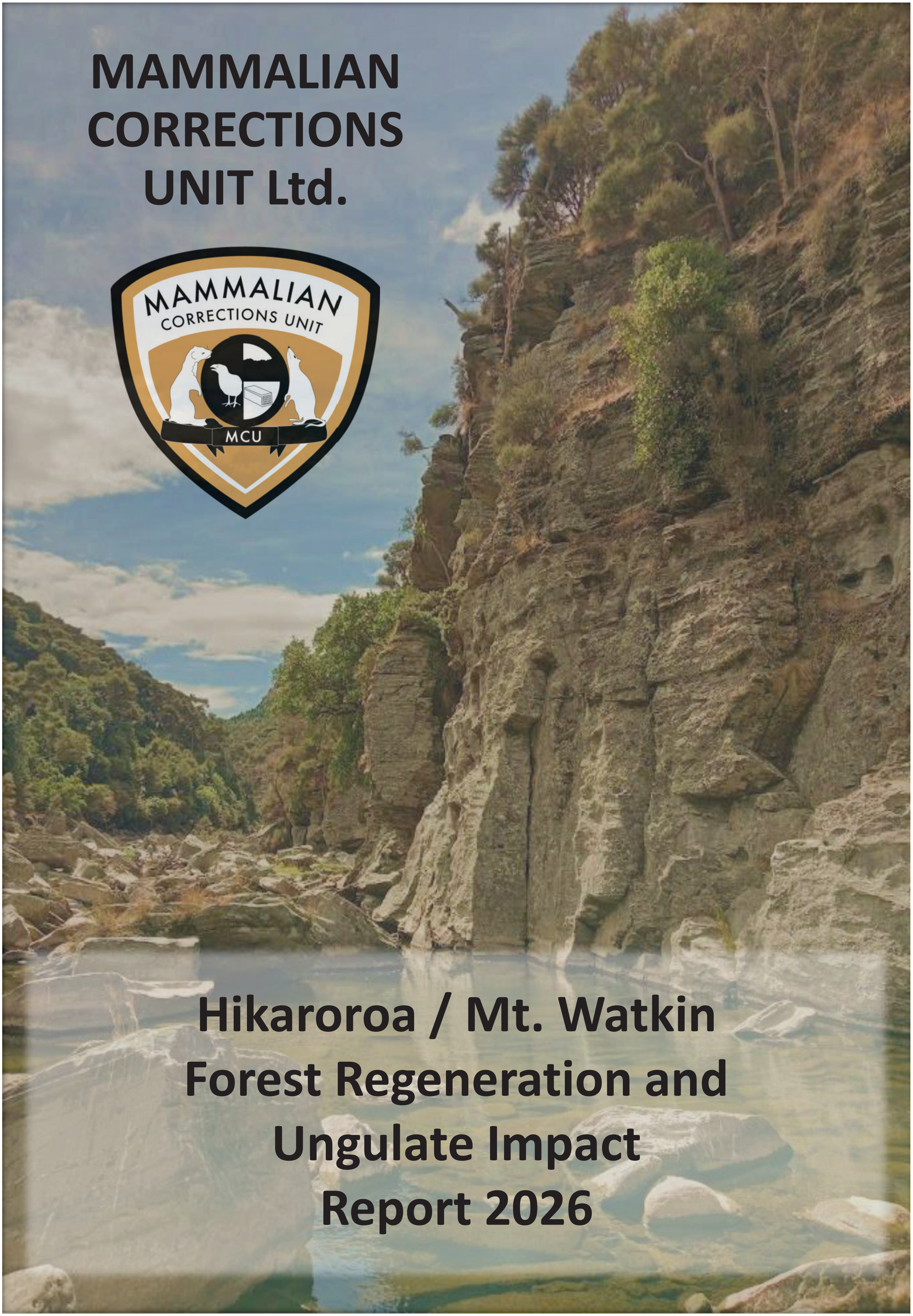
MAMMALIAN CORRECTIONS UNIT Ltd.



Hikaroroa / Mt. Watkin Forest Regeneration and Ungulate Impact Report 2026

Produced on behalf of the Dunedin City Council

&

The Hikaroroa / Mt. Watkin Conservation Group

By

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A Note on Reporting Scope and Management Structure

The Hikaroroa landscape comprises both the 660 ha Dunedin City Council (DCC) Hikaroroa / Mt. Watkin Scenic Reserve and a network of surrounding privately owned properties managed collaboratively through the Hikaroroa / Mt. Watkin Conservation Group (HMWCG). Although these are separate management entities with different funding arrangements and operational responsibilities, together they form an interconnected ecological landscape. Native species, introduced pests, and ecological processes move freely across property boundaries, making landscape-scale management practical and essential for both parties.

Mammalian Corrections Unit Ltd. (MCU) provides contracted pest management, monitoring, and reporting services for both organisations. Monitoring and reporting undertaken within the DCC Scenic Reserve is funded through DCC's operational pest management programme, while monitoring and reporting on HMWCG-managed private land is funded through the Department of Conservation Community Fund Project Coordinator role. All culling operations by other contractors mentioned in this report have been funded by the DCC .

Although these monitoring programmes are funded separately, they have been presented together in this report in good faith to provide a more holistic understanding of ecological conditions across the wider Hikaroroa landscape that give useful insight to both management parties.

