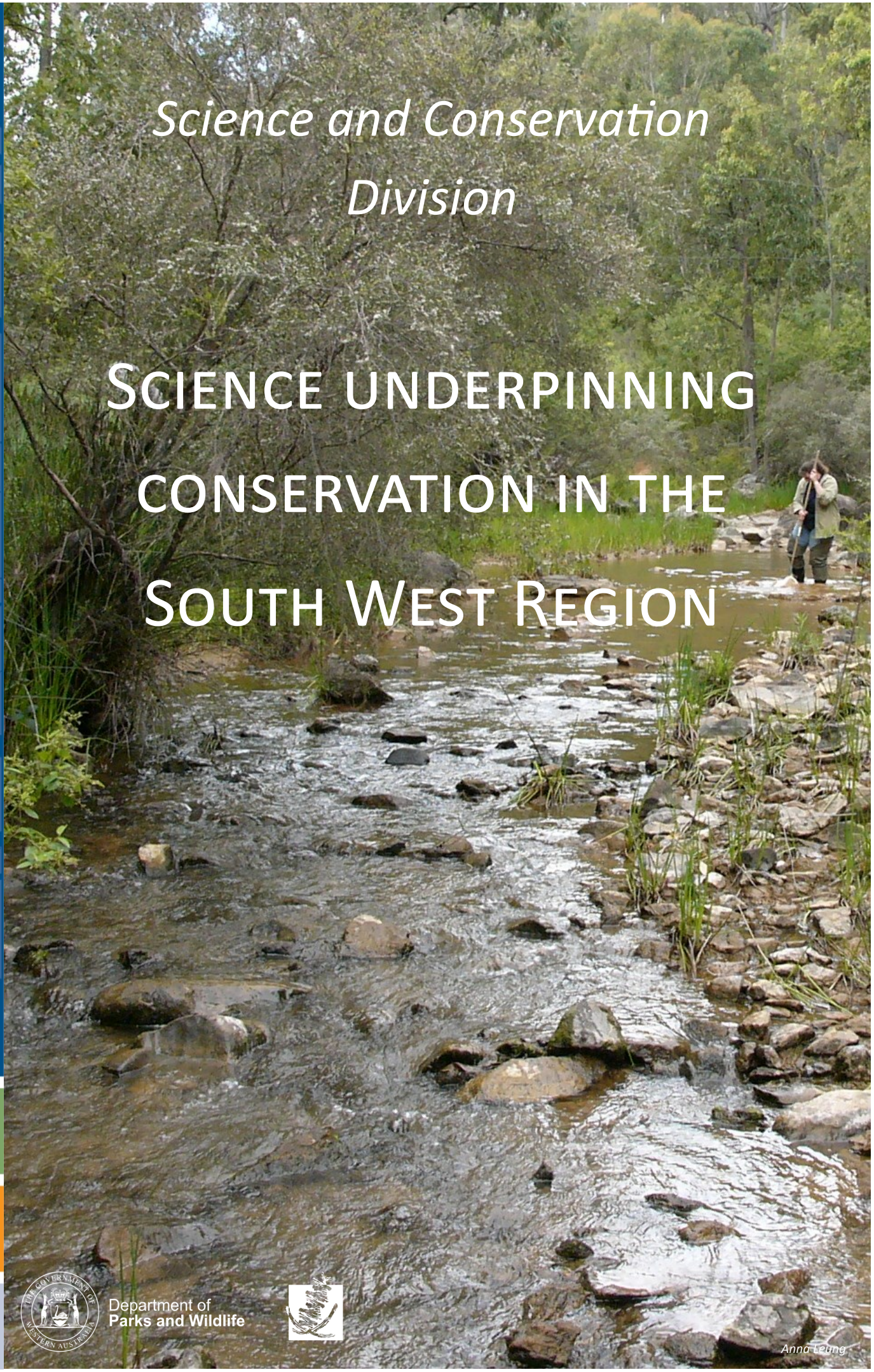
Science and Conservation Division

Science underpinning conservation in the South West Region



Department of Parks and Wildlife

Anna Leung

FOREWARD

Effective communication of the outcomes of science is particularly important for ensuring the results inform conservation policy and wildlife, forest and parks management practice. Science undertaken in the Science and Conservation Division is carried out in collaboration with staff in the regions and our research partners, which include CSIRO, universities and industry. We highly value these partnerships, which deliver immense benefits in providing a scientific, evidence-based approach to conservation.

To facilitate communication with all regional staff we have produced a series of non-technical publications that describe the science we are undertaking in each of the regions of the Department. These 'Science in the Regions' publications capture a snapshot of current science activities that support wildlife, forest and parks management in each region, and are available on the website. Please contact any of our scientists if you would like more information on any of the topics described here.

