Applicant Responses to Relevant Comments from the Department of Conservation on the Waihi North Project

(Comments 679 - 802)

Comment Number	Comment	OGNZL Technical Input	Where Addressed in the Application Documents	Response
679	The project poses uncertain but potentially significant adverse effects on Archey's frog and Hochstetter's frog, particularly from underground blasting vibrations, dewatering, and vegetation clearance.	Ecology	**B.38 – RMA Ecology – Assessment of Native Frogs, sections 2, 3 and 4.**	Refer to the statement provided by Mr Dylan van Winkel, appended as **Appendix D.** Refer to the statement provided by Dr Graham Ussher, appended as **Appendix M.**
680	DOC has concerns of the scale, feasibility and effectiveness of the proposed suite of mitigation, offsetting and compensation measures, including pest control, habitat enhancement and research funding.	Ecology	**B.38 – RMA Ecology – Assessment of Native Frogs, sections, 3 and 4; and B.40 - Boffa Miskell - Pest Animal Management Plan.**	Refer to the statement provided by Dr Graham Ussher, appended as **Appendix M.** In addition, please see a report provided as **Attachment 1** to this table which details further Biodiversity Offset Accounting Model modelling undertaken by Dr Graham Ussher. Refer to the statement provided by Ms Helen Blackie, appended as **Appendix N.**
681	DOC disputes the assumption frog populations will triple as a result of pest control, on the grounds of limited evidence and overly optimistic modeling assumptions.	Ecology	-	The conditions have been updated in relation to this matter to require the consent holder to achieve a 3 x frog population increase. Refer to the statement provided by Dr Graham Ussher, appended as **Appendix M.**
682	The Project has risks to other indigenous fauna, threatened flora, freshwater ecosystems, wetland, and heritage and recreational values.	Ecology, Hydrology, Heritage, Recreation	**Part B – Technical Reports**	A substantial assessment of the effects of the project on all these matters has been provided across a range of technical assessments. Please refer to Part B – Technical Reports of the application documents.
683	The application's data is inconsistent and has a lack of clarity in how ecological gains will be secured in perpetuity.	Ecology	**B.38 – RMA Ecology – Assessment of Native Frogs.**	Refer to the statement provided by Dr Graham Ussher, appended as **Appendix M.**
684	Despite DOCs engagement to date with OGL, several key issues remain unresolved, particularly the robustness of management plans, enforceability of consent conditions, and adequacy or monitoring and adaptive management frameworks.	Ecology, Planning	-	These matters are discussed further in the various statements provided with this response. Of particular relevance, please refer to the legal submission provided by Mr Stephen Christensen, included in **Part A** of the response package, and the statement provided by Mr John Kyle and Ms Abbie Fowler, appended as **Appendix H**.
685	The Project risks causing irreversible harm to high-value conservation areas and species.	Ecology	**Part B – Technical Reports**	A substantial assessment of the effects of the project on high-value conservation areas and species has been provided across a range of

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				technical assessments. Please refer to Part B – Technical Reports of the application documents. Further, matters raised in the comments provided by DOC have been addressed in a number of the statements provided in **Part B** to this response package. Refer to the statement provided by Dylan van Winkel, appended as **Appendix D.** Refer to the statement provided by Mr Christopher Simpson, appended as **Appendix G**. Refer to the statement provided by Mr Brian Lloyd, appended as **Appendix J**. Refer to the statement provided by Ms Katherine Muchna, appended as **Appendix K.** Refer to the statement provided by Dr Graham Ussher, appended as **Appendix M.** Refer to the statement provided by Ms Helen Blackie, appended as **Appendix N.** Refer to the statement provided by Mr Rhys James Girvan, appended as **Appendix O.** Refer to the statement provided by Mr Ian Boothroyd, appended as **Appendix P.** Refer to the statement provided by Ms Cassandra McArthur, appended as **Appendix Q**. Refer to the statement provided by Ms Kate Feickert, appended as **Appendix T**.
686	DOC recommends the Panel adopts a precautionary approach and ensure that any approvals are subject to stringent, enforceable conditions.	Planning	-	Refer to the statement provided by Mr John Kyle and Ms Abbie Fowler, appended as **Appendix H**.
687	Is it not yet clear whether OGNZL is seeking approval for potential to harm frogs caused by vibrations.	Ecology / Interpretation	-	Refer to the legal submission provided by Mr Stephen Christensen, included in **Part A** of the response package.

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688	DOC strongly disputes the estimate of the affected proportion of the Coromandel frog population and the conclusion the impact on the overall population as being 'low'.	Ecology	-	Refer to the statement provided by Brian Lloyd, appended as **Appendix J**. Refer to the statement provided by Dr Graham Ussher, appended as **Appendix M.**
689	DOC disagrees with the conclusion of OGNZL as to the extent to which leiopelmatid frogs will be affected by the vibrations - abandonment of shelter, male frogs abandoning their guard of egg clusters and other behavioral changes could lead to lower health and recruitment success for individual frogs.	Ecology	**B.38 – RMA Ecology – Assessment of Native Frogs, sections 2, 3 and 4; and B.38 – Bioresearches – Native Frog Effects Assessment, sections 5 and 9.**	Refer to the statement provided by Dylan van Winkel, appended as **Appendix D.** Refer to the statement provided by Dr Graham Ussher, appended as **Appendix M.**
690	Abandonment of shelter, male frogs abandoning their guard of egg clusters and other behavioral changes that could lead to lower health and recruitment success for individual frogs and the affected population have been observed following disturbance.	Ecology	-	Refer to the statement provided by Mr Dylan van Winkel, appended as **Appendix D.**
691	The effect of vibrations through the Wharekirauponga Underground Mine is also uncertain for Hochstetter's frogs.	Ecology	-	Refer to the statement provided by Dylan van Winkel, appended as **Appendix D.**
692	Underground mining-induce impacts such as subsidence and slumping, altered water flows, water-table lowering, and fracturing of surface and sub-surface rocks would significantly modify the leiopelmatid frogs semi-aquatic and terrestrial habitats.	Ecology, Geotechnical	-	No slumping or subsidence is expected, however there is an estimated 300 mm – 1000 mm settlement over a wide area over the life of the mine. This will not be noticeable at the surface. Refer to the statement provided by Mr Trevor Matuschka, appended as **Appendix S.** Refer to the statement provided by Dr Graham Ussher, appended as **Appendix M.** Refer to the statement provided by Mr Dylan van Winkel, appended as **Appendix D.**
693	Hochstetter's frogs would be adversely affected by changes in hydrology and sedimentation.	Ecology	-	Refer to the statement provided by Mr Dylan van Winkel, appended as **Appendix D.** Refer to the statement provided by Dr Graham Ussher, appended as **Appendix M.**

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694	Archey's frog would be adversely affected by subsidence and slumping, plus changes in local hydrology, with damage to retreat, feeding and breeding sites.	Ecology, Geotechnical, Hydrology	-	Subsidence is expected to be inconsequential. Refer to the statement provided by Trevor Matuschka, appended as **Appendix S.** Refer to the statement provided by Dr Graham Ussher, appended as **Appendix M.** Refer to the statement provided by Mr Dylan van Winkel, appended as **Appendix D.**
695	Potential damage from underground mining would be persistent past the cessation of mining operations as alteration to the water table cannot be remedied easily.	Hydrology, Ecology	**B.27 - WWLA - Wharekirauponga Assessment of Groundwater Effects, section 4.9.1.**	Wharekirauponga Assessment of Groundwater Effects notes that although effects from deep dewatering and resulting loss of surface water flows are minor (between 2-13% of the 7-day MALF), numerical groundwater modelling has indicated it would take 10 years after the cessation of pumping for the groundwater levels to recover to 90% of the preexisting levels, with full recovery expected within 20 to 30 years.
696	As Archey's frogs are highly site-faithful, to a point of a specific micro-site, vegetation and habitat clearance for the establishment of drill sites, vent shafts etc will directly impact any frogs residing at the specific site - either through injury or mortality or destruction of their localised habitat.	Ecology	-	Refer to the statement provided by Dr Graham Ussher, appended as **Appendix M.** Refer to the statement provided by Mr Dylan van Winkel, appended as **Appendix D.** Refer to the statement provided by Ms Katherine Muchna, appended as **Appendix K.**
697	There is a high degree of uncertainty associated with the level of effects on frogs which cannot be resolved with the current level of understanding.	Ecology	-	Refer to the statement provided by Dr Graham Ussher, appended as **Appendix M.** Refer to the statement provided by Mr Dylan van Winkel, appended as **Appendix D.**
698	DOC considers the potential effects in the level of individual frogs, the affected part of the populations and the species as a whole are significant due to the threat status and vulnerability of the species.	Ecology	**-**	Refer to the statement provided by Dr Graham Ussher, appended as **Appendix M.** Refer to the statement provided by Mr Dylan van Winkel, appended as **Appendix D.**
699	A reduction in flows of 17% to the Mataura Wetland and extending low flow conditions to a wetland is likely to be detrimental for the wetland environment and may cause a greater effect than that stated in the GHD report.	Ecology and Hydrology	**B.26 – GHD - Groundwater Assessment, Appendix M - BML Aquatic Ecology; B.43 – Boffa Miskell - Freshwater**	It is considered that the project is unlikely to result in any change to wetland hydrological function, as set out in application document B.45. Further, conditions have been updated to require a Mataura Wetland Monitoring and Management Plan (now in WRC conditions – see Conditions SC2.F.29 & 30). If any changes are identified, the consent holder must take all necessary measures to ensure that the ecological

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			Ecology, sections 14.1.10 and 15.1.5; and B.45 - WWLA - Wetland Hydrological Assessment, sections 5 and 6.	health and extent of the Mataura Wetland is restored to at least preconstruction baseline conditions. Refer to the statement provided by Mr Ian Boothroyd, appended as **Appendix P.** Refer to the statement provided by Mr Christopher Simpson, appended as **Appendix G**.
700	There is no assessment to how the indigenous vegetation present in the Mataura Wetland, including the threatened swamp maire, will respond to the loss in catchment area.	Ecology and Hydrology	-	See response to Comment 699 above.
701	DOC considers a reduction in groundwater discharge of 33% is likely to have a net-negative impact - extending the low flow conditions on the Gladstone wetland environment.	Ecology	-	Refer to the statement provided by Mr Ian Boothroyd, appended as **Appendix P.**
702	The reduction in wetland levels will lengthen the time the Gladstone wetland is dry - harming ecological functioning of the wetland that may cause any riparian or wetland planting to not succeed.	Ecology	-	Refer to the statement provided by Mr Ian Boothroyd, appended as **Appendix P.**
703	The loss of the tributary of the Mataura Stream where a rock stack is proposed, will have a significant impact on freshwater biodiversity currently inhabiting the stream.	Ecology	**B.43 – Boffa Miskell – Freshwater Ecology Assessment, section 14.1.8.**	As set out in Section 14.8.1 of application document B.43 the loss of Tributary 2 is temporary, but the effects management and stream offset calculations have assumed a permanent loss of this watercourse. Accordingly, an offset is proposed that will meet the potential ecological value assessed through an appropriate ecological offset model to inform a no net loss outcome. The rehabilitation of the tributary will result in an improved and enhanced catchment compared to that at present, i.e. the tributary will also meet its potential ecological value assessed through an appropriate ecological offset model. Combined, the proposed offset and the proposed rehabilitation of Tributary 2 will result in a net gain in freshwater ecological benefit.
704	The impacts of the diversion from the Ruahorehore Stream will include reduced aquatic connectivity and sediment discharge during construction.	Ecology	-	Refer to the statement provided by Mr Ian Boothroyd, appended as **Appendix P.**
705	It is unclear what this 'non-ecologically functioning' section of the diversion of the Ruahorehore will be as the draft Diversion and Development Plan states "this plan only applies to stream diversion channels and doesn't include clean water diversion channels that are intended only to move water and have no ecological value".	Ecology	-	Refer to the statement provided by Mr Ian Boothroyd, appended as **Appendix P.**

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707	It is unclear which ecological functions will be lost - DOCs view is that the entire diversion needs to be ecologically functioning.	Ecology	-	Refer to the statement provided by Mr Ian Boothroyd, appended as **Appendix P.**
709	Without proper site selection protocols for drilling activities, there could be adverse effects on heritage and recreation.	Heritage & Recreation	-	Refer to the statement provided by Ms Cassandra McArthur, appended as **Appendix Q**.
710	DOC does not consider the outcome of a three-fold increase in managed population of Archey's frog to be realistic or ecologically feasible over the time frame considered for these measures.	Ecology	-	A commitment to reach this outcome has now been included in the conditions. Refer to the statement provided by Dr Graham Ussher, appended as **Appendix M**.
711	DOC find the overall outcome to leiopelmatid frogs, after considering OGNZL's proposed actions to avoid, mitigate, remedy, offset and compensate for adverse effects, will likely not result in a net-gain.	Ecology	-	Refer to the statement provided by Dr Graham Ussher, appended as **Appendix M**.
712	Some proposed measures are not at an appropriate scale (pest control area), have a shown low rate of success and impact (salvage translocations) or relying on unproven, experimental or non-approved methods (pest control techniques) for the leiopelmatid frogs.	Ecology	-	Refer to the statement provided by Ms Helen Blackie, appended as **Appendix N**.
713	Significant further changes are required to the proposed mitigation measures to lower the risk of failure on frog populations. DOC welcome the opportunity to engage further with OGNZL on these points.	Ecology	-	Refer to the statement provided by Dr Graham Ussher, appended as **Appendix M**. Refer to the statement provided by Ms Helen Blackie, appended as **Appendix N**. Refer to the statement provided by Ms Katherine Muchna, appended as **Appendix K**.
715	Condition 173 of the HDC consent is framed as a "no-net loss" outcome rather than a "net gain" outcome which is not consistent with the outcomes stated in the substantive application reports to ensure adverse effects of the activity on native frogs are appropriately managed. An offset under the NPSIB should achieve a net gain.	Ecology	-	A commitment to achieve a 3x increase in frog population over 15 years has now been included in the conditions. Refer to the statement provided by Dr Graham Ussher, appended as **Appendix M**.
716	If the application purports that pest control will at least triple the population of the frogs in the vibration footprint, then the conditions should include performance targets to reflect this.	Ecology	-	See response to Comment 715.
717	The models OGNZL have used imply an unjustified level of certainty in the predicted tripling of population of frog population. Thus, the model has not been built to account for the worst-case scenario.	Ecology	-	Refer to the statement provided by Dr Graham Ussher, appended as **Appendix M.** In addition, please see a report provided as **Attachment 1** to this table which details further Biodiversity Offset Accounting Model modelling undertaken by Dr Graham Ussher.