Results from DCC and HMWCG monitoring are presented separately to acknowledge differences in management history, survey timing, and land tenure. However, synthesising these datasets provides valuable context for adaptive management and supports coordinated decision-making between project partners working towards the shared goal of protecting and restoring the ecological values of Hikaroroa / Mt. Watkin.

Executive Summary

The Hikaroroa / Mt. Watkin Scenic Reserve and surrounding HMWCG-managed forest remnants represent one of the largest and most ecologically significant remaining examples of dry coastal podocarp–broadleaf forest in eastern Otago. These nationally uncommon forests support a diverse range of indigenous plant communities and threatened biodiversity but are threatened from browsing by introduced deer and goats and ground disturbance by feral pigs. Understanding the extent to which these ungulates are limiting forest regeneration is critical for guiding long-term ecological protection of these forests.

Following establishment of ten regeneration monitoring transects (SRI) transects within the Dunedin City Council (DCC) Scenic Reserve in 2023, this report presents the first repeat SRI survey undertaken in 2025 together with the expansion of monitoring onto surrounding HMWCG-managed private forest remnants in 2026. In addition, a standardised camera monitoring programme was implemented across the wider Hikaroroa landscape to provide the first quantitative measure of relative ungulate abundance using the Department of Conservation's ungulate camera monitoring protocol. Together, these monitoring programmes provide complementary measures of forest regeneration, browsing pressure, ungulate abundance, and control effectiveness.

Results indicate that browsing ungulates continue to suppress regeneration of the reserve's most palatable forest species. Preferred species maintained negative SRI values across both the reserve (-0.20 : 2025) and surrounding private forest (-0.23 : 2026), indicating poor recruitment despite several years of ongoing ungulate control. Browse pressure remained highest on preferred species, consistent with selective feeding by introduced ungulates. While browse, pellet occurrence and pig rooting were generally lower on surrounding private land than within the reserve, regeneration potential of preferred species remained similarly poor, suggesting that densities of ungulates have not been suppressed to levels that result in measurable regeneration increases.

The camera monitoring programme demonstrated that all three ungulate species remain widespread throughout the Hikaroroa landscape. Relative abundance was consistently higher within the DCC Scenic Reserve than on adjacent private land, with mean CH1000 indices of 8 for deer, 7 for goats and 17 for pigs within the reserve compared with 5 for deer, 5 for goats and 8 for pigs on HMWCG-managed land. Distinct spatial hotspots were identified for each species, particularly for pigs and goats, providing valuable information for future management.

Hunter effort data suggests that several years of increased aerial and ground-based control are beginning to reduce goat abundance within the Reserve, with declining kill rates and fewer observations reported by experienced operators. Similar trends were not evident for deer or pigs, which continue to occur at relatively high levels across much of the project area. Taken together, the monitoring results indicate that while ungulate management is beginning to influence goat populations, overall browsing pressure remains sufficient to constrain regeneration of the most palatable forest species.

Continued monitoring will enable managers to identify the ungulate densities below which positive forest regeneration occurs, allowing future control objectives to be based on measurable ecological outcomes rather than operational effort alone. Ongoing coordinated management between the DCC, HMWCG, DOC, mana whenua, neighbouring landowners, and project partners will be essential to achieving long-term restoration of one of coastal Otago's most significant remaining native forest ecosystems.

Operation Overview: General Information

Purpose & Rationale

The remnant forest around Hikaroroa / Mt. Watkin is one of the most ecologically significant forest remnants in coastal Otago. The forest contains some of the best remaining examples of the native forest ecosystems that once dominated the coastal hills of eastern Otago prior to European settlement. These forest types are now nationally uncommon and are severely underrepresented within New Zealand's protected area network.

The Hikaroroa area is notable for containing one of only two remaining large unlogged stands of podocarp-broadleaf forest in coastal Otago, extensive areas of kowhai-lacebark-ribbonwood forest, and indigenous connectivity linking indigenous grasslands, kānuka forest, basalt boulder-fields (listed by DOC as a naturally uncommon rare and at risk ecosystem type), and dry coastal forest communities all the way from the river valley to the mountain summit. Twenty-eight vegetation types and more than 180 native plant species have been recorded within the reserve, including numerous threatened, uncommon, and regionally significant species.

Browsing pressure and ground disturbance, particularly from feral goats, pigs, and deer, are likely to represent one of most, if not the most, significant threat to the long-term ecological integrity of the forest. Browsing ungulates alter the structure and composition of the forest by selectively feeding on palatable seedlings, saplings, and understory vegetation. Over time this can prevent forest regeneration, simplify forest structure, shift species composition toward browse-resistant plants, in some instances cause canopy collapse, and ultimately compromise the ability of the ecosystem and these threatened habitats to sustain their unique biodiversity values.

Understanding the extent to which ungulates are impacting forest regeneration is therefore a critical component of long-term ecological management at Hikaroroa. This monitoring programme seeks to quantify browsing pressure and regeneration potential, allowing future changes in forest condition to be measured and ultimately informing the level of ungulate control required to protect and restore the area's outstanding ecological values.

Background & Scope of Operations

Seedling Ratio Index (SRI) monitoring is used to quantify the impact of feral ungulates on the ability of the native forest to regenerate itself within the Hikaroroa / Mt. Watkin Conservation Project Area. This data will help to determine the degree of browsing ungulate impacts on Hikaroroas forest ecology to date and when re measured, will show trends in these impacts over time. This data will also contribute to outcome reporting for pest control efforts undertaken and inform the level of ungulate control required to see positive recruitment of the measured forest species.