Dr Margaret Byrne, Director, Science and Conservation Division

Lachie McCaw

Melita Pennifold

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Monitoring stream health

Forest management activities, particularly prescribed burning and timber harvesting, can alter stream water chemistry, hydrology, sediment processes and physical habitats, with consequent effects on stream water quality and macro-invertebrate diversity. The Forest Stream Biodiversity Monitoring Project began biennial monitoring of 51 sites throughout the south-west forests during spring of 2005. Scientists used an environmental monitoring tool developed by the Australian River Assessment Scheme (AusRivAS) to predict the number of aquatic invertebrate families found in streams that are minimally disturbed, which was then used as a benchmark to determine levels of stream disturbance. The number of invertebrate families actually recorded in streams is compared with the number predicted by the AusRivAs model.

The sites monitored covered a wide geographic area and included streams in catchments subject to a range of current and future harvesting activities and/or prescribed burns, as well as in conservation areas with little stream disturbance. Scientists found that the ecological rating for all of the stream sites varied each year, due to inter-annual differences in rainfall and streamflow combined with local disturbance. While 16 sites were rated as significantly impaired and eight as severely impaired, this was related to salinity, reduced flows due to low rainfall or to local disturbance, rather than to the amount of timber harvested or the area burned within a catchment. Most of these sites were in the drier, northern jarrah forests. Reduced stream flow associated with a drying climate had the greatest impact on aquatic invertebrate communities, but future silvicultural management should avoid exacerbating this threat.

The monitoring program provides information on the interaction of silvicultural management and a drying climate, and is used to predict how aquatic invertebrate communities are affected by both local- and catchment-scale disturbance as stream flows reduce in a drier climate.

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Fire behaviour in the 21st century

Climate and weather, topography, vegetation and fuel will influence the ignition, behaviour and extent of fire in the landscape: together they encompass the 'fire environment'. As the climate of the south-west becomes warmer and drier, with less autumn and winter rainfall, the duration of the traditional fire season has extended. At the same time, changes in land use, socioeconomic and organisational factors has led to large areas of land being unburnt for two or more decades. This increases the risk of large-scale, high severity fires. Yet much of the information linking climate, fire weather and fire behaviour, and the resultant guidelines for fire management, have not been revised since data was first gathered in the 1960s and 1970s.

Scientists are developing new predictive models of fire occurrence and behaviour based on contemporary patterns of weather, fuel characteristics and human behaviour. To date they have developed models to predict the daily occurrence of human-caused bushfire in the South West, Swan and Warren regions, and have developed a database of fire caused by lightning strike. Lightning is a significant cause of fire in the south-west, with these fires burning a disproportionately large area relative to the number of ignitions. Understanding the interactions between weather patterns and lightning ignitions will help predict periods of above-normal activity, ultimately leading to improved deployment of resources during periods of high fire risk.

A specific focus for fire behaviour research will be on the coastal shrubland ecosystems that are a predominant vegetation type in coastal areas between Geraldton and Esperance. The lack of a fire behaviour prediction guide for coastal shrublands was highlighted as a significant gap to effective decision-making on the prescribed use of fire in these ecosystems. When dry, the fine fuels found in coastal shrublands are highly flammable, leading to the potential for intense and fast-moving fires when wind speeds are greater than 15 km/hr. In this vegetation type, fires may also jump from the litter layer to the shrub layer in response to small changes in wind speed and fuel dryness, increasing the difficulty in predicting how prescribed fires may behave. Systematically describing fuel characteristics is a key component of the project, and scientists have undertaken pilot studies at seven sites to test the effectiveness and practicality of a number of fuel sampling techniques. Data will continue to be gathered from planned burns, and scientists will undertake experimental burns to better understand under which conditions and in which shrubland types fire is likely to be sustained and spread.

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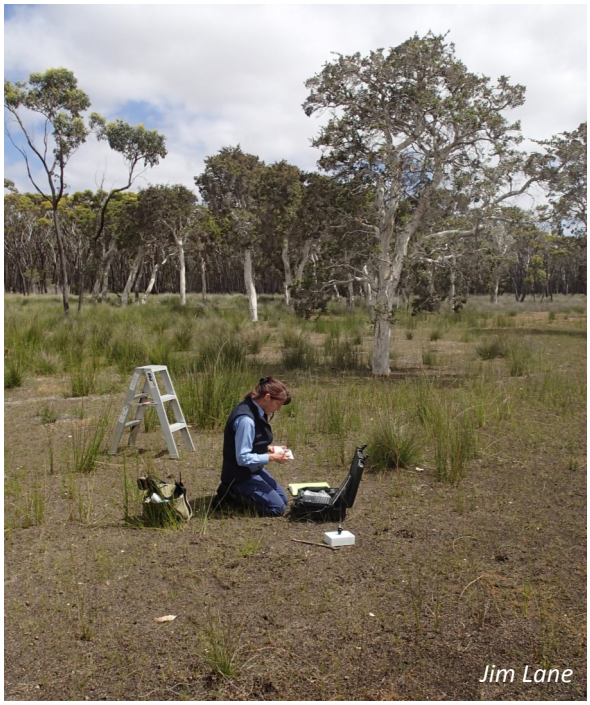
Jim Lane