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718	DOC has not seen any amended improvements to the Wharekirauponga Pest Animal Management Plan despite involvement in technical workshops with OGNZL.	Pest Control	-	Conditions relating to the specific requirements of a Wharekirauponga Pest Animal Management Plan have now been linked into the conditions.
719	Control on mice, rates and pigs should be delivered to a high standard and, where available, established best practice, as the pests with the greatest level of impact on native frogs.	Pest Control	-	Refer to the statement provided by Ms Helen Blackie, appended as **Appendix N.**
720	A ground-based bait station/trapping network overlayed with a three yearly aerial 1080 operation should adequately reduce numbers of possums, rats and mustelids. The addition of trapping will assist in reducing predators in the years between 1080 operations. DOC generally agrees with the proposed methods selected for deer and goat control with ground-based shooting being used as the main control method.	Pest Control	-	Refer to the statement provided by Ms Helen Blackie, appended as **Appendix N.**
721	Some components of the WPAMP need to be considered experimental rather than established and proven practice.	Pest Control	-	Refer to the statement provided by Ms Helen Blackie, appended as **Appendix N.**
722	Unproven tools and toxins should be removed from the WPAMP until they have been approved for use in New Zealand.	Pest Control	-	Refer to the statement provided by Ms Helen Blackie, appended as **Appendix N.**
723	Applying toxins once a year will not achieve the pest control target for rodents.	Pest Control	-	Refer to the statement provided by Ms Helen Blackie, appended as **Appendix N.**
724	DOC recommends monitoring of rodents should occur once per month within the core operational area and bait stations are kept loaded with toxin year-round.	Pest Control	-	Refer to the statement provided by Ms Helen Blackie, appended as **Appendix N.**
725	The area OGNZL has proposed for pest control is too small to suppress pest animals effectively and efficiently - there will be near constant reinvasion of the core area which would require more onerous pest control to reduce numbers to the targets set out in the WPAMP.	Pest Control	-	Refer to the statement provided by Ms Helen Blackie, appended as **Appendix N.**
726	DOC recommends expanding the area of pest-control so the core protected area has a larger buffer from reinvasion and therefore more likely to meet the targets set in the WPAMP.	Pest Control	-	Refer to the statement provided by Ms Helen Blackie, appended as **Appendix N.**
727	It is unlikely the measures set out in the WPAMP will be successful in controlling mice - landscape-scale mouse control in unfenced mainland sites has not been achieved in NZ, contrary to the OGNZL report.	Pest Control	-	Refer to the statement provided by Ms Helen Blackie, appended as **Appendix N.**
728	DOC recommends a maximum 25 m grid arrangement for bait stations for the control of mice.	Pest Control	-	Refer to the statement provided by Ms Helen Blackie, appended as **Appendix N.**
729	Chew card indexes are not appropriate as the primary monitoring tool to measure abundance of rodents. A more	Pest Control	**B.40 – Boffa Miskell - Pest**	As set out in Section 11.2.1 of application document B.40, chew cards have been found to have higher rates of detections for mice than tracking

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	appropriate option would be tracking tunnels which would allow for comparison against the Whareino study for its effectiveness at increasing the leiopelmatid frog population.		**Animal Management Plan.**	tunnels, and correlate to tracking tunnel rates for rats (Sweetapple & Nugent, 2011). The higher rates of detections for mice makes them a suitable choice over tracking tunnels for the project. Further Section 11.6 notes that new real-time monitoring technology will be incorporated into the WAPMA as it becomes available, which will allow for instant (real-time) detection of pests and tracking of populations. New technologies also have the advantage of higher detections of all pest species, but particularly smaller species such as rats and mice.
730	DOC agrees that the proposed control target of feral pig is zero density, but contends changes to the proposal will be required to achieve this - with no barriers to prevent re-entry, ground hunting will be insufficient. DOC recommends fencing to exclude pigs is included as a tool to limit pig impacts.	Pest Control	-	Refer to the statement provided by Ms Helen Blackie, appended as **Appendix N.**
731	DOC recommends that fencing to exclude pigs from the area is included as a tool to limit pig impacts.	Pest Control	-	Refer to the statement provided by Ms Helen Blackie, appended as **Appendix N.**
732	The WAPMP will need to be modified to exclude Schedule 4 areas and provide for additional pest control sites to reach the same mitigation requirement - or not be exercised until the additional permissions are granted.	Pest Control	-	The application clearly states that no approvals are proposed for activities within Schedule 4 areas. Additional approvals for such activities will be applied for from DOC outside of the Fast-track process.
733	DOC has not yet been provided a copy of the Native Frog Salvage Release Plan.	Ecology	-	Conditions relating to the specific requirements of a Native Frog Salvage Release have now been linked into the conditions.
734	DOC considers improvements are required to the Native Frog Monitoring Plan to ensure methods are rigorous and the knowledge gained in statistically robust.	Ecology	-	Refer to the statement provided by Brian Lloyd, appended as **Appendix J**.
735	Without the identified changes to the draft monitoring plan, DOC considers the proposed approach is insufficient to ensure potential adverse effects to frogs can be appropriately identified and addressed.	Ecology	-	The Native Frog Monitoring Plan has been provided in draft form and requires certification by DOC prior to implementation. This provides opportunity for the plan to be developed further in consultation with DOC. Refer to the statement provided by Brian Lloyd, appended as **Appendix J**.
736	DOC considers more targeted consent conditions should be considered, given the critical importance of native frogs.	Ecology	-	Amendments have been made to the condition set in relation to native frogs. Refer to the statement provided by Brian Lloyd, appended as **Appendix J**. Refer to the statement provided by Dr Graham Ussher, appended as **Appendix M.**

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				Refer to the statement provided by Mr Dylan van Winkel, appended as **Appendix D.**
737	The consent conditions need to have robust monitoring standards and practices to ensure OGNZL will be able to identify if or when the groundwater levels change and need to implement adaptive management.	Hydrology	-	Refer to the statement provided by Mr Christopher Simpson, appended as **Appendix G**. Refer to the statement provided by Mr Tim Mulliner, appended as **Appendix E**.
738	The actual losses and gains of freshwater are uncertain as they are inconsistent in tables and assessments contained within the application documentation - making it difficult to make an accurate assessment of the offsetting and compensation proposals.	Hydrology	-	Refer to the statement provided by Mr Christopher Simpson, appended as **Appendix G**. Refer to the statement provided by Mr Tim Mulliner, appended as **Appendix E**.
738a	DOC also notes that the application states that only 1,800 m of the 2,503 m Tailing Storage Facility diversion is intended to be 'ecologically functional', but Table 51 states that it "excludes [diversion streams] with no or little ecological functionality"54. If this is correct it would be even more of a shortfall in the calculations for offsetting.	Ecology	-	Refer to the statement provided by Mr Ian Boothroyd, appended as **Appendix P.**
740	There is insufficient information in the ELMPs about timeframes, species, spacing, fencing, pest control, releasing and performance standards.	Ecology	-	Refer to the statement provided by Mr Ian Boothroyd, appended as **Appendix P.**
741	DOC recommends a covenant or equivalent should be instated over all sites that are remediated, offset or compensated to ensure long-term protection of the habitat.	Ecology		Such protections are already provided for in the conditions.
742	In the situation where streams are proposed to be relocated back to their original locations post-mining, it is unclear how the effects of two instances of complete loss of values from the de-watered reaches have been considered as part of the proposed compensation and mitigation of effects.	Ecology	-	Refer to the statement provided by Mr Ian Boothroyd, appended as **Appendix P.**
744	OGNZL has not shared relevant details of the Biodiversity Project with DOC - this has been raised as a concern by tangata whenua also.	Ecology	**B.35 - OGNZL – Biodiversity Project Overview.**	As stated in application document B.35, the "the Department of Conservation, as the land administrator of the Project area, are also expected to be a key stakeholder in the collaborative process to design and implement the Project".
745	The analysis of NPSIB does not adequately recognise the uncertainty of the effects on biodiversity. No further detail is provided beyond identifying Policy 3.	Ecology	-	Refer to the statement provided by Mr John Kyle and Ms Abbie Fowler, appended as **Appendix H**.
746	The range of plans for managing ecological effects that have not yet been provided leave significant uncertainty about what those plans will contain and what ecological outcomes will be stated.	Ecology	-	Reliance on management plans has been removed from the proposed revised DOC related approval conditions. Refer to updated conditions and the statement provided by Mr John Kyle and Ms Abbie Fowler, appended as **Appendix H**.
747	The Project relies primarily on biodiversity offsetting and compensation to achieve its net-gain outcome - the	Ecology	-	Refer to the statement provided by Mr John Kyle and Ms Abbie Fowler, appended as **Appendix H**.

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	assessment against the NPSIB focusses on overall objectives and policies but does not consider the Appendices that provide the requirements for biodiversity offsetting and compensation.			
748	Under Clause 3.10(4) of the NPSIB, if biodiversity offsetting or compensation is applied, OGNZL must demonstrate how they have complied with principles 1 to 6 in Appendix 3 and 4; and have regard to the remaining principles as appropriate. There are several principles within Appendix 3 that are not met by OGNZL's WPAMP and other compensation.	Ecology	-	Refer to the statement provided by Mr John Kyle and Ms Abbie Fowler, appended as **Appendix H**.
749	Principle 2 of the NPSIB states that biodiversity offsets are not appropriate in situations where indigenous biodiversity values cannot be offset to achieve a net gain - the potential effects on leiopelmatid frogs is uncertain and could lead to a significant adverse outcome.	Ecology	-	Refer to the statement provided by Mr John Kyle and Ms Abbie Fowler, appended as **Appendix H**.
750	The proposed timeframe for which to secure gains, under Principle 2(c) of the NPSIB, is not considered appropriate as DOCs technical advisors consider it would take 10 years for the species to recover after 18 years of mining.	Ecology	-	Refer to the statement provided by Mr John Kyle and Ms Abbie Fowler, appended as **Appendix H**.
751	The consent conditions state monitoring and pest control only need to continue until there has been no net-loss of leiopelmatid frog population numbers. This would be before a net-gain as required by Principle 3 of the NPSIB	Ecology	-	A commitment to achieve a 3x increase in frog population over 15 years has now been included in the conditions. This will be accompanied by monitoring and pest control. Refer to the statement provided by Dr Graham Ussher, appended as **Appendix M**.
752	Translocating frogs within the Wharekirauponga Underground Mine site would place them into an existing frog population, placing stress on the ability to provide food sources and shelters for existing and translocated frogs - this could result in a net-loss for both populations which would amount to leakage which is what Principle 5 of the NPSIB states should be avoided.	Ecology	-	Refer to the statement provided by Ms Katherine Muchna, appended as **Appendix K**.
753	Unless wider pest control is undertaken, or a conservation translocation is undertaken, any net gain in biodiversity values will not last longer than the life of pest control operation - this is against Principle 6 of the NPSIB.	Ecology	-	Refer to the statement provided by Mr John Kyle and Ms Abbie Fowler, appended as **Appendix H**.
754	DOC considers the proposal is inconsistent with the NPSIB principles for offsetting.	Ecology	-	Refer to the statement provided by Mr John Kyle and Ms Abbie Fowler, appended as **Appendix H**.
755	The research fund proffered in the RC conditions is considered inadequate to provide for a proposed research endeavor.			The fund is only one of the measures offered to deal with the management of ecological effects. The applicant is open to further discussions with DOC about the quantum of such measures.

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756	Due to inconsistent and insufficient information, DOC are unable to determine if the provisions of the NPSFM would be met.	Ecology		Refer to the statement provided by Mr John Kyle and Ms Abbie Fowler, appended as **Appendix H**. Further, a range of responses to this matter have been included in the selection of statements provided by the ecological experts.
757	The activities sought do not align with the objectives and policies of the WCMS.	Ecology	-	Refer to the statement provided by Mr John Kyle and Ms Abbie Fowler, appended as **Appendix H**. Refer to the statement provided by Ms Cassandra McArthur, appended as **Appendix Q**.
758	DOC consider the Northern Concession and Wharekirauponga Access Arrangement as currently proposed to be inconsistent with the conservation planning documents (Conservation General Policy and WCMS).	Ecology	-	Refer to the statement provided by Mr John Kyle and Ms Abbie Fowler, appended as **Appendix H**. Refer to the statement provided by Ms Cassandra McArthur, appended as **Appendix Q**.
759	It would be difficult to reconcile the varying objectives of conditions to a state of demonstrable net benefit to native frogs.	Ecology	-	Refer to the statement provided by Dr Graham Ussher, appended as **Appendix M**.
760	DOC is concerned with the use of management plan conditions for the purpose of the resource consent and wish to ensure that the conditions which establish the management plans and subsequent amendments for the lifespan of the project are consistent with the principles set out in DOC's Covering Report.	Ecology	-	Amendments have been made to the previously proposed management plan approach, as set out in the DOC approval related conditions, and as discussed in the legal submission provided by Mr Stephen Christensen, provided in **Part A** of the response package, and the statement provided by Mr John Kyle and Ms Abbie Fowler, appended as **Appendix H.**
761	Conditions should not leave substantive decisions to council officers to be made after the decision on the consent themselves and many of the proposed management plan conditions lack certainty.	Administrative	-	Refer to response provided to Comment 760.
762	DOC considers OGNZL should be required to meet the targets and thresholds set in the conditions, and not those set or amended by OGNZL in the WPAMP.	Pest Control	-	Conditions relating to the specific requirements of a Wharekirauponga Pest Animal Management Plan have now been linked into the conditions.
763	HDC conditions 169, 171A and 171C all reference thresholds but do not include when the thresholds are triggered and adaptive management is required. If the actions required once thresholds are triggered are not included, they are unenforceable and fail to provide for offsetting requirements.			Refer to the statement provided by Mr John Kyle and Ms Abbie Fowler, appended as **Appendix H**.
764	Uncertain management plan conditions create the risk of 'unlawful' delegation of substantive decisions to a third party, through the process proposed for amendments.	Administrative	-	Amendments have been made to the previously proposed management plan approach, as set out in the revised DOC approval related conditions, and as discussed in the legal submission provided by Mr Stephen Christensen, provided in **Part A** of the response package, and the statement provided by Mr John Kyle and Ms Abbie Fowler, appended as **Appendix H.**