Ten seedling ratio index (SRI) transects were established in April 2023 inside the DCC reserve in order to help quantify the impact of wild ungulates. After this initial 2023 survey showed suppression of forest regeneration capacity, guidance from the DOC WAM (Wild Animal Management) team informed the strategic framework of the DCC's Hikaroroa / Mt. Watkin Scenic Reserve Vertebrate Pest Management Strategy. The Strategy recommends that SRI monitoring be repeated on a two year basis as ungulate control is increased until a positive regeneration score for palatable species is achieved. That control effort would then become the recommended ongoing control pressure and SRI monitoring would be switched to a 5-year basis.

Following this protocol, SRI was repeated in the DCC Reserve in 2025, and was expanded onto the surrounding forest remnants (**Map 1**) on private land in 2026 via the Hikaroroa / Mt. Watkin Conservation Group (HMWCG), a conservation group made of the surrounding landowners of the reserve who are working collaboratively across council, manawhenua, DOC and other project partners to help manage and protect the values of the Hikaroroa area at a coordinated landscape scale. The private land SRI transects will provide valuable knowledge of forest recruitment in fragmented forest areas and how regeneration compares between the reserve and the surrounding area.

In addition to vegetation monitoring, the 2025-2026 FY monitoring programme utilized the already established landscape-scale camera monitoring network to provide the first standardised measure of relative ungulate abundance across the Hikaroroa project area following the recently published DOC ungulate camera monitoring protocol (**Table 1)**. While the Seedling Ratio Index (SRI) and browse assessments quantify the ecological impacts of ungulates, they may respond slowly to changes in population density in a dry forest system. A complementary measure of ungulate abundance was therefore considered important to evaluate the effectiveness of ongoing control efforts and to better understand the relationship between ungulate abundance and forest regeneration.

Historically, trends in ungulate abundance at Hikaroroa have been inferred primarily from hunter effort metrics (animals observed or killed per hunter day or UPHD). This data has proved valuable and remains an important operational measure of control effectiveness. However, hunter-derived indices are influenced by a range of factors in addition to animal abundance, including differences in detectability between species, weather conditions, vegetation density, hunter experience, familiarity with the landscape, and the relatively small number of hunting days undertaken each year.

For example, goats may appear more abundant than deer simply because they are generally less cryptic and occur in more conspicuous groups, resulting in higher detection and kill rates for an equivalent population density. Similarly, annual hunting effort often comprises only a small number of field days, meaning short-term environmental conditions or natural variation in animal movements can have a disproportionate influence on results. An anecdotal example from the 2025–26 financial year illustrates this limitation. Both HCC and CWAC reported relatively low goat kill numbers during scheduled control operations, yet only a week later a mob of approximately 25 goats was observed on the mountain flanks of Hikaroroa—a group size that had not been seen in many years (J. Taurima, pers. comm.). Likewise, hunter efficiency typically improves over time as operators become increasingly familiar with access routes, terrain, and locations where animals are consistently encountered. Although this represents a genuine improvement in operational efficiency, it can complicate interpretation of long-term hunter effort indices as a measure of population change.

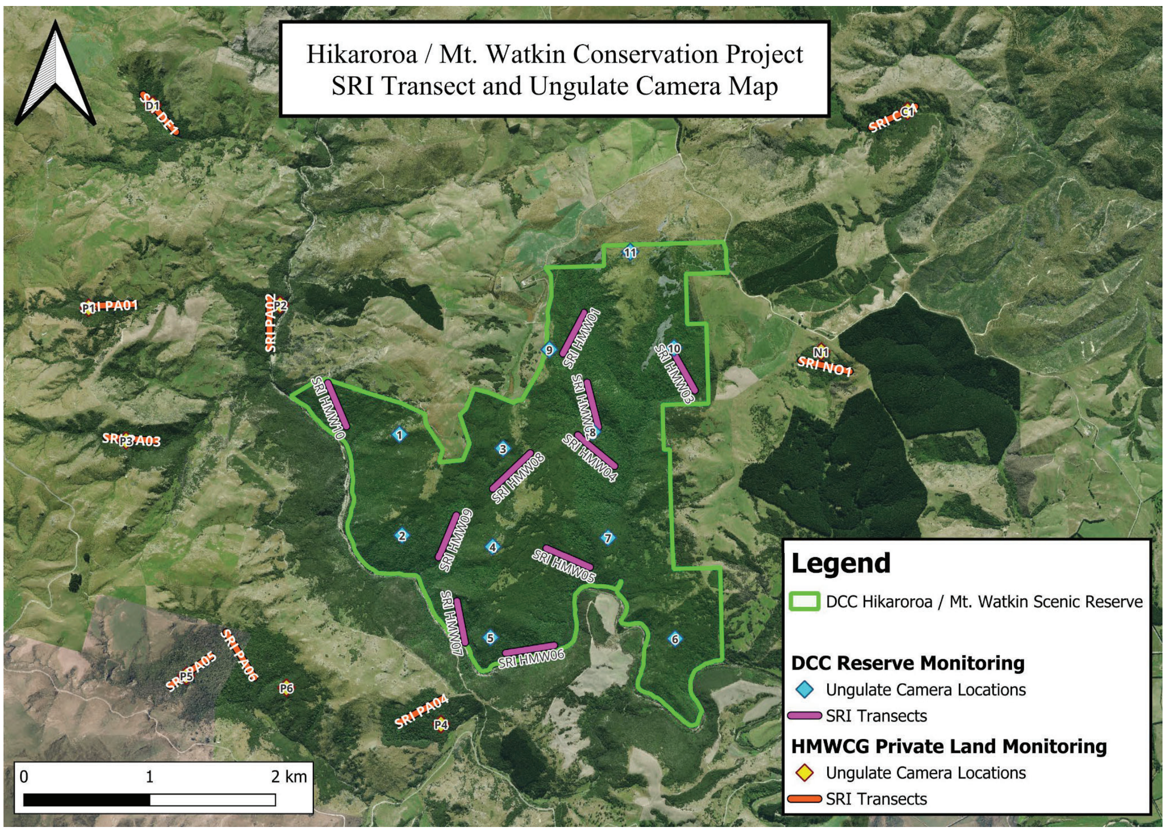
Ungulate control undertaken across the surrounding private land presents additional challenges for monitoring. Control is largely opportunistic, being carried out by landowners and local recreational hunters rather than through a standardised programme. Consequently, hunting effort, reporting frequency, and data quality vary considerably between properties, making direct comparisons through time difficult.

