and limited to the understorey. Nevertheless, revegetation can take a long time, and it's a process that needs close study.

Scientists from CSIRO have conducted research at both sites for a number of years, classifying vegetation and studying regeneration processes.

Work at the moment involves Dr Mike Hopkins and Mr Andrew Graham in studies of the germination of seed on the floor of the rainforest, the flowering and fruiting patterns of trees, and the dynamics of plant succession.

A heavy tank turning at battle speed is a formidable engine of destruction.

Dr Hopkins has developed a computer model of the regeneration of rainforest. The 'Kiambram' model (Aboriginal for 'rainforest') was developed for subtropical rainforest, but should work well in tropical ones too, once the basic information on the life cycles of tropical trees has been documented. Dr Hopkins hopes he will be able to predict the long-term consequences of any disturbance to the rainforest.

What next?

It is clear that, environmentally, areas can benefit from the presence of the military. Indeed, Dr Myers believes many national parks would benefit if, like defence estab-

lishments, they could employ enough people to control fire and destroy feral animals.

Use of land inevitably means change of some kind. The aim in the military training areas is to attain a stable (albeit dynamic) relation between military activities and the system of soil, vegetation, and wildlife. Although there is no guaranteed formula, this is what research helps to achieve.

Andrew Bell

More about the topic

Lands of the Tianjara Army Training Area, N.S.W. CSIRO Division of Water and Land Resources Technical Memorandum (in press).

An ecological reconnaissance of the Evans Head Training Area, Bundjalung National Park, N.S.W. CSIRO Division of Land Use Research Technical Memorandum No. 81/35, 1981.

Soil water store, infiltration and run-off characteristics of forest and grassland catchments at Puckapunyal in central Victoria. G.J. Burch, R.K. Bath, A.P. Spate, A.O. Nicholls, and E.M. O'Loughlin. *Proceedings, Hydrology and Water Resources Symposium, Hobart, November 1983.*

Measuring the impact of Army exercises.