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765	OGNZL need to review the conditions relating to these management plans and sub-management plans with the view to ensure appropriate objective and performance indicators to make it easy for certifiers to confirm that management plans are meeting the environmental standards. The following relevant management plans are:
	• Wharekirauponga Underground Mine Ecology and Landscape Management Plan;
	  ○ Terrestrial Ecological Management Plan;
	  ○ Vegetation Remediation Plan;
	  ○ Aquatic Fauna Salvage and Relocation Plan;
	  ○ Kauri Dieback Management Plan; and
	  ○ Landscape and Visual Mitigation Plan.
	• Waihi Area Ecology and Landscape Management Plan
	  ○ Residual Effects Offset Plan;
	  ○ Planting Plan;
	  ○ Lizard Management Plan;
	  ○ Avifauna Management Plan;
	  ○ Bat Management Plan;
	  ○ Aquatic Fauna Salvage and Relocation Plan; and
	  ○ Landscape and Visual Management Plan,
	• Coromandel Forest Park Kauri Dieback Management Plan;
	• Wharekirauponga Pest Animal Management Plan;
	• Wharekirauponga Underground Mine Water Management Plan;
	• Archaeological Management Plan;
	• Native Frog Monitoring Plan; and
	• Vibration Management Plan.
		Administrative	-	Amendments have been made to the previously proposed management plan approach, as set out in the revised DOC approval conditions, and as discussed in the legal submission provided by Mr Stephen Christensen, provided in **Part A** of the response package, and the statement provided by Mr John Kyle and Ms Abbie Fowler, appended as **Appendix H.**

766	Each management plan should cross-reference other relevant conditions to which the management plan relates - given the number of plans involved, should be done by a schedule.	Administrative	-	Amendments have been made to the previously proposed management plan approach, as set out in the revised DOC approval related conditions, and as discussed in the legal submission provided by Mr Stephen Christensen, provided in **Part A** of the response package, and the statement provided by Mr John Kyle and Ms Abbie Fowler, appended as **Appendix H.**
767	Detailed ecological survey should be undertaken at every drill location - if site selection protocols are to be used, they will require further refinement.	Ecology	-	Refer to the statement provided by Ms Cassandra McArthur, appended as **Appendix Q**.
768	A 6m buffer should be utilised for ecological surveys.	Ecology	-	Refer to the statement provided by Ms Katherine Muchna, appended as **Appendix K**.

Comment Number	Comment	OGNZL Technical Input	Where Addressed in the Application Documents	Response
				Refer to the statement provided by Ms Cassandra McArthur, appended as **Appendix Q**.
769	If a 6 m buffer is not adopted, OGNZL should identify the night retreat of the frog and ensure the buffer includes the night retreats.	Ecology	-	Refer to the statement provided by Ms Katherine Muchna, appended as **Appendix K**. Refer to the statement provided by Ms Cassandra McArthur, appended as **Appendix Q**.
770	Annual frog surveys should be undertaken to confirm whether frogs are maintaining a territory at the site.	Ecology	-	Refer to the statement provided by Ms Katherine Muchna, appended as **Appendix K**.
771	The outcome sought by the condition should be to ensure each frog has no less than 50% connectivity (as opposed to the current 25%).	Ecology	-	The 25% condition is taken directly from existing DOC approvals. No evidence has been provided as to why this is no longer appropriate.
772	The current site selection protocol does not adequately address potential impacts on frogs and lizards.	Ecology	-	Refer to the statement provided by Ms Katherine Muchna, appended as **Appendix K**.
773	The MCA tool does not contain exclusion criteria, which is inconsistent with a desired outcome of avoiding effects on a species.	Ecology	-	Refer to the statement provided by Ms Cassandra McArthur, appended as **Appendix Q**.
774	There are still fundamental gaps regarding the salvage protocols within the ELMP.	Ecology	-	Amendments have been made to the previously proposed management plan approach, as set out in the revised DOC approval related conditions, and as discussed in the legal submission provided by Mr Stephen Christensen, provided in **Part A** of the response package, and the statement provided by Mr John Kyle and Ms Abbie Fowler, appended as **Appendix H.** This includes provision of salvage protocols within the conditions.
775	No conditions require any additional effects assessment on heritage features beyond the site selection protocol including their avoidance. This creates an unacceptable and unmitigated risk that heritage features will be impacted by exploration or mining activities and associated operations.	Heritage	-	Refer to the statement provided by Ms Cassandra McArthur, appended as **Appendix Q**.
776	Archaeological assessments are required given two archaeological sites have been identified within proposed drilling areas it is appropriate that additional investigation is undertaken at the time of site selection for these sites and is supplementary required to be undertaken for the 50 portable drill sites as well.	Heritage	-	Refer to the statement provided by Ms Cassandra McArthur, appended as **Appendix Q**.
777	It is unclear if OGNZL propose to include the Native Frog Salvage and Release Plan as part of the ELMP-WUG for the purposes of Resource Consents.	Ecology	-	See response to Comment 774.

Comment Number	Comment	OGNZL Technical Input	Where Addressed in the Application Documents	Response
778	If the Native Frog Monitoring Plan is required to be certified under the advice note of Condition C5 - then it should be stated as a condition.	Ecology	-	Amendments have been made to the previously proposed management plan approach, as set out in the revised DOC approval related conditions, and as discussed in the legal submission provided by Mr Stephen Christensen, provided in **Part A** of the response package, and the statement provided by Mr John Kyle and Ms Abbie Fowler, appended as **Appendix H.**

rma ecology

Memo

To:	Cassie McArthur, Oceana Gold	Job No:	2034
From:	Duncan Nicol, RMA Ecology Ltd Graham Ussher, RMA Ecology Ltd	Date:	21 July 2025
cc:	Kerry Watson, Oceana Gold		
Subject:	OGNZL Wharekirauponga mine: simulation analysis of Archey's frog value outcomes		

Dear Cassie,

As part of the consultation being undertaken by OceanaGold (NZ) Ltd (OGNZL) with the Department of Conservation (DOC) for the Wharekirauponga underground mine in the southern Coromandel, DOC has requested additional information regarding the modelling of biodiversity losses and gains for Archey's frogs.

The information that we have prepared to date[1] for OGNZL in this regard has included an effects assessment of the type, likelihood and scale of potential adverse effects on Archey's frogs form surface vibrations, and an analysis of the potential benefits to frog populations of a proposed wide-scale predator control programme within and surrounding the mine site.

DOC has requested that our offset modelling explore a greater range of potential input values into the models used, including a broader range of values for potential uplift and certainty linked to outcomes, and how these are reflected in the model outputs in terms of net-loss, no-let loss and net-gain.

This memorandum provides the results of an examination of the models and presents the outputs from using a broader range of inputs than assumed by us in our original modelling. This examination is essentially a sensitivity test of the offset models, and the results confirm the ability of the proposed pest control programme at the site to provide net benefits that exceed potential impacts on Archey's frogs.

We have not modelled the potential impacts or benefits on Hochstetter's frogs in a similar manner; however, given that there are a greater number of studies elsewhere that show benefits for Hochstetter's frogs from pest control, and because Hochstetter frog habitat is present in only a small part of the site, it is likely that a positive result obtained for Archey's frogs will also infer a positive result for Hochstetter's frog.

1 Overview

A more detailed analysis was requested by DOC regarding the net value outcomes as a result of potential vibrational impacts on Archey's frog population. This study provides additional statistical rigour to the use of the Biodiversity Compensation Model (BCM) and Biodiversity Offset Accounting Model (BOAM) models, and it is a continuation of the previous report prepared by RMA Ecology (2025).

A simulation-based approach of the BCM and BOAM models was used to investigate the varying effects of non-fixed parameters on the net value outcome. Iterative sampling was used to provide the full range of possible scenarios. Several steps were taken in the sensitivity analysis to understand the impact of the non-fixed parameters from

[1] RMA Ecology Ltd. January 2025. OGNLZ Wharekirauponga mine: potential adverse effects on native frogs. Report prepared for OceanaGold (NZ) Ltd. 30 pages plus Appendices.

different perspectives. The general plan statistically assessed the outcomes of the BCM and BOAM output given two sampling methods based on informed or uninformed prior knowledge, giving four output scenarios: BCM with and without prior knowledge and BOAM with and without prior knowledge.

2 Methods

2.1 Input Parameters

Both the BCM and BOAM models have fixed and non-fixed parameters. The RMA Ecology 2025 report provides detail for all parameter decisions which are summarised in this report. The fixed parameters were based on prior research informing the model development, or they were site-specific and required values from field surveys or site studies, or they were established by expert recommendation; these fixed parameters were held constant across the modelling scenarios (Tables 1, 3).

The non-fixed parameter ranges were obtained from the model formulas or from the details within the previous report (Maseyk et al. 2015; RMA Ecology 2025; Table 2). The non-fixed parameters have a range of values and were randomly sampled from parametric distributions. However, two approaches ('Approach one' and 'Approach two') of model variability were developed alongside the two BCM and BOAM models (Tables 2, 4).

The first approach was chosen to represent sampling without prior knowledge using uniform distributions across the parameter ranges. The second approach was chosen to represent sampling with prior expert judgement and knowledge using truncated normal distributions set around likely values.

The ecological value impact (i.e. percentage of the frog population that is assumed to die) proportion range was based on a potential minimum 10 % loss to maximum 100 % loss. A 10 % loss was chosen as a nominal level of very low loss; obviously choosing 0 % loss would make the analysis unwarranted, as the project would deliver only benefits with no associated potential loses to analyse. Approach one sampled from a uniform distribution between these values, whereas Approach two set the mean of the truncated normal distribution at 25 % based on the estimate from the OGNZL expert advisory group who stated "Given that Archey's frog seems able to survive and persist in 2 mm /sec vibration environments, it is unlikely that all or most frogs will die when exposed to marginally greater vibrations" (RMA Ecology 2025).

The offset effect (pest control benefit) confidence (BOAM) and the compensation effect confidence (BCM) are key uncertainties in both models, and a confidence rate below 50 % invalidates the models. Three levels of confidence are available: moderate (50 %–70 %), high (75 %–90 %), and very high (> 90 %). Approach one sampled from a uniform distribution between 50 %–99 %, whereas Approach two set the mean of the truncated normal distribution at 75 % based on an appropriate level of confidence recommended by the OGNZL advisory group as 'moderate' or 'low' (RMA Ecology 2025).

The offset benefit multiplier which estimates the potential benefits of the animal pest control programme in terms of increasing the abundance of native frogs had a value range of 1.5 to 4.5. Approach one sampled from a uniform distribution between these values, whereas Approach two set the mean of the truncated normal distribution at 3 based on the expert estimate from the OGNZL advisory group and informed by several studies which produced estimated multiplied benefits between 2.3 and 4 (RMA Ecology 2025).

The BCM model has two impact contingency parameters which increase the impact value based on a certain percentage to account for the ecological risk and the uncertainty risk[2]. The ecological risk contingency parameter increases the impact value based on the discrete range: negligible value (+0 %), moderate value (+5 %), high value (+10 %), and very high value (+20 %). The uncertainty risk parameter increases the impact value based on the discrete range: low uncertainty (+5 %), moderate uncertainty (+10 %), high uncertainty (+20 %).

For the contingency parameters, Approach one sampled from both uniformly, whereas Approach two set the mean of the truncated normal distribution at high levels for ecological risk (+10 %) to recognise the threat status of Archey's frogs and the high-value forest ecosystem at site, and Approach two also set the mean at high levels for uncertainty risk (+20 %) given the lack of information surrounding vibrational impacts on herpetofauna.

[2] These are two of several parameters that a user of the model chooses as part of 'programming' the model. Tables 1 and 2 list all of the parameters, and show which ones were varied as part of this sensitivity analysis, and why.

Table 1. Fixed parameters, their values, and their summarised justification in the BOAM model. Further details are provided in the OGNZL Assessment of effects on native frogs (RMA Ecology 2025).

Fixed parameters	Value	Justification
Impact discount rate	0	Impacts are assumed to occur immediately.
Offset discount rate	0.03	As recommended in the BOAM user manual (Maseyk et al. 2015) and in the offset study by Gibbons et al. (2015).
Areas	314, 318	Vibration footprint is 314 ha, and the offset area is 318 ha.
Times	0, 15	Impacts are assumed to occur immediately, and the pest control programme will be undertaken for a minimum of 14.5 – 15 years.
Benchmark value	900	Chosen as a reasonable expectation for a long-term benchmark, and informed by density estimates from the study by Lloyd.
Estimated value	286	Calculated by dividing a mid-range population estimate by the study area, and informed by the study by Lloyd.

Table 2. Non-fixed parameters and their values in the two approaches for the BOAM model. Further details are provided in the text and also in the OGNZL Assessment of effects on native frogs (RMA Ecology 2025).

Non-fixed parameter	Minimum value	Maximum value	Approach one	Approach two
Ecological value impact proportion	0.1	1	Uniform	Normal: mean = 0.25, sd = 0.25
Offset effect confidence	0.5	0.99	Uniform	Normal: mean = 0.75, sd = 0.1
Offset benefit multiplier	1.5	4.5	Uniform	Normal: mean = 3, sd = 0.35

Table 3. Fixed parameters and their values in the BCM model. Further details are provided in the OGNZL Assessment of effects on native frogs (RMA Ecology 2025).

Fixed parameters	Value	Justification
Discount rate	0.03	As recommended in the BCM user guide (Baber et al. 2021).
Benchmark value	5	The benchmark is always 5 (Baber et al. 2021).
Estimated value	1.5	Based on the current degraded site baseline relative to a population after long-term intensive pest control programme.
Net gain target	0.1	As recommended in the BCM user guide (Baber et al. 2021).
Areas	314, 318	Vibration footprint is 314 ha, and the offset area is 318 ha.
Times	15	The pest control programme will be undertaken for a minimum of 14.5 – 15 years.

Table 4. Properties for the non-fixed parameters in the two approaches for the BCM model. Further details are provided in the text and also in the OGNZL Assessment of effects on native frogs (RMA Ecology 2025).