Long-term wetland monitoring to inform conservation actions

Wetlands in the south-west are under intense pressures from urban, agricultural and other land uses, exacerbated by declining rainfall. These pressures manifest as changes to hydrology and water quality, leading to changes in biodiversity. While the impacts of surrounding land use on wetlands can be complex, a few key measurements, including water level and elements of water quality, provide managers with early warnings of problems as well as long-term trends in condition at individual wetlands and across a region. This understanding enables managers to determine priorities for wetlands requiring management action.

Data from the South West Wetlands Monitoring Program (SWWMP) has been used by managers of wetlands in the broader south-west of WA since 1977. Currently 104 wetlands are monitored (150 have been monitored in total), with 55 monitored for 30 or more years. Almost all of these are in the conservation estate, including most Ramsar sites. Importantly, the SWWMP is providing a highly valuable multi-decadal dataset allowing managers to determine when changes in hydrology and water quality are within an acceptable range or should be of concern warranting management action. This is particularly important in a drying climate and for the sustainable use of the region's water resources.

While initially established to inform duck-hunting regulation, then altered hydrology and salinity as part of the State Salinity Strategy, the program is now focussed on wetlands on conservation estate, particularly high value, fresh-brackish, near-coastal wetlands to quantify the effects of declining rainfall and increased development of water resources. For example in Harvey 12632 Nature Reserve, the peat lake bed has been exposed in summer during recent years, and terrestrial native vegetation has become established on the previously 'open water' lake. This is a major change requiring active adaptive management to ensure it retains high conservation value as an ephemeral wetland, that may still be used by some water birds. Record-high salinities recorded in 2014 at Lake Davies in Leeuwin–Naturaliste National Park are being investigated to determine the source of the salinity and assess potential for remediation.

Further inland, SWWMP data has been used to assess the effectiveness of input creek diversion and outlet control for managing water quality for recreation and nature conservation purposes at Lake Towerrinning Nature Reserve. In the Muir-Byenup Ramsar wetlands the Tordit-Gurrup Lagoon has recently acidified following an intense period of drying. The multi-decadal record of water quality allowed scientists to understand the likely cause of the acidification through complete drying out of the lake that had not occurred previously during the last 40 years of monitoring. Investigations of hydrogeochemistry of the peat wetlands is contributing to assessment of the risk of further acidification events and providing information for adaptive management through remediation.

Information from the SWWMP is also being used to assist with recovery of threatened species. Breeding habitat requirements for the Australasian bittern (*Botaurus poiciloptilus*) are being determined from water depth and hydro-period data, enabling settings of hydrological targets to ensure breeding habitat is maintained at critical wetlands.

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FORESTCHECK is a long-term, landscape-scale monitoring program that seeks to inform the adaptive management of jarrah forests. Scientists are investigating how forest structure and biodiversity are affected by timber harvesting and silvicultural treatments (regeneration release through gap creation or regeneration establishment using shelterwood and selective harvesting), compared with forests that have never been harvested or were harvested more than 40 years ago. Monitoring is carried out on a series of 2 ha grids (65 grids in total) in seven locations within five jarrah forest ecosystems, with the grids located across ecological gradients associated with rainfall, evapotranspiration and soil fertility.

While the silvicultural treatments did not affect species richness or the abundance of understorey plants, the soil disturbance associated with timber harvesting was found to be an important contributing factor in altering plant species composition. The areas trafficked by harvesters, skidders and loaders are often subject to excessive disturbance and compaction, with consequent effects on soil and forest health. Scientists measured soil bulk density as a measure of soil compaction across the sampling grids. Although highly variable, the mean bulk densities for soils in areas that had been harvested were significantly greater than in areas that had never been harvested. The effects of machinery activity on soil bulk density were still apparent in the reference grids that were harvested more than 40 years ago. This information allowed scientists to revise the limits for soil disturbance and the criteria for moist soil harvesting operation in jarrah forest.