To reduce these sources of variation, a standardised camera monitoring programme across the wider project area was trialled. Motion-activated trail cameras were deployed for approximately three months, allowing ungulates to be monitored continuously without human presence or disturbance. By sampling over an extended period, the monitoring is expected to reduce the influence of short-term weather events and daily variation in animal movements while providing a repeatable index of relative abundance.

It is anticipated that this camera-based index will become a quantitative measure of ungulate abundance within the project. Over successive monitoring cycles it will be analysed alongside Seedling Ratio Index (SRI), browse, pellet, and pig rooting data to establish ecological management thresholds. Ultimately, this will enable control objectives to be expressed in biologically meaningful terms—for example, identifying the level of deer, goat, and pig detections per 1,000 camera hours below which positive forest regeneration is consistently observed. Such thresholds would provide a robust, outcome-based framework for evaluating the effectiveness of future ungulate management at Hikaroroa.

Table 1 Provides links to methodologies and general information on survey effort.

Methodology	Monitoring	DCC program	HMWCG program	Current Frequency
SRI Methodology (Sweetapple&Nugent 2004) WAM SRI Field Protocol (DOC 2025-2026)	Forest Regeneration	10 transects	9 transects	Every other year (1/2yr)
DOC Ungulate Camera Index Protocol	Ungulate Relative Abundance	11 Cameras	9 Cameras	Recommended Annually
Hunter Effort Indices	Ungulate Relative Abundance / control effectiveness	Thermal shooter, indicator dogs, and aerial cull	Landowner Control, MCU opportunistic shooting	Bi-product of control operations



Map 1. SRI Transect and Ungulate Camera Map

Field Methods

Forest Regeneration Transect Monitoring

Seedling Ratio Index

Ten Seedling Ratio Index (SRI) transects (Sweetapple & Nugent 2004) were established in April 2023 at the DCC scenic reserve. Nine SRI transects were established across the HMWCG managed private land in 2026. SRI transects were semi-randomly located with restricted random bearings across the reserve. Transects on private land were selected based on ecologically significant forest remnants with restricted random bearings. Methods followed (Sweetapple & Nugent 2004), but field methodology is regularly updated to adhere with DOC WAM best practice. Each transect is 400 metres long and comprises 20 sun-plots spaced at 20 metre intervals. The transect start locations were permanently marked, individual plots were not.

On each plot, plant species with seedlings less than 30cm high (short seedlings) were counted as present within a 0.49m radius circular plot. Species with seedlings between 30 cm and 2m high (tall seedlings) were recorded as present within a 1.41m radius circular plot. All species capable of growing above 30cm tall without support were recorded for the SRI measurements in these plots.

Data analysed in this report follows the SRI field protocol developed by the Department of Conservation in 2025 (Department of Conservation 2025). Note this is slightly different from the previous analysis and report produced as most fern and climber species have been excluded from the data set analysed in this report.

Browse along SRI Transects

Recent ungulate browse was scored on all species present between 15 cm and 2m (both rooted within and hanging into the 1.41m radius plot). Browse was scored using the categories identified in Table 2.

Table 2. Browse score categories

Browse score	% of stems with recent browse observed
0	No browse observed
1	1-10%
2	11-25%
3	26-50%
4	51-75%
5	76-100%

Faecal Pellets along SRI Transects

The presence or absence of ungulate faecal pellets was recorded for each 1.41m radius plot. Where possible, the species from which the pellet/s originated was also recorded.

Ground Disturbance (rooting) by Pigs along SRI Transects

A cover score for recent soil disturbance by pigs (rooting) was recorded for each 1.41m radius plot using the categories identified in Table 3.