Non-fixed parameter	Minimum value	Maximum value	Approach one	Approach two
Ecological value impact proportion	0.1	1	Uniform	Normal: mean = 0.25, sd = 0.25
Impact risk (ecological)	1	1.2	Uniform	Normal: mean = 1.1, sd = 0.025
Impact risk (uncertainty)	1.05	1.2	Uniform	Normal: mean = 1.2, sd = 0.05
Compensation effect confidence	0.5	0.99	Uniform	Normal: mean = 0.75, sd = 0.1
Compensation benefit multiplier	1.5	4.5	Uniform	Normal: mean = 3, sd = 0.35

2.2 Net Value Outcome

A histogram of the net value outcomes distribution across all simulations was produced, and 99 % confidence intervals were calculated for the mean of all values, for the mean of values below the mean (pessimistic scenario), and a mean for the values above the mean (optimistic scenario). Additionally, the proportion of negative cases out of all simulated cases was calculated, along with a binomial proportion 99 % confidence interval, using a one-sample proportion test. This test determines whether the proportion of negative outcomes was different than chance (50 %). The test of proportions was run using the *prop.test* function from the *stats* package in R.

2.3 Logistic Regression

A logistic regression model (with the logit link function) was fitted to the simulated data to assess the relationship between the non-fixed parameters and the binary outcome of positive net value outcome. This model fits parameters and identifies their positive or negative association with the net value outcome. The regression model was fitted using the *glm* function from the *stats* package in R.

2.4 Threshold Analyses

Target non-fixed parameters were individually isolated from the others. All non-target non-fixed parameters were held constant at their mean value. Each model was run across one thousand even increments of the full range of the target parameter. The purpose was to identify the individual association of each target parameter with the net value outcome. By holding all other variables constant, it was possible to analyse the effect each target parameter had by itself. In particular, a 50 % threshold value was calculated which identifies the point along the range at which the parameter is associated with a switch from a positive to negative outcome or *vice versa*. For the non-fixed parameters, a set of one-variable-at-a-time sensitivity analyses was performed:

1. For each parameter, a sequence of 1,000 values was generated across its range.
2. The remaining variables were held constant at their mean values.
3. Predictions were generated using the previously fit logistic regression model (from Section 2.3.1).
4. The point at which the predicted probability of a positive net value outcome equalled 0.5 was identified as the threshold (inflection point).

Non-fixed parameters whose 50 % thresholds fell within its available range were considered influential. These represent thresholds at which the model outcome flips from negative to positive or *vice versa*. Non-fixed parameters whose 50 % threshold points lay beyond their available range (either above or below the limits) were interpreted as having little to no individual effect on the outcome. Instead, their role may be more conditional on particular values of other non-fixed parameters.

3 Results

3.1 Input Parameters

All non-fixed parameters for the BOAM (Appendix A) and BCM (Appendix B) models and the corresponding two approaches were sampled as intended.

3.2 Net Value Outcomes

3.2.1 *BOAM*

Both BOAM approaches had similar means. Approach one had a mean of 84.0 % net gain (99 % CI: 82.5, 85.6), and Approach two had a mean of 121.9 % net gain (99 % CI: 121.0, 122.8). The distribution of net value outcomes for Approach one was positively skewed and had a range from –81.6 % to 387.9 %. The distribution of Approach two was normally distributed around the mean and had a range from –57.8 to 305.1%.

The pessimistic scenario (taking the mean of values below the mean) for Approach one was 21.6 % net gain (99 % CI: 20.7, 22.6) and was lower than Approach two at 82.9 % net gain (99 % CI: 82.1, 83.6). The optimistic scenario for Approach one was 159.7 % net gain (99 % CI: 158.1, 161.3) and was lower than Approach two at 161.4% net gain (99 % CI: 160.6, 162.2).

Regarding simulations with negative outcomes, in Approach one, 16.4 % of simulations were net losses (99 % CI: 15.7, 17.1), whereas in Approach two, 0.4 % of simulations were net losses (99 % CI: 0.3, 0.5).

Although the non-fixed parameters had different associated trends with the net value outcome, the trends were consistent between Approach one and two (Appendix C). The proportional impact on ecological values was negatively associated with net value outcomes, whereas the compensation effect confidence and offset benefit multiplier were both positively associated with net value outcomes.

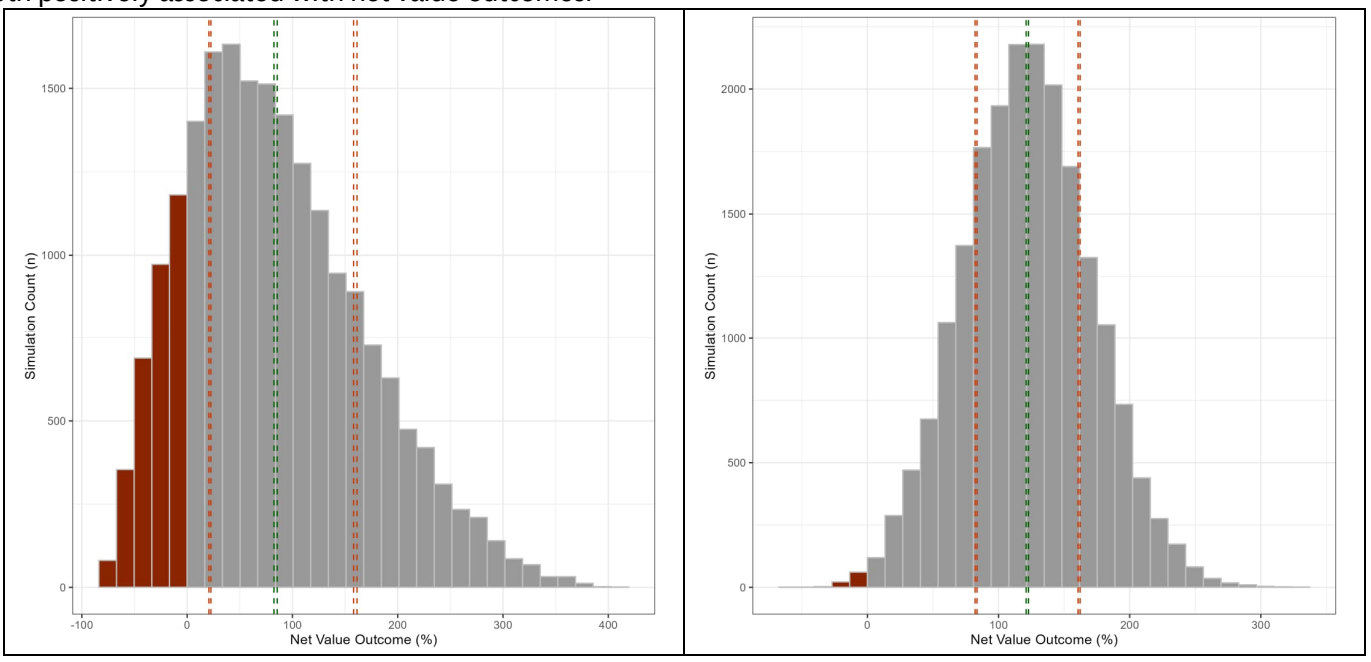

Figure 1. Distribution of net value outcomes for Approach one (left) and Approach two (right) of the BOAM model. Vertical lines delineate the 99 % confidence intervals for the mean (green), pessimistic (values below the mean), and optimistic (values above the mean). Net losses are highlighted as red bars.

3.2.2 *BCM*

Both BCM approaches had similar means. Approach one had a mean of 194.2 % net gain (99 % CI: 188.5, 200.0), and Approach two had a mean of 362.0 % net gain (99 % CI: 356.1, 367.8). The distributions of net value outcomes were also positively skewed for both approaches. Approach one had a range from –85.7 % to 3037.1 %, and Approach two had a range from –67.9 % to 2222.9 %.

The pessimistic scenario for Approach one was estimated at 35.5 % net gain (99 % CI: 34.0, 37.0) and was lower than Approach two at 167.16 % net gain (99 % CI: 164.9, 169.4). The optimistic scenario for Approach one was 543.5 % net

gain (99 % CI: 531.8, 555.2) and was higher than Approach two at 691.7 % net gain (99 % CI: 682.9, 700.5).

In Approach one, 24.7 % of simulations were net losses (99 % CI: 23.9, 25.5), whereas in Approach two, 1.7 % of simulations were net losses (99 % CI: 1.5, 2.0).

Similar to the BOAM model, the non-fixed parameters in the BCM model had different associated trends with the net value outcome, but the trends were consistent between Approach one and two (Appendix D). The proportional impact on ecological values was strongly negatively associated with net value outcomes. The compensation confidence was weakly positive, and the two impact contingency risks, ecological and uncertainty, were weakly negative. The offset benefit multiplier was strongly positively associated with net value outcome.

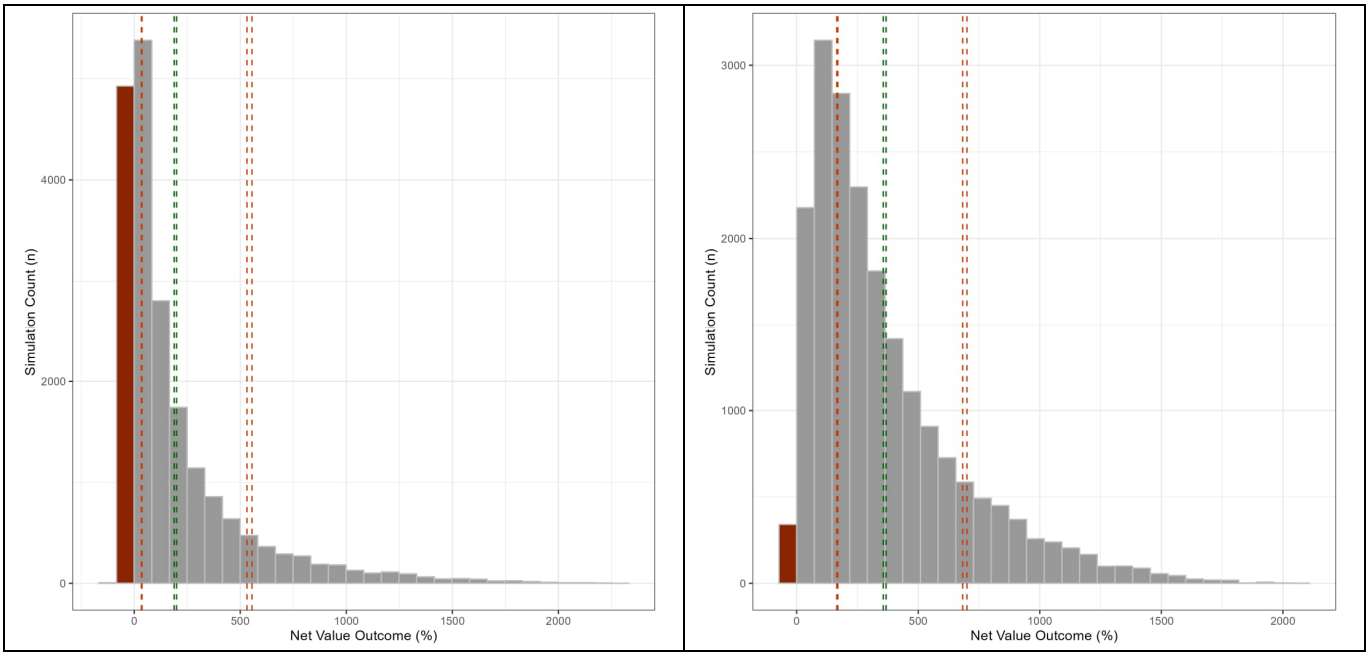

Figure 2. Distribution of net value outcomes for Approach one (left) and Approach two (right) of the BCM model. Vertical lines delineate the 99 % confidence intervals for the mean (green), pessimistic scenario (values below the mean), and optimistic scenario (values above the mean). Net losses are highlighted as red bars.

3.3 Logistic Regression

The coefficient estimates for the parameters in the logistic regression analyses were similar to the associated trends that the parameters had in relation to the net value outcomes. However, the logistic regression analyses evaluate the relationship between the non-fixed parameters and a net gain outcome or a net loss outcome instead of the net value.

3.3.1 *BOAM*

In the BOAM models (including Approaches one and two), the proportional ecological value impact had a strong negative coefficient, whereas both the offset effect confidence and the offset benefit multiplier had strong positive coefficients. All coefficient estimates were statistically significant.

3.3.2 *BCM*

In the BCM models (including Approaches one and two), the proportional ecological value impact had a strong negative coefficient estimate, and the offset benefit multiplier had a strong positive coefficient. The compensation benefit confidence was positive in both Approach one and two, but it was weaker in Approach one. The two impact contingency risks, ecological and uncertainty, were weakly negative in both Approaches. All coefficient estimates were statistically significant.

3.4 Threshold Identification

3.4.1 *BOAM*

The range for the proportional ecological value impact (loss of frogs) is 0.1 to 1. The threshold was 0.98 in Approach one and 0.99 in Approach two (Fig. 3). There were 1.65 % of simulation cases in Approach one and 0.02 % of cases in Approach two in which the impact value was above its threshold; 0.86 % of Approach one and 0.01 % of Approach two in which it was above and the outcome was a net loss; and 0.80 % of Approach one and 0.01 % of Approach two in which it was above and the outcome was a net gain.

The range for the offset benefit multiplier is 1.5 to 4.5. The threshold was 1.77 in Approach one and 1.5 in Approach two (Fig. 4). In Approach one, there were 9.20 % of simulation cases in which the offset benefit multiplier was below its threshold; 5.52 % of simulation cases in which it was below its threshold and the outcome was negative; and 0.80 % of simulation cases in which it was below its threshold and the outcome was positive. Because the threshold was identified at the lower limit in Approach two, there were no cases in which the offset benefit multiplier was below its threshold.

The threshold for the confidence in offset effect was on the edge of its range limits in both Approach one and two. There were no simulation cases in either approach in which the threshold was tipped.

