Environmental Excellence
Research and Publications

Environmental Research Program

A comprehensive research program provides the scientific data and knowledge to inform leading practice environmental management at our operations.

Science and technology underpin our rehabilitation processes which have seen continuous improvement over many years.

We have pioneered new techniques to eradicate Phytophthora dieback, while our mine site fauna research has made a significant contribution to global leading practice.

Alcoa's Research Team conducts and coordinates the research program, collaborating with universities across Australia, and with government research bodies such as the Department of Biodiversity, Conservation and Attractions.

Together, we're contributing to the global understanding of effective conservation and environmental management strategies for mine site restoration, and a more sustainable future for our industry.

Since 1975, Alcoa has supported the publication of more than 250 refereed journal papers and book chapters, 80 technical studies, and about 60 higher-degree research theses.

We recognise the long-term value of environmental research and we encourage publication of work and sharing of key findings as part of our commitment to raising industry standards.

Selected Publications

(Alcoa authours underlined)

Mine restoration

Bell, D.T., Plummer, J.A. and Taylor, S.K. (1993). Seed germination ecology in Southwestern Western Australia. Botanical Review **59**: 24-73.

Commander, L, Barker, J, Blackburn, C, Grigg, A, Mullins, G & Pattinson, A (2024). 'Research-led adaptive management in rehabilitation' in M. T. A.B. Fourie and G. Boggs (eds.), Australian Centre for Geomechanics, Perth, pp. 415-426, 10.36487/ACG_repo/2415_30.

Chia, K.A., Koch, J.M., Sadler, R. and Turner, S. (2016). Re-establishing the mid-storey tree Persoonia longifolia (Proteaceae) in restored forest following bauxite mining in southern Western Australia. Ecological Restoration **31**: 627-638.

Daws, M.I., Downes, K.S., Koch J.M. and Willyams, D. (2014). Is broad-scale smoke–water application always a useful tool for improving seedling emergence in post-mining restoration? Evidence from jarrah forest restoration in Western Australia. South African Journal of Botany **90**, 109-113.

Daws, M.I., Standish, R.J., Koch, J.M., Morald, T.K., Tibbett, M. and Hobbs, R.J. (2015). Phosphorus fertilisation and large legume species affect jarrah forest restoration after bauxite mining. Forest Ecology and Management **354**, 10-17.

Koch, J.M. (2007). Restoring a jarrah forest understorey vegetation after bauxite mining in Western Australia. Restoration Ecology Supplement **15**: S26-S39.

Krauss, S.L. and Koch, J.M. (2004). Rapid genetic delineation of provenance for plant community restoration. Journal of Applied Ecology **41**, 1162-1173.

Rosa, J.C.S., Morrison-Saunders, A., Hughes, M. & Sánchez, L.E. (2020). Planning mine restoration through ecosystem services to enhance community engagement and deliver social benefits. Restoration Ecology **28**, 937-946.

Tacey, W.H. and Glossop, B.L. (1980). Assessment of topsoil handling techniques for rehabilitation of sites mined for bauxite within the jarrah forest of Western Australia. Journal of Applied Ecology **17**: 195-201.

Turner,S.R., Steadman,K.J., Vlahos,S., Koch,J.M. and Dixon, K.W. (2013). Seed treatment optimizes benefits of seed bank storage for restoration-ready seeds: the feasibility of prestorage dormancy alleviation for mine-site revegetation. Restoration Ecology **21**: 186-192.

White-Toney, T., Korczynskyj, D., Grigg, A. and Bulsara, M. (2019). Variable tree establishment in bauxite mine restoration in south west Australia linked to rainfall distribution, seasonal temperatures and seed rain. Ecological Management and Restoration **20**, 266-270.

Willyams, D. (2015). Challenges in domesticating and propagating Jarrah forest geophytes for revegetation and ornamental horticulture. Acta Horticulturae **1104**, 229-236.

Selected Publications

(Alcoa authours underlined)

Fauna restoration

Craig, M.D., Hardy, G.E.StJ., Fontaine, J.B., Garkakalis, M.J., Grigg, A.H., Grant, C.D., Fleming, P.A. and Hobbs, R.J. (2012). Identifying unidirectional and dynamic habitat filters to faunal recolonisation in restored mine-pits. Journal of Applied Ecology **49**: 919–928.

Craig, M.D., Kirkby, T., Stokes, V.L., Renton, M. and Hobbs, R.J. (2021). Does the need to drink influence nest site selection in a wide-ranging threatened cockatoo? Forest Ecology and Management **505**.