Table 3. Pig rooting score categories

Pig rooting score	Proportion of plot impacted
0	0%
1	1-25%
2	26-50%
3	51-75%
4	76-100%

Ungulate Camera Index Monitoring

Twenty (20) motion-activated trail cameras were repositioned across the Hikaroroa project area in November 2025 during the collection of the 21-night predator camera survey and collected in Feb.2026 alongside the terrestrial invertebrate pitfall monitor to establish a baseline index of relative ungulate abundance. Camera locations were distributed across the DCC reserve and surrounding HMWCG managed private land to provide broad landscape coverage of ecologically significant habitat. At each location, cameras were positioned within approximately 50 metres of the standard camera sites at locations most likely to intercept ungulate movements, including game trails, forest margins, natural clearings, ridgelines, and areas showing recent ungulate signs. Camera placement followed the Department of Conservation Camera Trap Catch Index (CTCI) protocol for deer and goats with minor adaptations for local conditions (as identified in **Table 4**).

Table 4. Cameras were mounted approximately 1.2m above ground level, angled slightly downward, with the following standardized settings.

Option	**Setting**
Date/time	Check correct (USA date format)
Mode	Trail
capture delay	None / minimum (1s)
Pic Size	Medium
MultiShot	5 shot rapid
Capture time	1200am-1200am
Smart IR	On
Night EXP	Long range
Temp unit	C
Info strip	on
Motion detect	Long range
Name	Station ID + “UM” (ie. MW11UM or DEC01UM)

Data analysis

Seedling Ratio Index and Browse

Species were grouped according to palatability class based on ungulate diet literature summarised in Forsyth et al. 2002. Palatability classes were based on the Forsyth et al. 2002 three-way classification of ungulate preference shown in Table 5.

Table 5. Classification of palatability classes

Palatability class	Criteria
Preferred (P)	Plant species eaten more often than expected from their availability
Not selected (NS)	Plant species eaten in proportion to their availability
Avoided (A)	Plant species proportionately less eaten than available

In some cases species were assigned to a class based on local experience due to their palatability rating not being listed anywhere in Forsyth et al. (2002) or within other published literature. See **Appendix 1** for species palatability classifications.

Avoided species are species with low palatability to ungulates, with some examples from Hikaroroa being Matai (Prumnopitys taxifolia), Kanuka (Kunzea ericoides) & Horopito (Pseudowintera colorata). Preferred species are species with high palatability to ungulates, for example, Kāpuka (Griselinia littoralis), Kōtukutuku (Fuchsia excorticata) and Mahoe (Melicytus ramiflorus). Not selected species have moderate palatability to ungulates such as Kowhai (Sophora microphylla), Weeping Māpou (Myrsine divaricata) and many of the Coprosma species.

The SRI was calculated for each palatability class for each transect as follows;

SRI= $(\Sigma Tall-\Sigma short)/(\Sigma tall+\Sigma short)$

where Σ=the sum of species across all plots in the transect.

A mean browse score was calculated for each transect grouping browse scores for preferred and non-selected species. The mean transect SRI and browse score for each palatability class in each year was calculated and plotted with standard deviation.

Faecal Pellets and Pig Rooting

A faecal pellet index was calculated for each transect and was plotted as the proportion of 141 cm plots for each transect within which presence or absence of browsing ungulate (goat or deer) pellets were recorded.

Pig rooting data was plotted as a mean score per transect.

Ungulate Camera Index Monitoring

Images were reviewed manually following the DOC ungulate CTCI protocol. An independent ungulate encounter was defined as one or more images separated by at least five minutes from any previous image of that species. For each encounter, species, date, time, camera location, and the maximum number of individuals observed were recorded. Relative abundance was calculated as independent ungulate encounters per 1,000 camera hours for each species. Although the DOC protocol was developed for deer and goats, all ungulate species recorded during the survey, including feral pigs, were included in the analysis.

Ungulate Control Data

Beyond pellet and rooting measures, DCC hunters and cullers including High Country Contracting Ltd, Contract Wild Animal Control, and Mana Wild Game Solutions, have been carrying out ground and aerial-based hunting within the reserve and surrounding private margins. Kill data has been collated and graphed in an attempt to demonstrate trends in hunter effort and ungulate abundance over time.

Hunting kill and observation data was divided by the hours spent hunting to create an index of effort to kills/sightings and a metric of ungulates per hunter day (UPHD) for each culling method (ground hunting, hunter w/ dog, and aerial).

Results

Seedling Ratio Index

Seedling ratio index values will range between -1 and 1, with values well below zero indicating poor regeneration potential, values near zero demonstrating an even presence of seedlings in the short and tall categories. Values well above zero indicate a greater proportion of tall seedlings present and thus better regeneration potential for those species.

DCC results (Inside Reserve)

Initial measurement of the transects established within the reserve in April 2023 show an SRI score of -0.24 for Preferred species, 0.36 for Non- selected species and 0.09 for Avoided species.

Measurement of the reserve transects in March 2025 show an SRI score of -0.20 for Preferred species, 0.11 for Non- selected species and -0.07 for Avoided species.

These results are depicted in **Figures 1 - 3**.