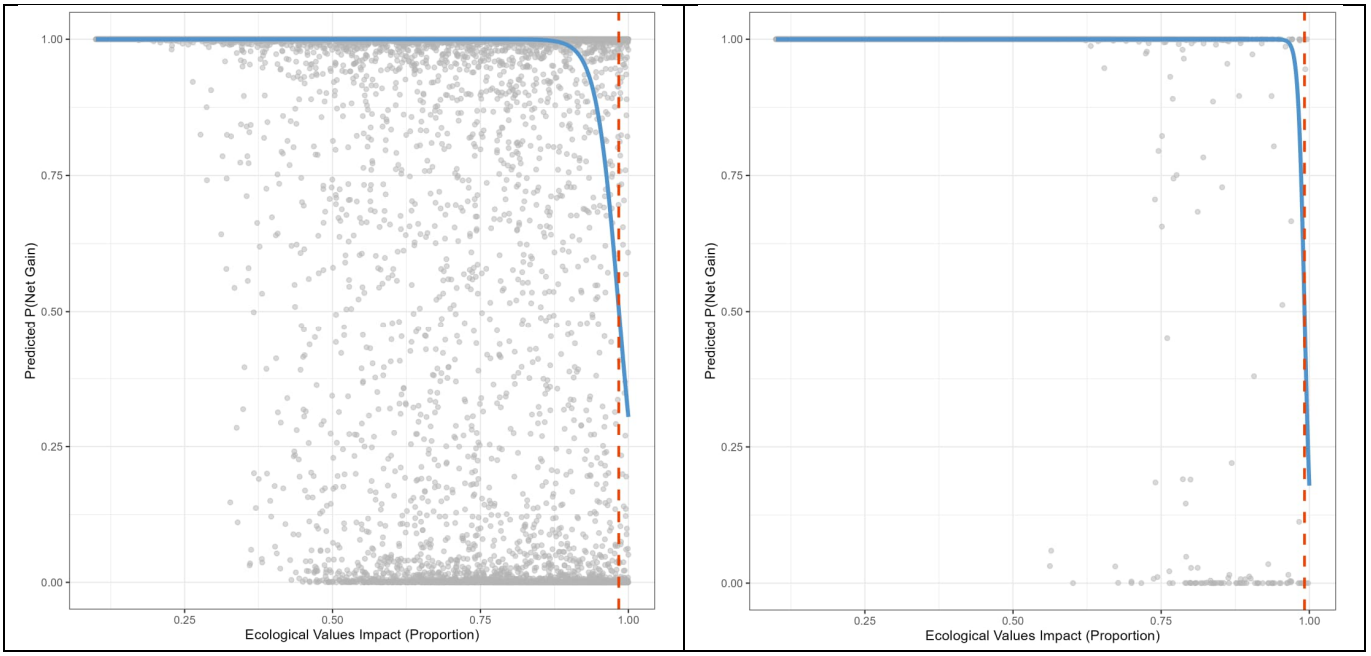

Figure 3. Threshold analyses for Approach one (left) and Approach two (right) for the BOAM model. Blue line indicates the relationship between the proportional impact on ecological values and the predicted probability of a net gain outcome. The red dashed line indicates the threshold point at which the parameter tips the probability from a net gain to a net loss and vice versa.

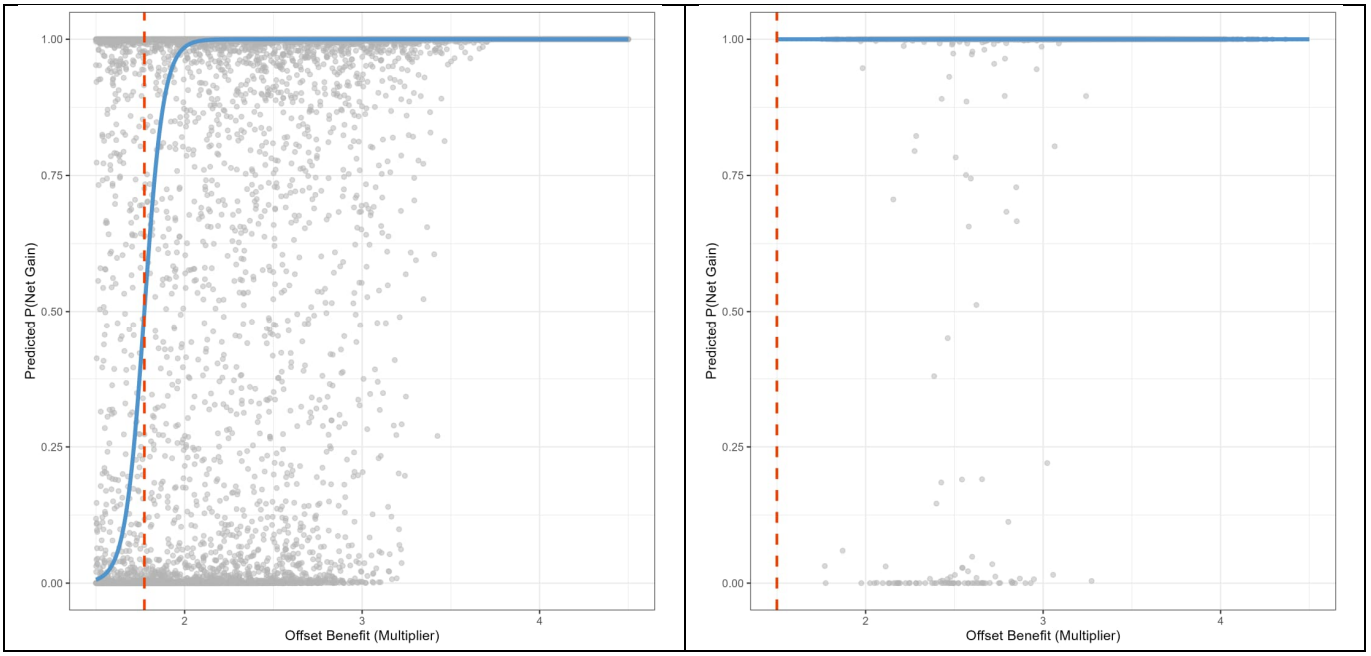

Figure 4. Threshold analyses for Approach one (left) and Approach two (right) for the BOAM model. Blue line indicates the relationship between the offset benefit multiplier and the predicted probability of a net gain outcome. The red dashed line indicates the threshold point at which the parameter tips the probability from a net gain to a net loss and vice versa.

3.4.2 *BCM*

The range for the proportional ecological value impact is 0.1 to 1. The threshold was 0.81 in Approach one and 0.86 in Approach two (Fig. 5). There were 21.16 % of simulation cases in Approach one and 0.58 % of simulation cases in Approach two in which the impact value was above its threshold; 13.61 % of Approach one and 0.58 % of Approach two in which it was above and the outcome was a net loss; and 7.54 % of Approach one and 0.21 % of Approach two in which it was above and the outcome was a net gain.

The range for the offset benefit multiplier is 1.5 to 4.5. The threshold was 1.91 in Approach one and 1.50 in Approach two (Fig. 6). In Approach one, there were 13.98 % of simulation cases in which the offset benefit multiplier was below its threshold; 8.89 % of simulation cases in which it was below its threshold and the outcome was negative; and 5.09 % of simulation cases in which it was below its threshold and the outcome was positive. Because the threshold was identified at the lower limit in Approach two, there were no cases in which the offset benefit multiplier was below its threshold.

The thresholds were all on the range limits for the impact contingency risks (ecological and uncertainty) and the compensation confidence. For these three non-fixed parameters, there were no simulation cases in either Approach in which the thresholds were tipped.

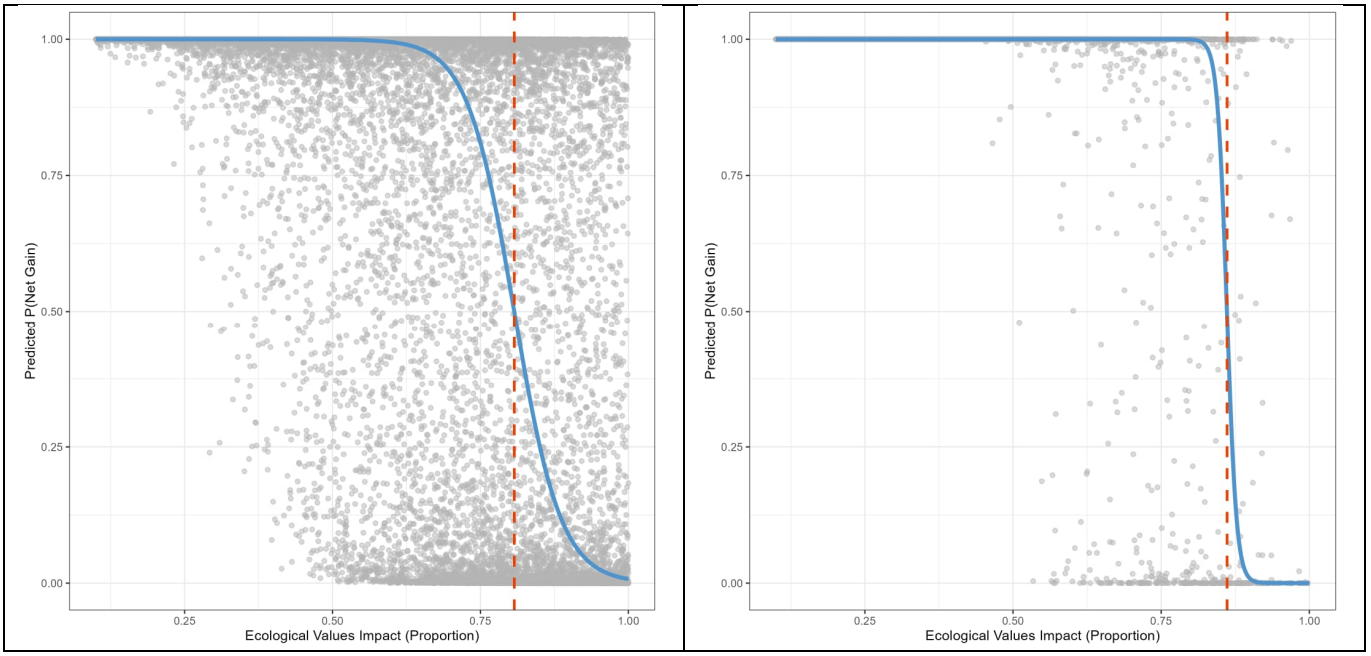

Figure 5. Threshold analyses for Approach one (left) and Approach two (right) for the BCM model. Blue line indicates the relationship between the proportional impact on ecological values and the predicted probability of a net gain outcome. The red dashed line indicates the threshold point at which the parameter tips the probability from a net gain to a net loss and vice versa.

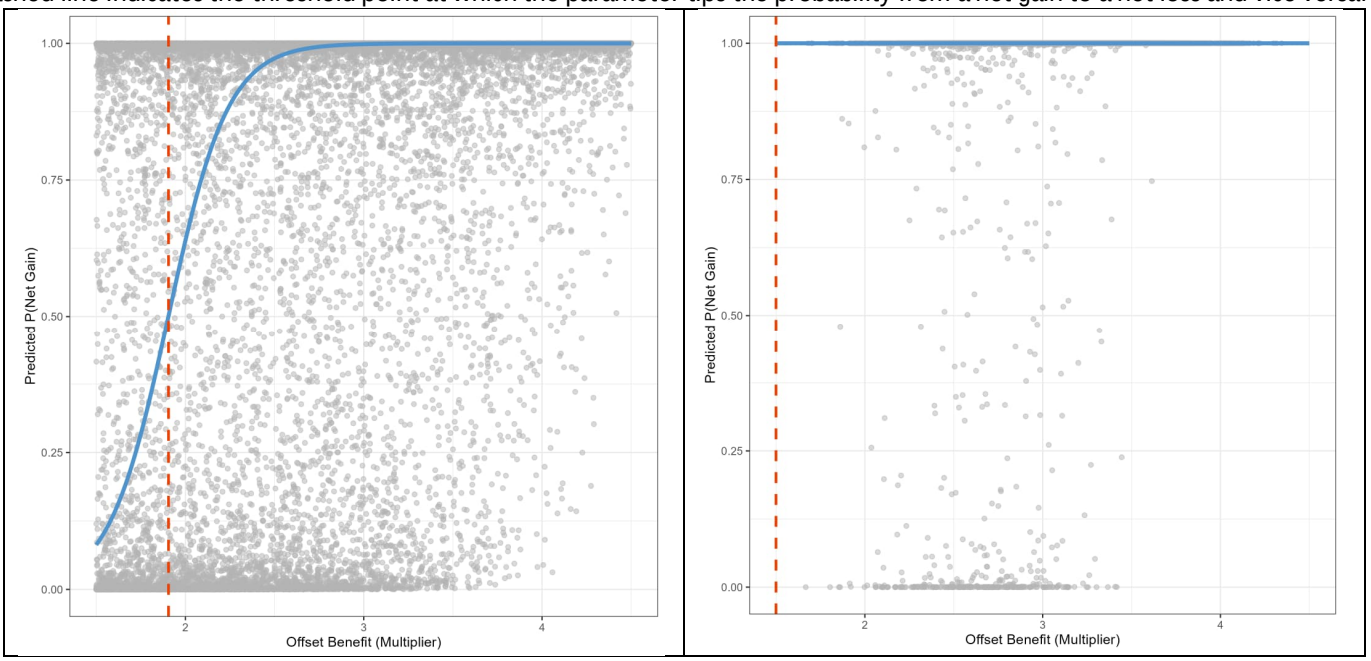

Figure 6. Threshold analyses for Approach one (left) and Approach two (right) for the BCM model. Blue line indicates the relationship between the offset benefit multiplier and the predicted probability of a net gain outcome. The red dashed line indicates the threshold point at which the parameter tips the probability from a net gain to a net loss and vice versa.

4 Conclusions

This study provides a comprehensive understanding of net value outcomes for vibration impacts on native frog populations. The study evaluated the BOAM and BCM behaviour using 20,000 randomised simulations. Moreover, two further approaches were incorporated within each model, in which the non-fixed parameters were sampled from both uninformed uniform distributions (Approach one) and informed truncated normal distributions (Approach two).

The distributions of net value outcomes were generally positive in all scenarios. Both BOAM and BCM models for both Approach one and two had positive net value outcomes even in the pessimistic scenarios (measuring the mean of all values below the mean). The lower percentage of simulated net losses for Approach two suggests that the negative outcomes in Approach one were overestimated because of unrealistic parameter setting (i.e. the scenarios modelled were not plausible in a real world setting).

The threshold analyses identified two non-fixed parameters as influential: the proportion of ecological impact (percentage of the frog population that may die due to vibration effects) and the offset benefit multiplier (the degree to which the frog population may increase with pest animal control). These factors are also shared between the BOAM and BCM models. In the BOAM model, the threshold for value impact was identified as 0.99, meaning that the probability switch from net gain to net loss occurs when more than 99 % of the frog population at the impact site are lost. The BCM estimated a lower threshold at 0.81 (Approach one) and 0.86 (Approach two), meaning the probability switch from net gain to net loss occurs when more than 81 % or 86 % of the frog population at the impact site are lost. However, the probability of these events is very low. In Approach one of the BCM model, for example, only 13.6 % of cases were both above the 81 % threshold and resulted in net losses.