The silvicultural treatments favoured species with an abundant soil seed store (e.g. *Kennedia coccinea*) over those with woody stems that are vulnerable to mechanical disturbance. More species of small and medium shrubs were recorded in forests that had not been harvested or were harvested before 1960. While grids in the gap release treatment were well stocked with saplings and ground coppice, regeneration of seedlings in the shelterwood treatment was not adequate to satisfy regeneration stocking standards within 10 years of treatment. The silvicultural treatments had a significant impact on the composition of cryptogam communities (lichens and bryophytes). Half of all cryptogams recorded were found on coarse woody debris, and 40% of them depended on it entirely, emphasizing the importance in retaining coarse woody debris over a range of sizes and in various stages of decomposition. Each forest ecosystem supported a unique fungal community, and the species composition of macrofungi differed in each treatment. The landscape mosaic of mature forest and stands of forest at various stages of succession after timber harvesting, combined with a range of times since fire, is important in maintaining fungal biodiversity in jarrah forests.

Scientists found that the type of jarrah ecosystem and the year of sampling had a greater influence on macro-invertebrate communities than did the silvicultural treatments. The maintenance of a mosaic of mature forest adjacent to harvested forest, as well as retaining macro-invertebrate habitat within harvested areas, will help to maintain species diversity locally and across the jarrah forest ecosystems. The silvicultural treatments also had little effect on bird community structure or on individual species, despite the typically strong association of bird species with vegetation type and structure. Most of the birds found in the jarrah forest are widespread throughout the south-west and have evolved to be resilient to disturbance. For terrestrial vertebrates (mammals, reptiles and frogs) the effect of silvicultural treatments were examined in combination with the impacts of fox control. Fox control had a greater impact on terrestrial vertebrates than silvicultural treatment: three times as many individuals of native animals were recorded in areas that had been baited. While the disturbance from harvesting will temporarily favour some species, the silvicultural treatments did not negatively impact terrestrial vertebrate fauna.

The information gained from FORESTCHECK's systematic monitoring of the jarrah forests is used to guide future silvicultural practice, to ensure that timber harvesting in these forests is ecologically sustainable in the long-term.

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Richard Robinson


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Ecosystem Science Program


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Adrian Wayne

Which seeds from where? Best-practice seed collection for ecological restoration

For restoration programs, a conservative approach to collecting seed only from 'local' zones or of 'local provenance' has traditionally been advocated, based on the assumption of strong adaptation in plants to local conditions, or concerns about the potential deleterious genetic impacts of mixing seed from different populations. What constitutes a 'local' seed collection zone may, however, be difficult to define and, in a changing climate, not the most appropriate approach to ensure the establishment and long-term persistence of restored vegetation.

There is little information on patterns of local adaptation, genetic diversity, likelihood of hybridization and invasiveness for most of the understorey species in the jarrah and karri forests. Scientists are using genetic approaches to determine these factors in a number of understorey species commonly used to rehabilitate areas after logging. For coral vine (*Kennedia coccinea*) and dwarf sheoak (*Allocasuarina humilis*), the analysis has shown that seed can be sourced from the same landscape management unit as the area to be restored, or from nearby areas in an adjacent landscape unit. Genetic analysis of parrot bush (*Banksia sessilis*) and marri (*Corymbia calophylla*) is currently underway. Knowledge of genetic structure in forest species has been used to define seed provenance approaches in the Forest Management Plan.

A similar approach is being used to identify areas for seed collection for the restoration of areas of blackberry decline along the Warren and Donnelly rivers. Three study species, *Astartea leptophylla*, *Callistachys lanceolata* (wonnich) and *Taxandria linearifolia*, have been selected for analysis. Leaf and seed material from 12 populations of both *C. lanceolata* and *T. linearifolia* across three climate zones, and from 12 populations of *A. leptophylla* across four climate zones, has been collected, with genomic analysis of all species currently underway. Using seed from the most appropriate seed collection zone will ensure that plant communities restored along the river bank have the greatest chance of long-term success.

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Feral cat control for native mammal recovery

Predation by introduced predators is a key barrier to the recovery of native mammal populations. The initial recovery of threatened mammal populations following fox (*Vulpes vulpes*) control in Western Shield Projects was encouraging, but unfortunately gains weren't sustained and mammal populations began to decline once more. After confirming that the 1080 fox-baits were still effective, researchers questioned whether fox baiting resulted in 'mesopredator release', whereby the control of a dominant, larger predator (in this case foxes) leads to an increase in the number of smaller predators (such as feral cats, *Felis catus*) . Comparing indices of cat abundance at sites that were baited for foxes with those that were not baited, scientists confirmed that the fox control undertaken in the northern jarrah forest over the past 15 years had led to an increase in the numbers of feral cats. The severe decline in woylie (*Bettongia penicillata ogilbyi*) numbers after their initial recovery following earlier fox-baiting programs has been attributed to predation by increased numbers of feral cats.

In order to control feral cats, scientists have developed and trialled an effective cat bait (*Eradicat®*) that was recently registered for operational use. Broad scale deployment of both cat and fox baits by Western Shield has now commenced at selected sites, and the impacts on fox and cat populations and recovery of mammal populations are being monitored.

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