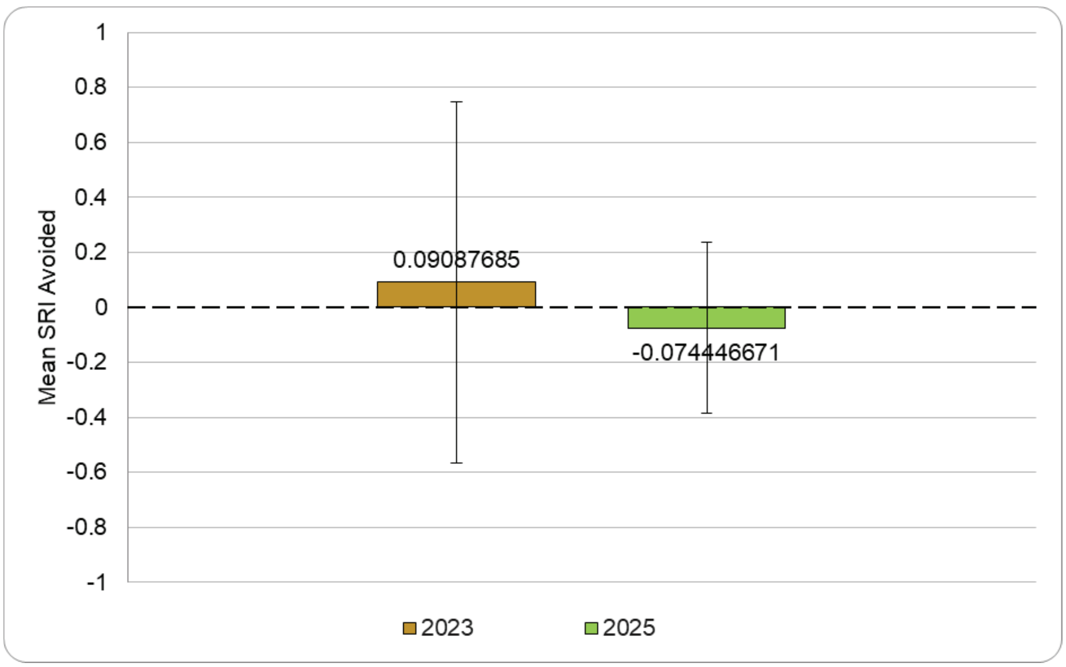


Figure 1. Mean SRI score for 'Avoided' species groups across all transects in April 2023 and April 2025. Error bars show standard deviation.

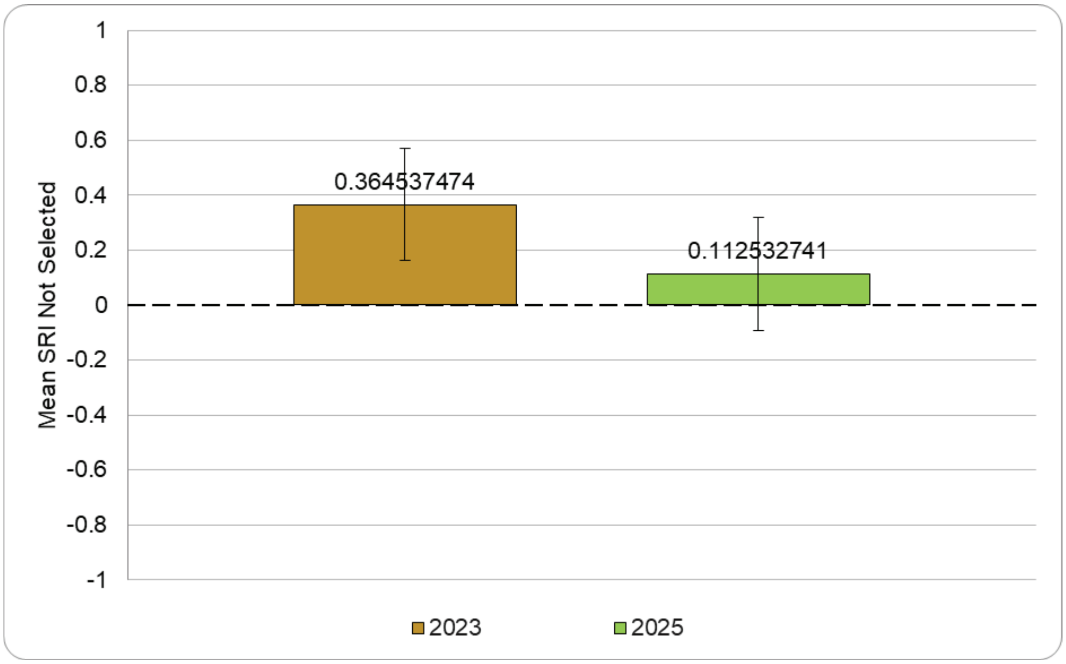


Figure 2. Mean SRI score for 'Not Selected' species groups across all transects in April 2023 and March 2025. Error bars show standard deviation.