For the offset benefit multiplier, Approach one of the BOAM model estimated that 5.52 % of cases were both below the offset benefit multiplier threshold and resulted in net losses; Approach two of the BOAM model estimated none. Similarly, the BCM Approach one estimated that 13.61 % of cases were both below the offset benefit multiplier threshold and resulted in net losses.

The compensation and offset model analyses here indicate that although the chances are not zero, there is a very low chance that there will be a net loss outcome that results from the proposed mine programme, and from the proposed frog population enhancement pest animal control programme.

The values indicated in the threshold analyses for parameters tipping the probability into net loss outcomes were always very different from the expectations provided by the OGNZL expert advisory group. The worst threshold impact proportion was 98 % for the BOAM model and 81 % for the BCM model. Both of these are far above the expectation from the advisory group which conservatively estimates 25 %, but they acknowledge this also may be overestimated.

Similarly, the worst case threshold for offset or compensation benefit require at least a 1.77 (BOAM Approach one) or a 1.91 (BCM Approach one) multiplier value at the minimum to reach a positive outcome. Yet prior research and expert judgement expect that the offset or compensation package will generate at least 3 times value for frog abundance under the proposed pest animal control programme, meaning that again, the chances of a net-loss outcome are very small, and that pest control programme favours by a large margin a net-benefit and net-gain outcomes for frogs at the site.

This sensitivity analysis reinforces the robustness of the BOAM and BCM calculations presented in RMA Ecology 2025.

There is very high confidence in the outcomes of the models, and the sensitivity analyses demonstrate that to produce net loss outcomes requires that implausible assumptions about both impacts on frogs from mine development and failure of predator control to increase frog numbers need to be made.

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Maseyk F, Maron M, Seaton R & Dutson G 2015. A biodiversity offsets accounting model for New Zealand: User Manual. Report prepared for Department of Conservation, Hamilton, New Zealand.

RMA Ecology Ltd. 2025. OGNLZ Wharekirauponga mine: potential adverse effects on native frogs. Report prepared for OceanaGold (NZ) Ltd. 30 pages plus Appendices.

Appendix A: Input Parameter Histograms – BOAM

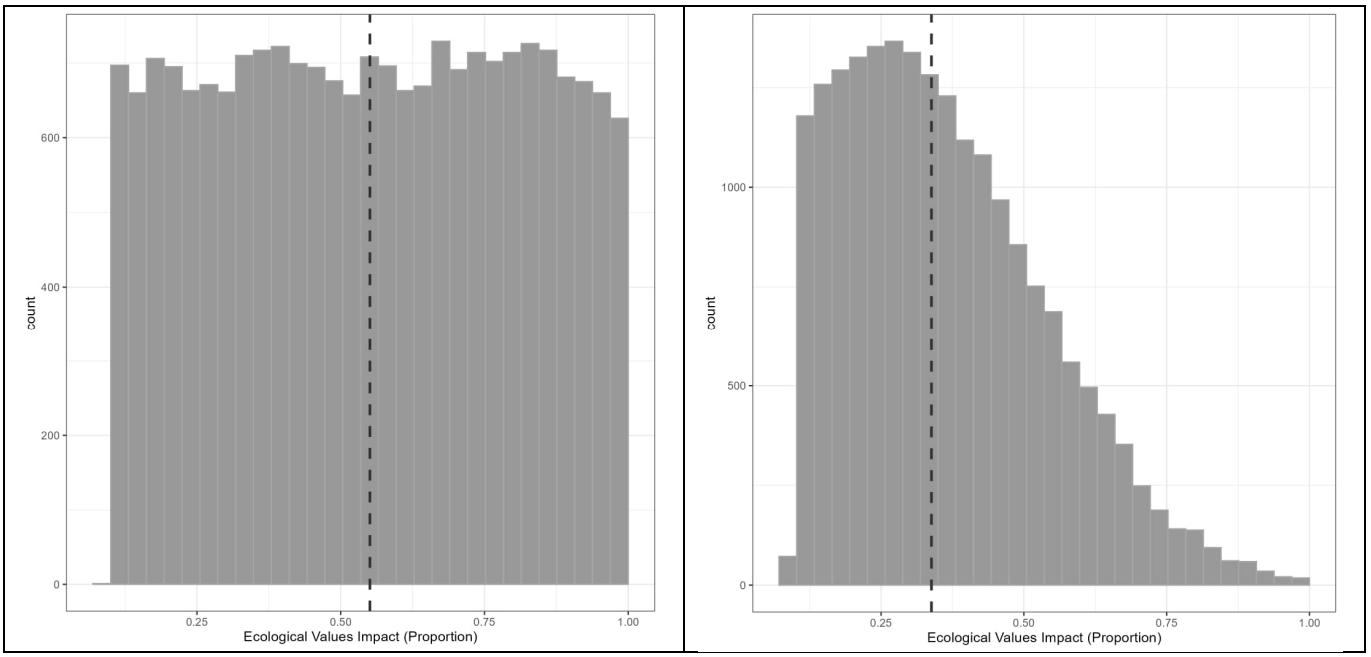

Figure A1. Distributions for the proportional impact for the BOAM model for Approach one (left) and Approach two (right). Simulation cases were sampled from a uniform distribution (left) or a manually set truncated normal distribution (right). Dashed vertical line indicates the median.

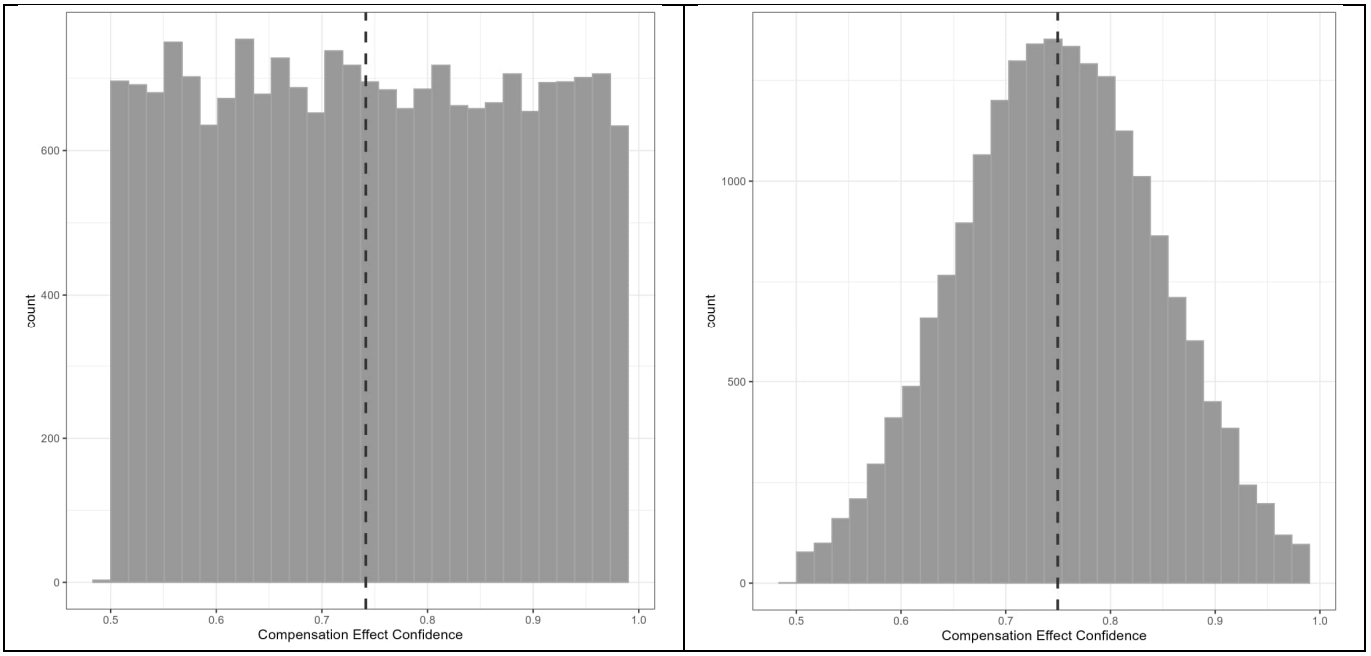

Figure A2. Distributions for the offset effect confidence for the BOAM model for Approach one (left) and Approach two (right). Simulation cases were sampled from a uniform distribution (left) or a manually set truncated normal distribution (right). Dashed vertical line indicates the median.

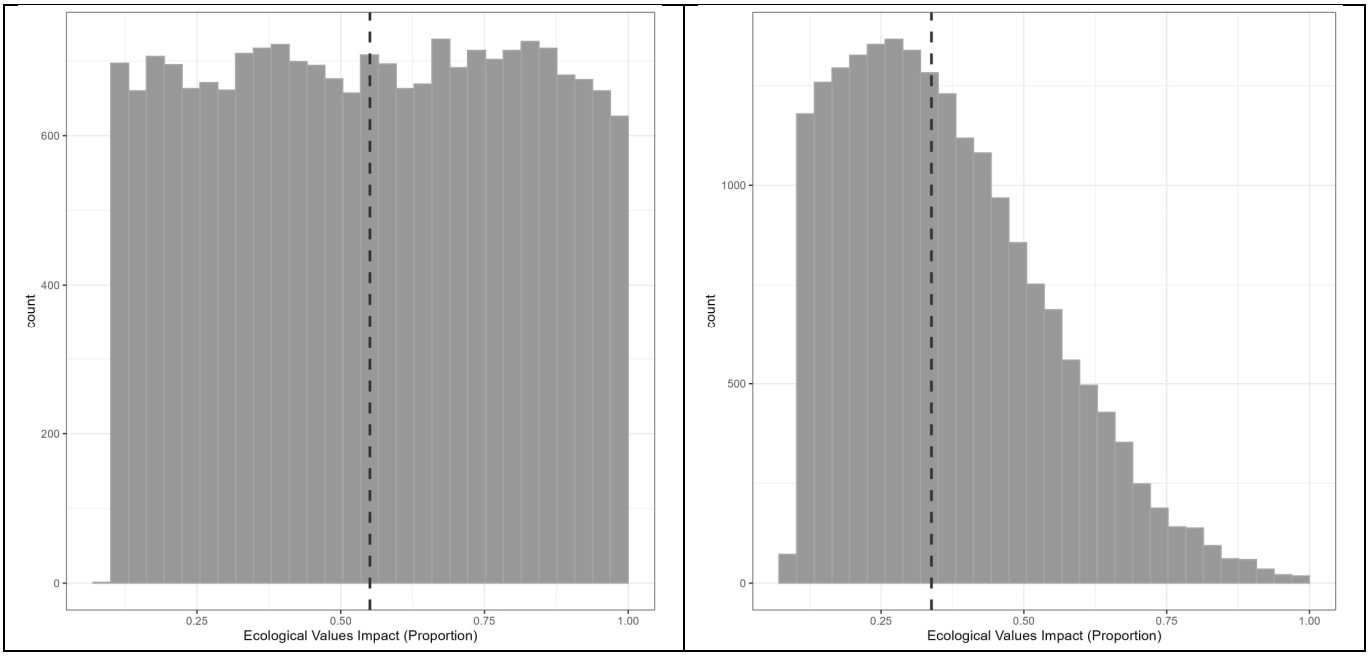

Figure A3. Distributions for the offset benefit multiplier for the BOAM model for Approach one (left) and Approach two (right). Simulation cases were sampled from a uniform distribution (left) or a manually set truncated normal distribution (right). Dashed vertical line indicates the median.

Appendix B: Input Parameter Histograms – BCM

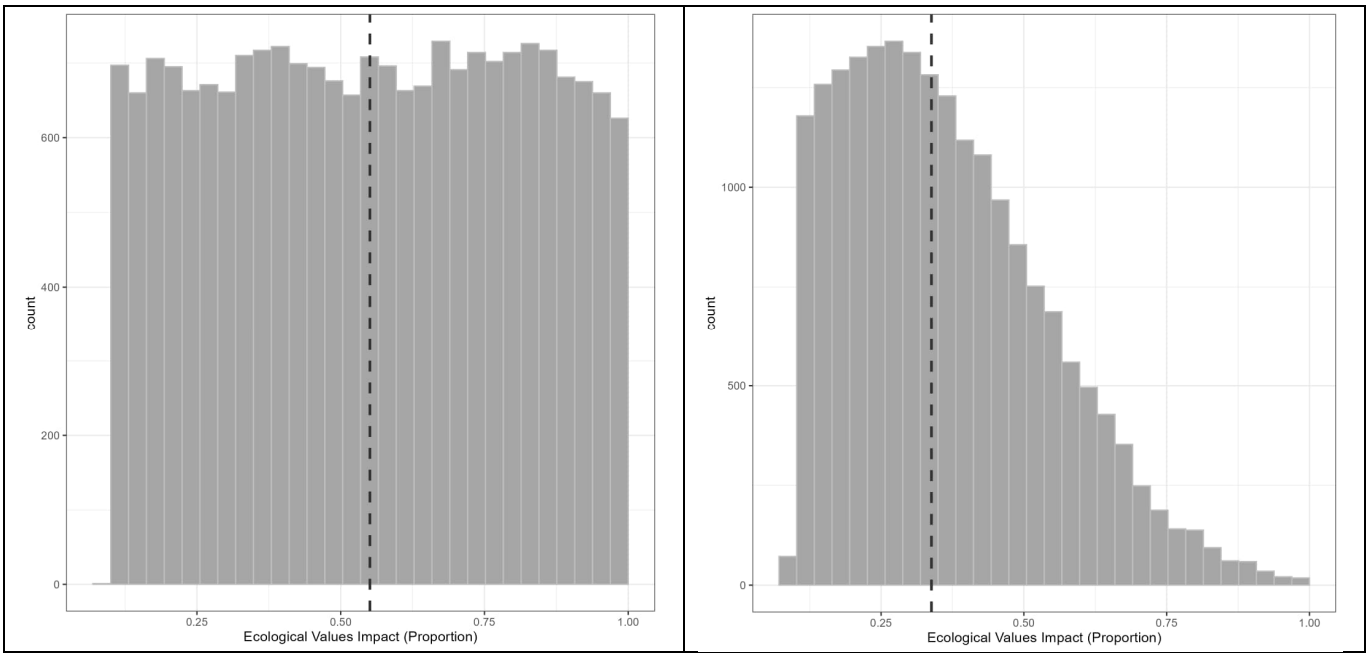

Figure B1. Distributions for the proportional impact for the BCM model for Approach one (left) and Approach two (right). Simulation cases were sampled from a uniform distribution (left) or a manually set truncated normal distribution (right). Dashed vertical line indicates the median.