Craig, M. D., Smith, M. E., Stokes, V. L., Hardy, G. E. St. J., G. E. and Hobbs, R. J. (2018). Temporal longevity of unidirectional and dynamic filters to faunal recolonization in post-mining forest restoration. Austral Ecology, 43, 973–988. doi:10.1111/aec.12647

Craig, M.D., Stokes, V.L., Fontaine, J.B., Hardy, G.E., Grigg, A.H and Hobbs, R.J. (2015). Do state-and transition models derived from vegetation succession also represent avian succession in restored mine-pits? Ecological Applications **25**: 1790-1806.

Craig, M.D., White, D.A., Stokes, V.L. and Prince, J. (2017). Can postmining revegetation create habitat for a threatened mammal? Ecological Management & Restoration **18(2)**:149-155.

Mastrantonis, S., Craig, M.D., Hobbs, R.J., Grigg, A.H. and Renton, M. (2022). Identifying optimal solutions between competing economic and conservation land use objectives for species that require widely distributed resources. Environmental Modelling and Software 148, 105292.

Majer, J.D., Brennan, K.E.C. and. Moir., M.L (2007). Invertebrates and the restoration of a forest ecosystem: thirty years of research following bauxite mining in Western Australia. Restoration Ecology Supplement **15**: S104-S115.

McGregor, R.A., Stokes, V.L. and Craig, M.D. (2014). Does forest restoration in fragmented landscapes provide habitat for a wide-ranging carnivore? Animal Conservation **17**: 467-475.

Nichols, O.G., and Grant, C.D. (2007). Vertebrate fauna recolonisation of restored bauxite mines – key findings from almost 30 years of monitoring and research. Restoration Ecology Supplement. **15**: S116-S126.

Triska, M.D., Craig, M.D., Stokes, V.L., Pech, R.P. and Hobbs, R.J. (2016). The relative influence of in situ and neighborhood factors on reptile recolonization in post-mining restoration sites. Restoration Ecology **24**: 517-527.

Triska, M.D., Craig, M.D., Stokes, V.L., Pech, R.P. and Hobbs, R.J. (2017). Conserving reptiles within a multiple-use landscape: determining habitat affiliations of reptile communities in the northern jarrah forest of south-western Australia. Australian Journal of Zoology 65, 21-32.

Tudor, E.P., Cross, A.T and Tomlinson, S. (2023). Insect community reassembly in a spatiotemporally heterogenous restoration landscape. Landscape Ecology doi.org/10.1007/s10980-023-01747-2

Ecosystem development and management

Banning, N.C., Gleeson, D.B., Grigg, A.H., Grant, C.D., Andersen, G.L., Brodie, E.L. and Murphy, D.V. (2011). Soil microbial community successional patterns during forest ecosystem restoration. Applied and Environmental Microbiology **77**: 6158-6164.

Daws, M.I., Barker, J.M., Blackburn, C. and Grigg, A.H. (2023). Overstorey-understorey interactions reveal trade-offs for achieving competing land-use goals in jarrah forest restored after bauxite mining: Initial prescription and targets affect restoration success over 32 years. Ecological Engineering **189**: 106913.

Daws, M.I., Blackburn, C., Standish, R.J. & Tibbett, M. (2022). Canary in the coal mine: Lessons from the Jarrah Forest suggest long-term negative effects of phosphorus fertilizer on biodiverse restoration after surface mining. Front. For. Glob. Change, **5**.

Gardner, J.H. and Malajczuk, N. (1988). Recolonisation of rehabilitated bauxite mine sites in

Grant, C.D. (2006). State-and-Transition successional model for bauxite mining rehabilitation in the jarrah forest of Western Australia. Restoration Ecology **14**: 28-37.

Liddicoat, C., Krauss, S.L., Bissett, A., Borrett, R.J., Ducki, L.C., Peddle, S.D., Bullock, P., Dobrowolski, M.P., Grigg, A., Tibbett, M., Breed, M.F. (2022). Next generation restoration metrics: Using soil eDNA bacterial community data to measure trajectories towards rehabilitation targets. Journal of Environmental Management **310**: 114748.

Smith, M.A, Grant, C.D., Loneragan, W.A., and Koch, J.M. (2004). Fire management implications of fuel loads and vegetation structure in jarrah forest restoration on bauxite mine sites in Western Australia. Forest Ecology and Management **187**: 247-266.

Standish, R. J., Gove, A. D., Grigg, A. H., & Daws, M. I. (2021). Beyond species richness and community composition: Using plant functional diversity to measure restoration success in jarrah forest [Article]. Applied Vegetation Science, **24(3)**: e12607.

Standish, R.J., Daws, M.I., Gove, A.D., Didham, R.K., Grigg, A.H., Koch, J.M. and Hobbs, R.J. (2015). Longterm data suggest jarrah-forest establishment at restored mine sites is resistant to climate variability. Journal of Ecology **103**: 78–89.