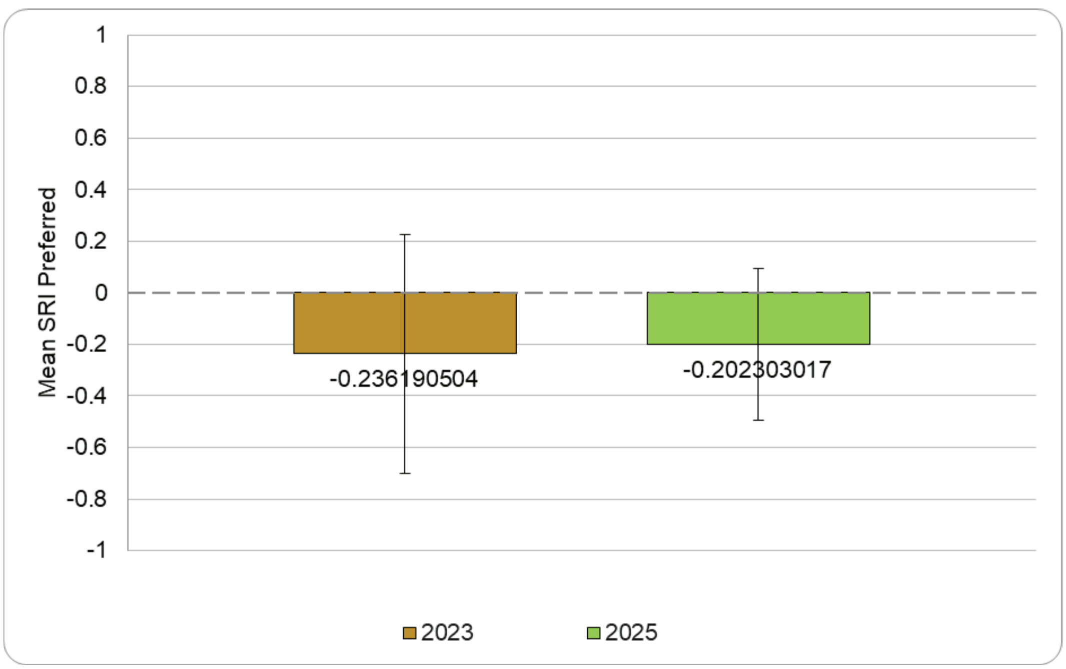


Figure 3. Mean SRI score for 'Preferred' species groups across all transects in April 2023 and March 2025. Error bars show standard deviation.

HMWCG Results (Private Land)

Initial measurement of the transects established on the HMWCG private land in February 2026 show an average SRI score of -0.23 for Preferred species, 0.03 for Non- selected species and -0.01 for Avoided species, as depicted in Figure 4.

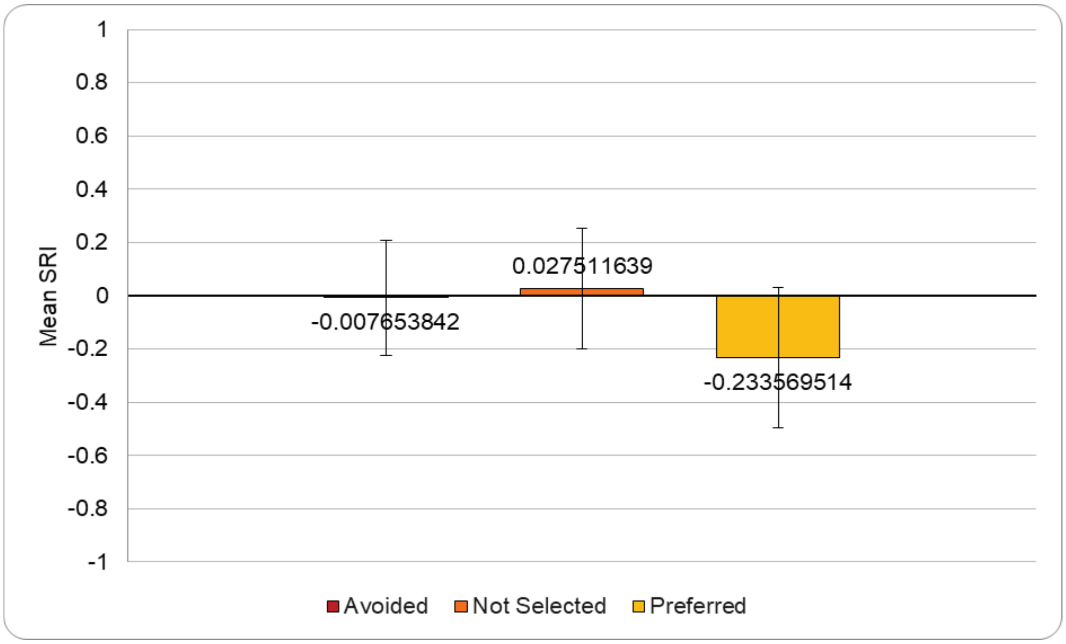


Figure 4. Mean SRI score for 'Avoided', 'Not Selected' and 'Preferred' species groups across all Private land transects in Feb 2026. Error bars show standard deviation

Browse

DCC Results (Inside Reserve)

Initial measurement of the transects established within the reserve in April 2023 show a mean browse score of 2.09 for Preferred species, 1.04 for Non- selected species and 0.51 for Avoided species.

Mean browse of Preferred and Not Selected species across transects in April 2023 show values ranging from 0.76 to 2.39, with the highest mean browse scores occurring within 7,8,9 & 10 on the western side of the reserve. Mean browse scores in 2023 were 1.98 for Preferred species, .98 for Non- selected species and 0.50 for Avoided species.

Re-measurement of the transects in the reserve in March 2025 show a mean browse of Preferred and Not Selected species across transects ranging from 1.03 to 2.1, with a more even spread of browse scores throughout the reserve compared to 2023. Mean browse scores in 2025 were 2.08 for Preferred species, 1.02 for Non- selected species and 0.99 for Avoided species.