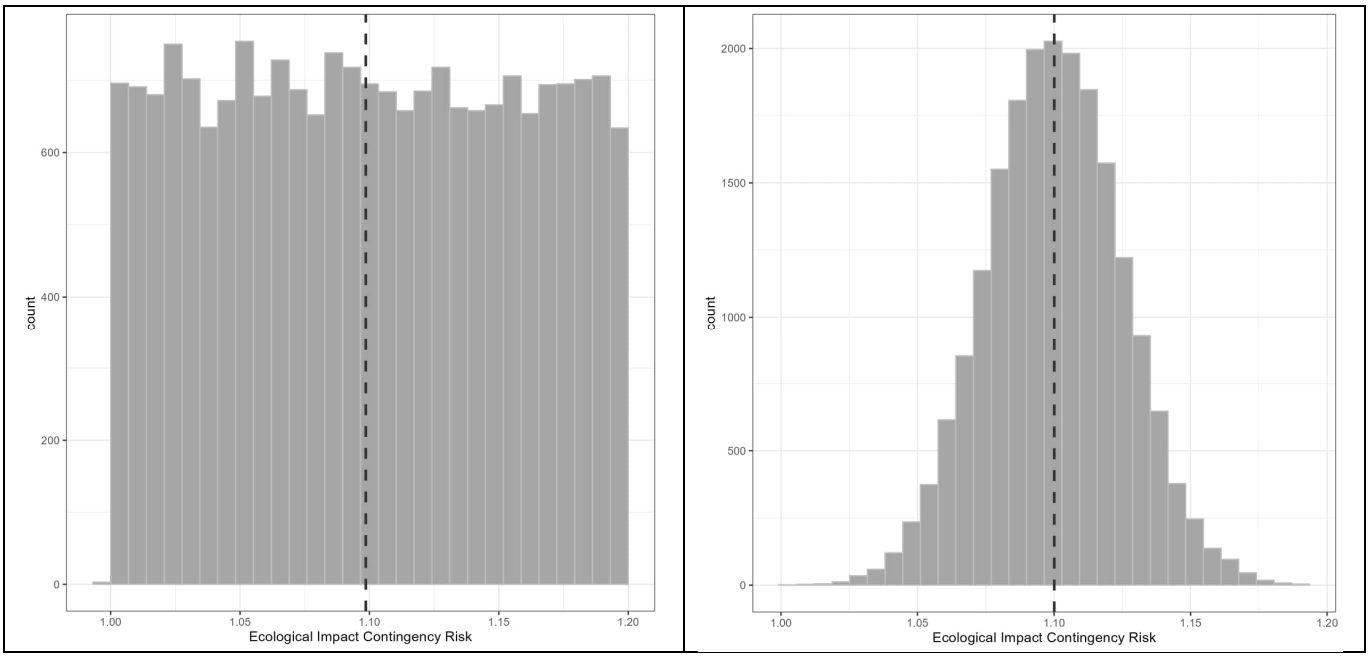

Figure B2. Distributions for the ecological impact contingency risk for the BCM model for Approach one (left) and Approach two (right). Simulation cases were sampled from a uniform distribution (left) or a manually set truncated normal distribution (right). Dashed vertical line indicates the median.

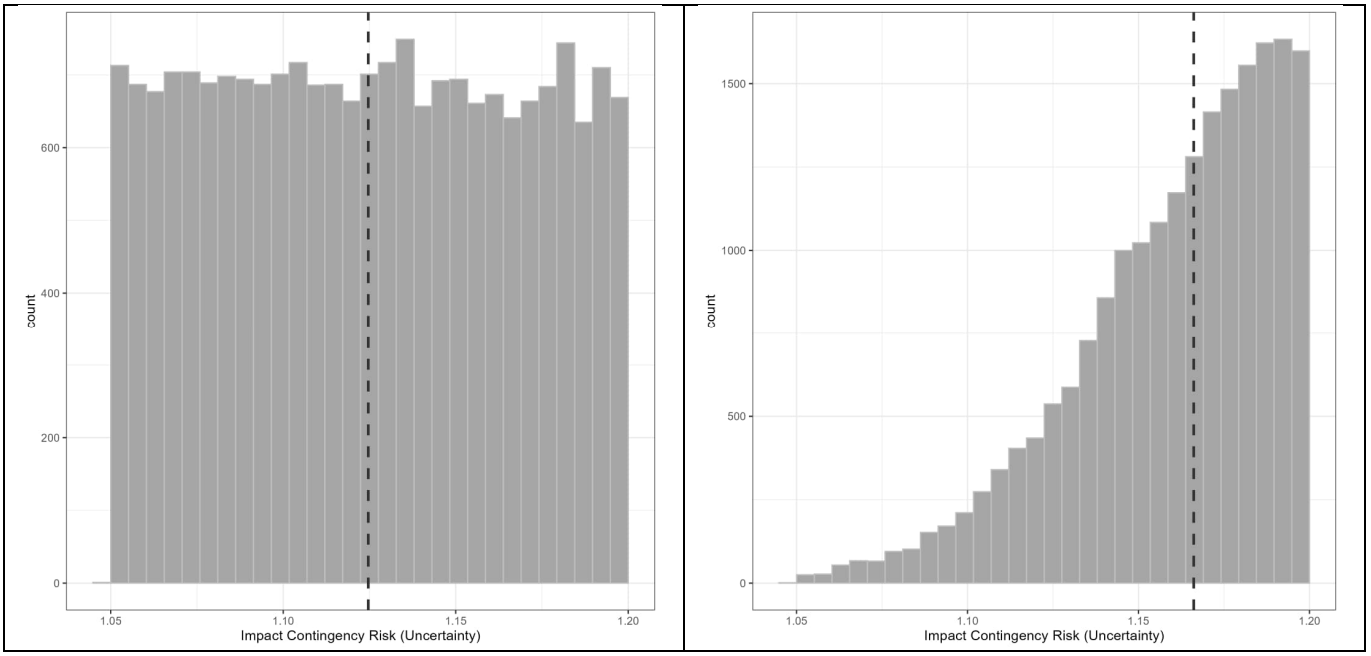

Figure B3. Distributions for the impact contingency uncertainty risk for the BCM model for Approach one (left) and Approach two (right). Simulation cases were sampled from a uniform distribution (left) or a manually set truncated normal distribution (right). Dashed vertical line indicates the median.

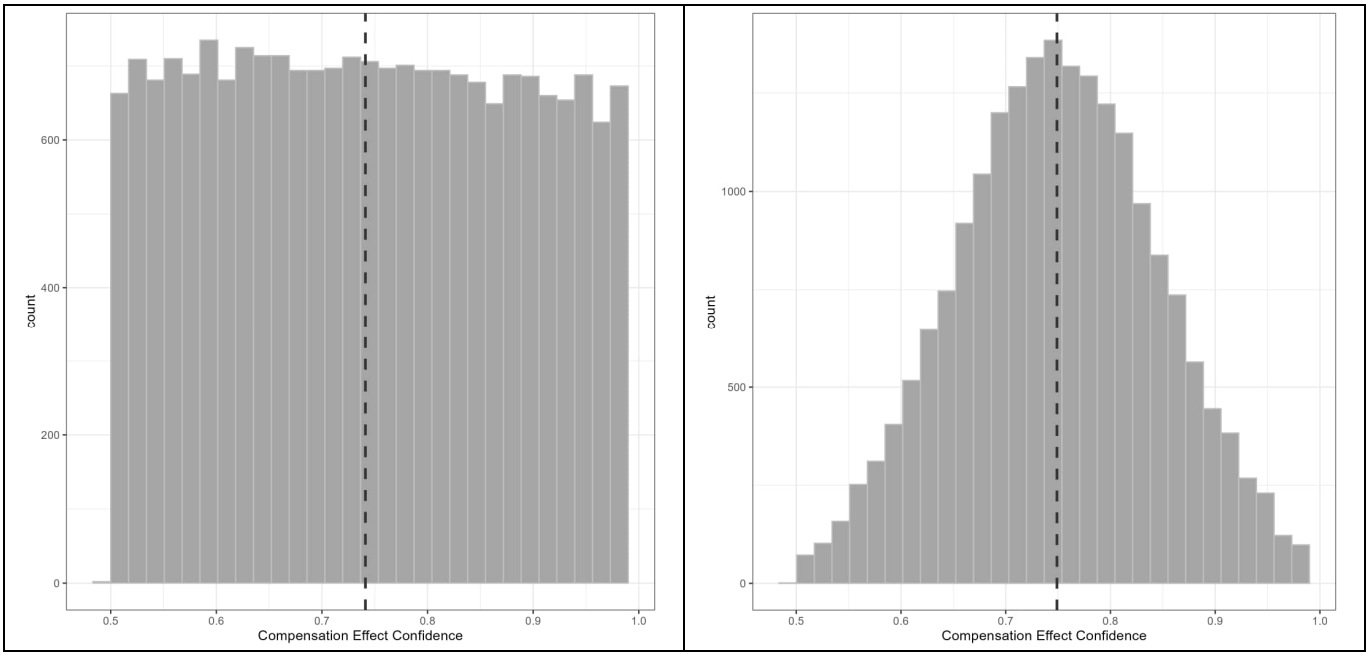

Figure B4. Distributions for the compensation effect confidence for the BCM model for Approach one (left) and Approach two (right). Simulation cases were sampled from a uniform distribution (left) or a manually set truncated normal distribution (right). Dashed vertical line indicates the median.

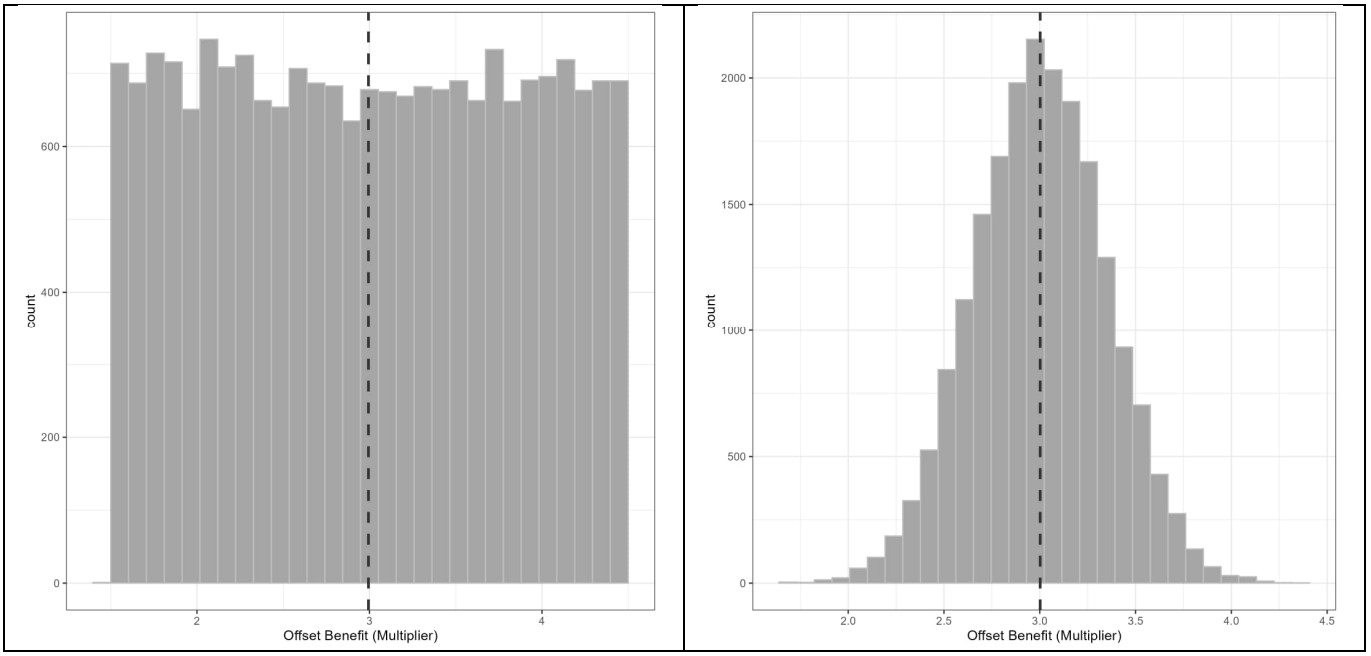

Figure B5. Distributions for the compensation benefit multiplier for the BCM model for Approach one (left) and Approach two (right). Simulation cases were sampled from a uniform distribution (left) or a manually set truncated normal distribution (right). Dashed vertical line indicates the median.