Ward, S.C. (2000). Soil development on rehabilitated bauxite mines in south-west Australia. Australian Western Australia by mycorrhizal fungi. Forest Ecology and Management **24**: 27-42.

Environmental Excellence
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Phytophthora Dieback

Colquhoun, I. J. and Kerp, N. L. (2007). Minimising the spread of a soil-borne plant pathogen during a largescale mining operation. Restoration Ecology Supplement. **15**: S85-S93.

Colquhoun, I.J. and Hardy, G.E.St.J. (2000). Managing the risks of Phytophthora root and collar rot during bauxite mining in the Eucalyptus marginata (jarrah) forest of Western Australia. Plant Disease, **84**: 116-127

Dunstan, W.A., Howard, K., Grigg, A.H., Shaw, C., Burgess, T. and Hardy, G.E.St.J. (2020).Towards eradication of Phytophthora cinnamomi using a fallow approach in a Mediterranean climate. Forests, **11**: 1101

Gyeltshen, J., Dunstan, W.A., Shaw, C., Howard, K., Grigg, A.H., Hardy, G.E.St.J., Burgess, T.I. (2021). Metabarcoding shows multiple Phytophthora species associated with individual plant species: implications for restoration. European Journal of Plant Pathology **159(2)**: 359-369.

Kunadiya, M., Dunstan, W., White, D., Hardy, G., Grigg, A. and Burgess, T. (2019). A qPCR assay for the detection of Phytophthora cinnamomi including an mRNA protocol designed to establish propagule viability in environmental samples. Plant Disease doi. org/10.1094/PDIS-09-18-1641-RE

Kunadiya, M., Dunstan, W., White, D., Hardy, G., Grigg, A. and Burgess, T. (2019). A qPCR assay for the detection of Phytophthora cinnamomi including an mRNA protocol designed to establish propagule viability in environmental samples. Plant Disease **103(9)**: 2443-2450.

Jarrah forest hydrology

Grigg, A.H. (2017). Hydrological response to bauxite mining and rehabilitation in the jarrah forest in south west Australia. Journal of Hydrology: Regional Studies 12: 150-164.

Grigg, A.H. and Hughes, J. (2018). Non-stationarity driven by multi-decadal change in catchment groundwater storage: a test of modifications to a common rainfall-runoff model. Hydrological Processes, 32(24): 3675-3688.

Grigg, A.H. and Kinal, J. (2020). On the contribution of groundwater to streamflow in laterite catchments of the Darling Range, south-western Australia. Hydrological Processes 34(25): 5070-5084.

Hughes, J.D., Petrone, K.C. and Silberstein, R. (2012). Drought, groundwater storage and stream flow decline in south-western Australia. Geophysical Research Letters 39: L03408.

Macfarlane, C., Grigg, A., McGregor, R., Ogden, G. and Silberstein, R. (2018). Overstorey evapotranspiration in a seasonally dry Mediterranean eucalypt forest: response to groundwater and mining. Ecohydrology 11(5): e1971.

Refinery residue rehabilitation

Banning, N.C., Sawada, Y., Phillips, I.R. and Murphy, D.V. (2014). Amendment of bauxite residue sand can alleviate constraints to plant establishment and nutrient cycling capacity in a water-limited environment. Ecological Engineering **62**: 179-187.

Goloran, J.B., Phillips, I.R. and Chen, C.R. (2017). Forms of Nitrogen Alter Plant Phosphorus Uptake and Pathways in Rehabilitated Highly Alkaline Bauxite Processing Residue Sand. Land Degradation and Development **28(2)**: 628-637.

Goloran, J.B., Phillips, I.R., Xu, Z.H., Condron, L.M. and Chen, C.R. (2014). Effects of amendments and fertilization on plant growth, nitrogen and phosphorus availability in rehabilitated highly alkaline bauxite-processing residue sand. Soil Use and Management **30**: 198-208.

Jones, B.E.H., Haynes, R.J. and Phillips, I.R. (2010). Effect of amendment of bauxite processing sand with organic materials on its chemical, physical and microbial properties. Journal of Environmental Management **91**: 2281-2288.

Phillips, I.R. and Chen, C. (2010). Surface charge characteristics and sorption properties of bauxite-processing residue sand. Australian Journal of Soil Research **48**: 77-87.

Phillips, I.R. and Courtney, R. (2022). Long term trials demonstrate sustainable nutrient supply and uptake in rehabilitated bauxite residue. Science of the Total Environment **804**: 150134.

Banning, N.C., I.R. Phillips, D.L. Jones and D.V. Murphy. (2011) Development of microbial diversity and functional potential in bauxite residue sand under rehabilitation. Restoration Ecology **19**:78-87.