Appendix C: BOAM Net Value Outcome vs Parameter Associations

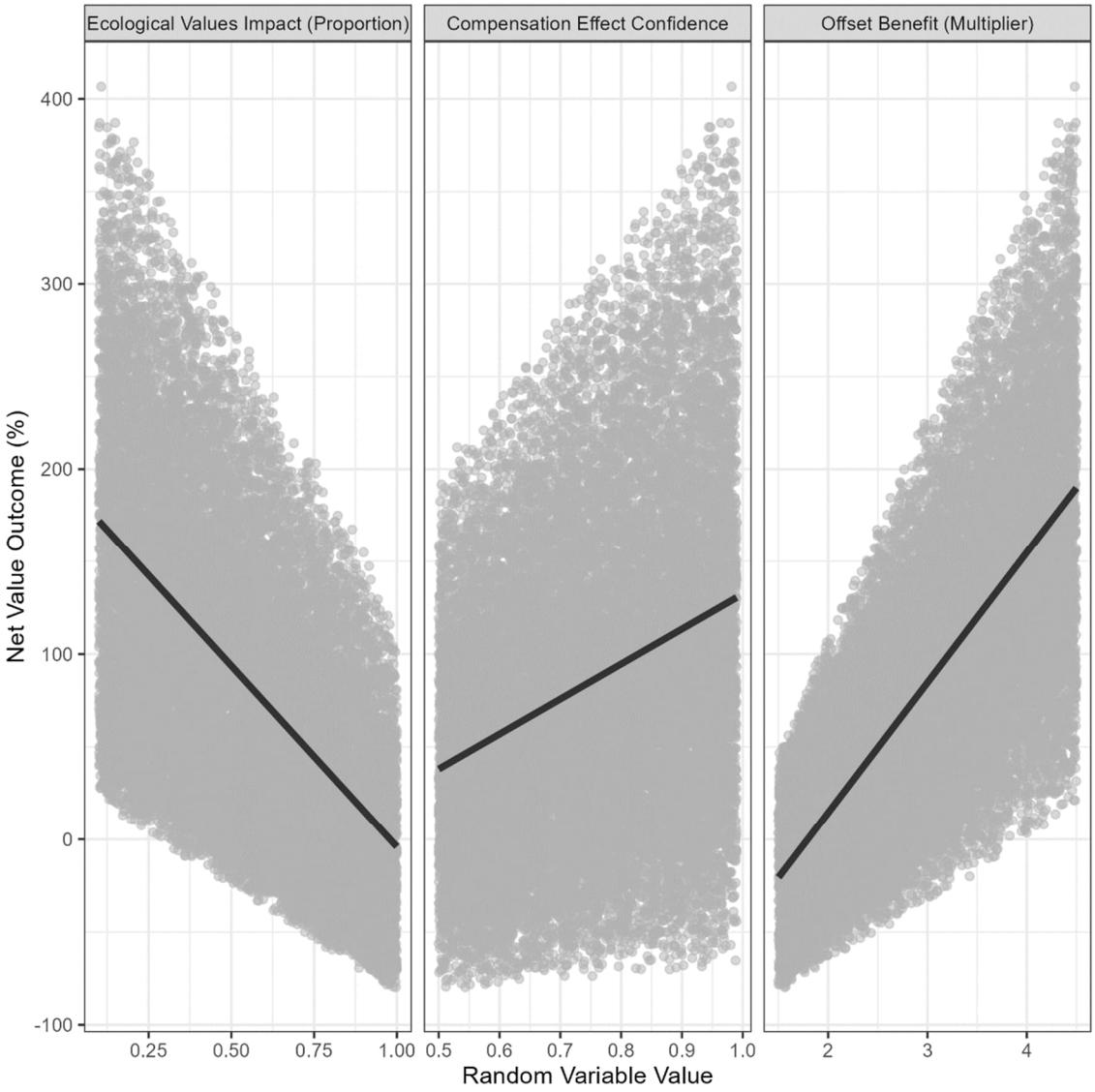

Figure C1. Association between the non-fixed parameters and the net value outcome for the BOAM model using Approach one (uniform distribution sampling). Black lines show trends. Each point is a simulation result.

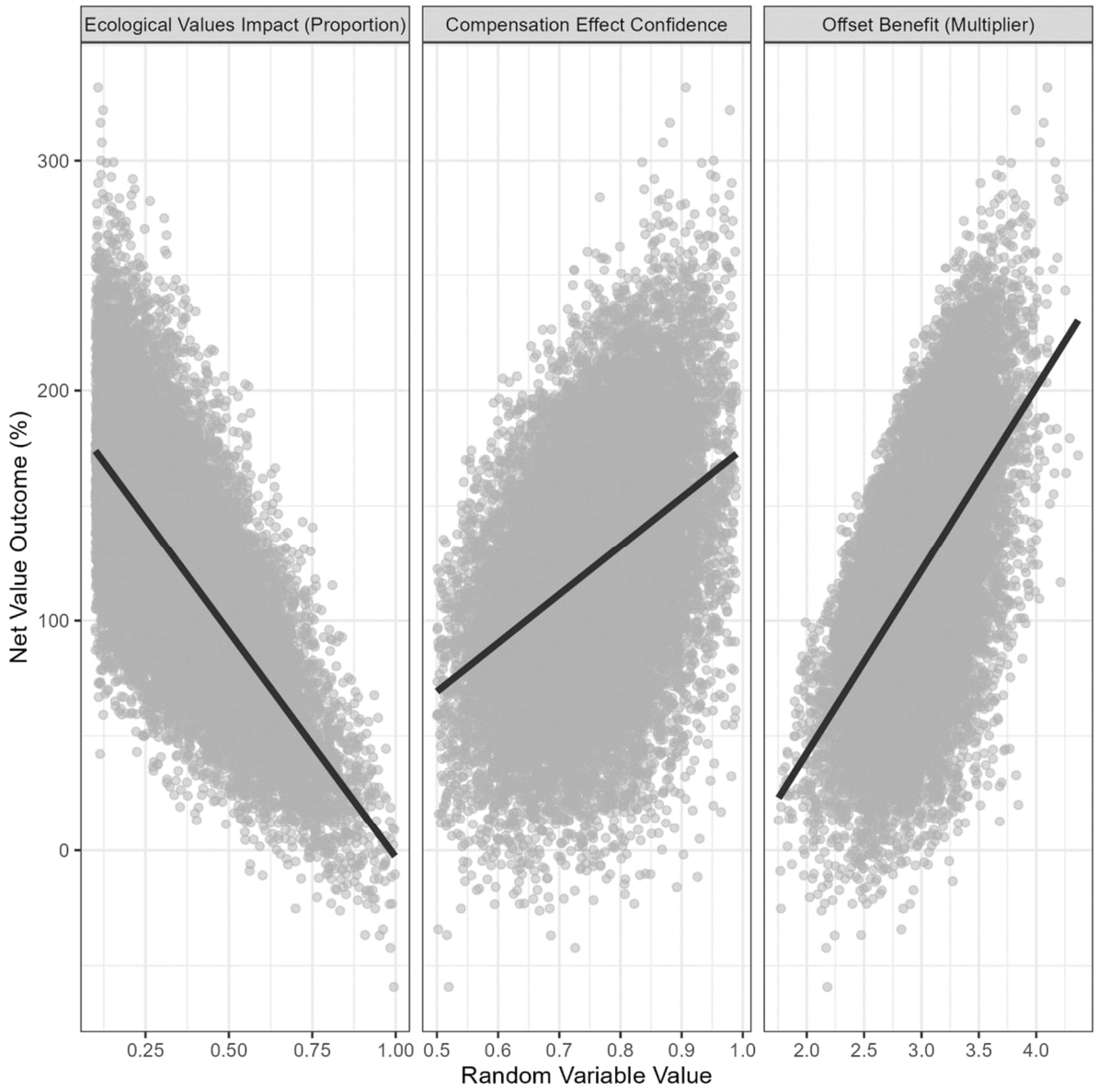

Figure C2. Association between the non-fixed parameters and the net value outcome for the BOAM model using Approach two (truncated mean distribution sampling). Black lines show trends. Each point is a simulation result.

Appendix D: BCM Net Value Outcome vs Parameter Associations

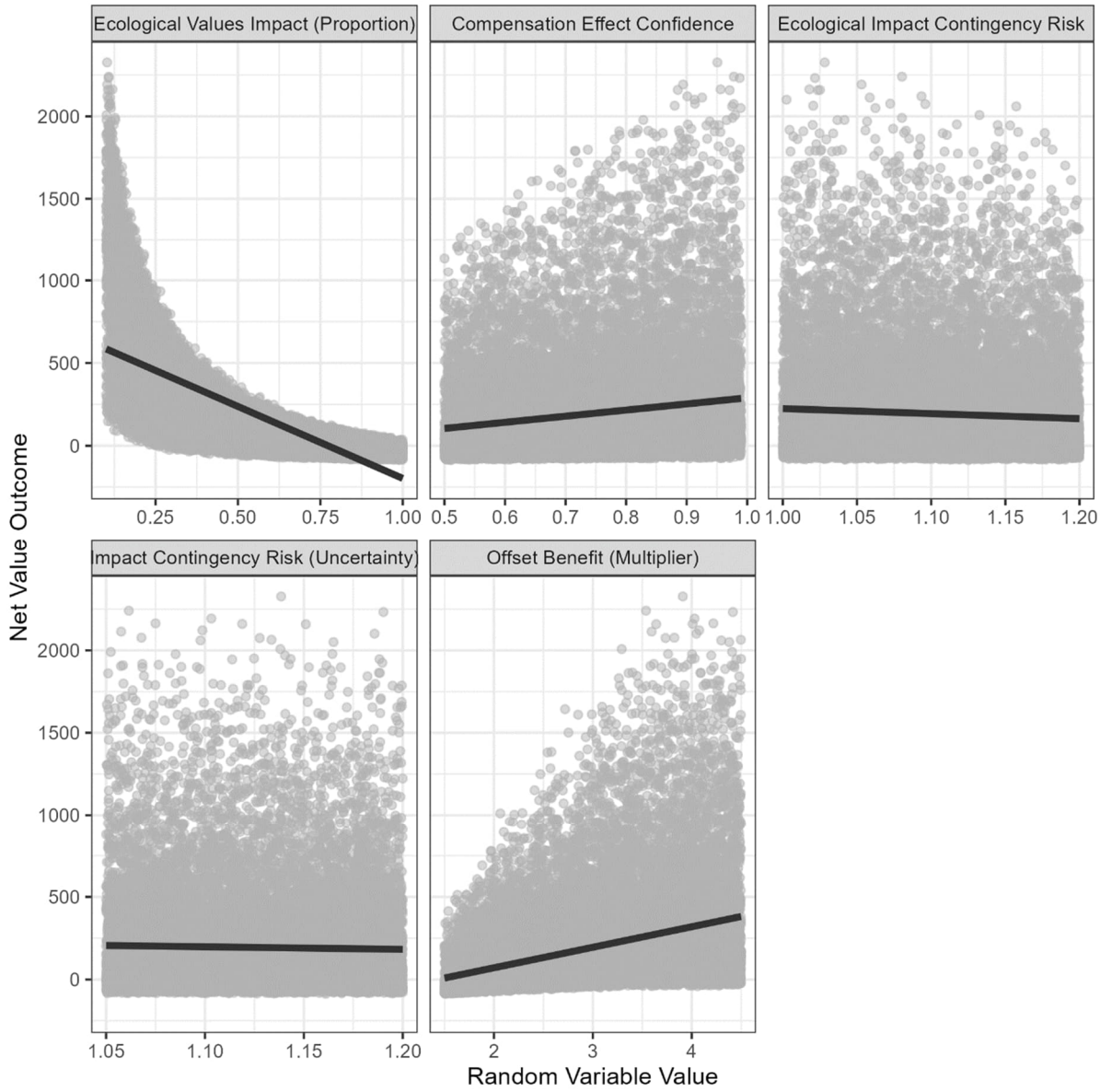

Figure D1. Association between the non-fixed parameters and the net value outcome for the BCM model using Approach one (uniform distribution sampling). Black lines show trends. Each point is a simulation result.

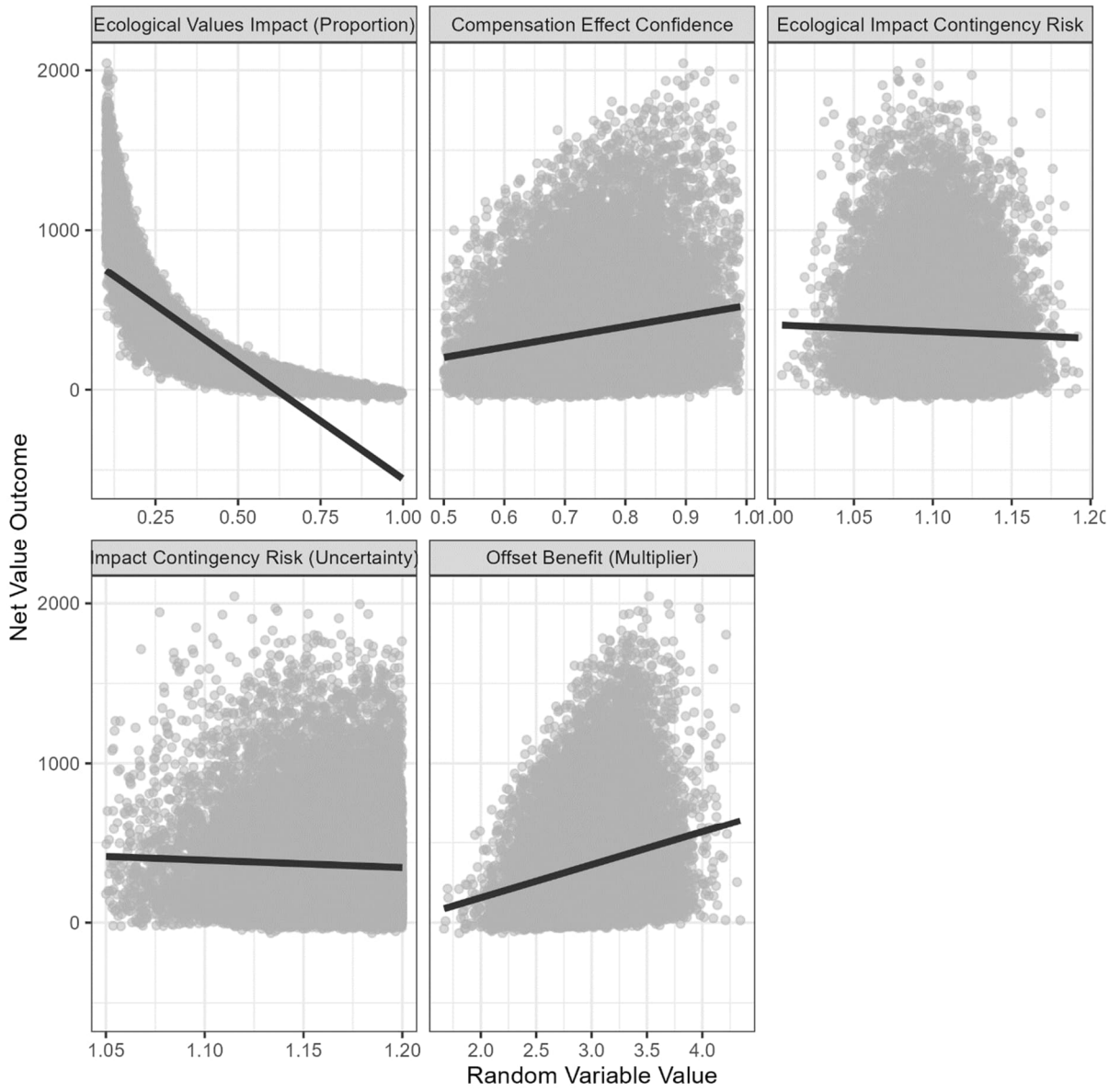

Figure D2. Association between the non-fixed parameters and the net value outcome for the BCM model using Approach two (truncated mean distribution sampling). Black lines show trends. Each point is a simulation result.