Mean browse of Preferred and Not Selected species across transects in March 2025 show values ranging from 1.03 to 2.1, with the highest mean browse scores occurring within transects 7,8,9 & 3. Transects 7-9 occur on the western side of the reserve in the river and western tributary catchment. Line 3 is on the eastern boundary with Zac Noone and is co-located where a mob has been regularly seen in recent field operations (MCU, pers.comms).

Comparisons across 2023 and 2025 results are shown in Figures 5-8.

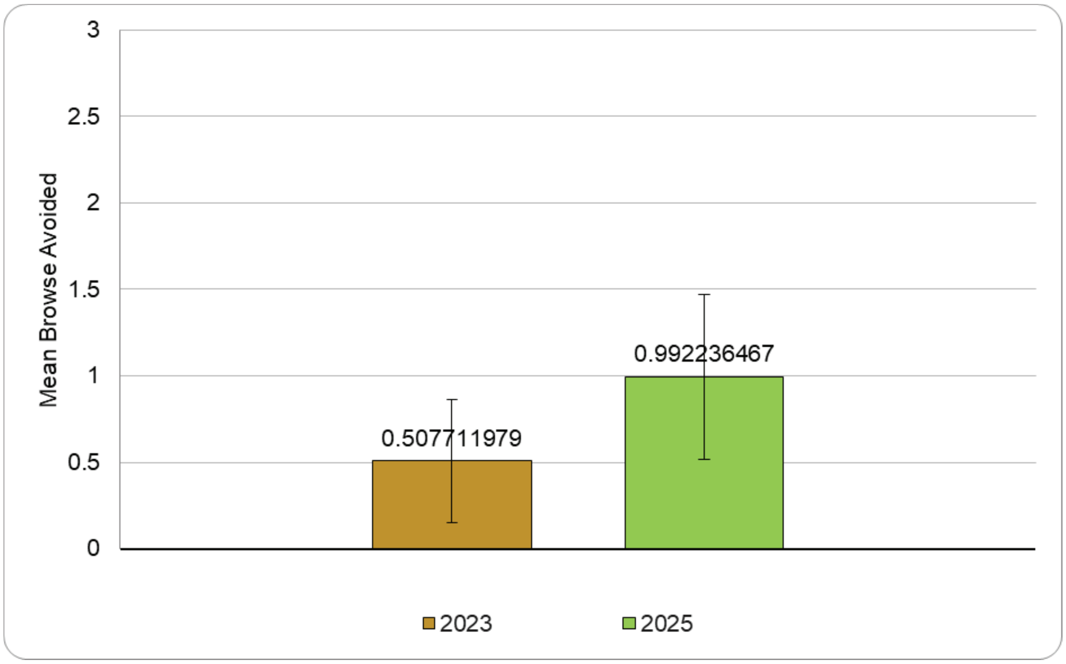


Figure 5. Mean Browse score for 'Avoided' species groups across all transects inside the Reserve in April 2023 and March 2025. Error bars show standard deviation.

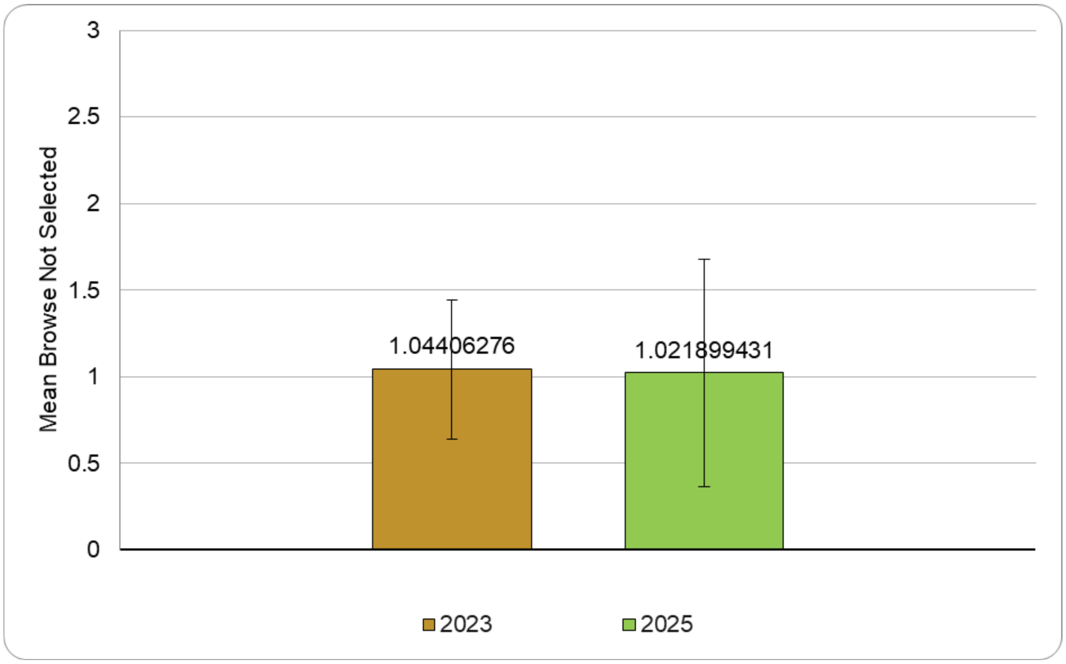


Figure 6. Mean Browse score for 'Not Selected' species groups across all transects inside the Reserve in April 2023 and March 2025. Error bars show standard deviation.

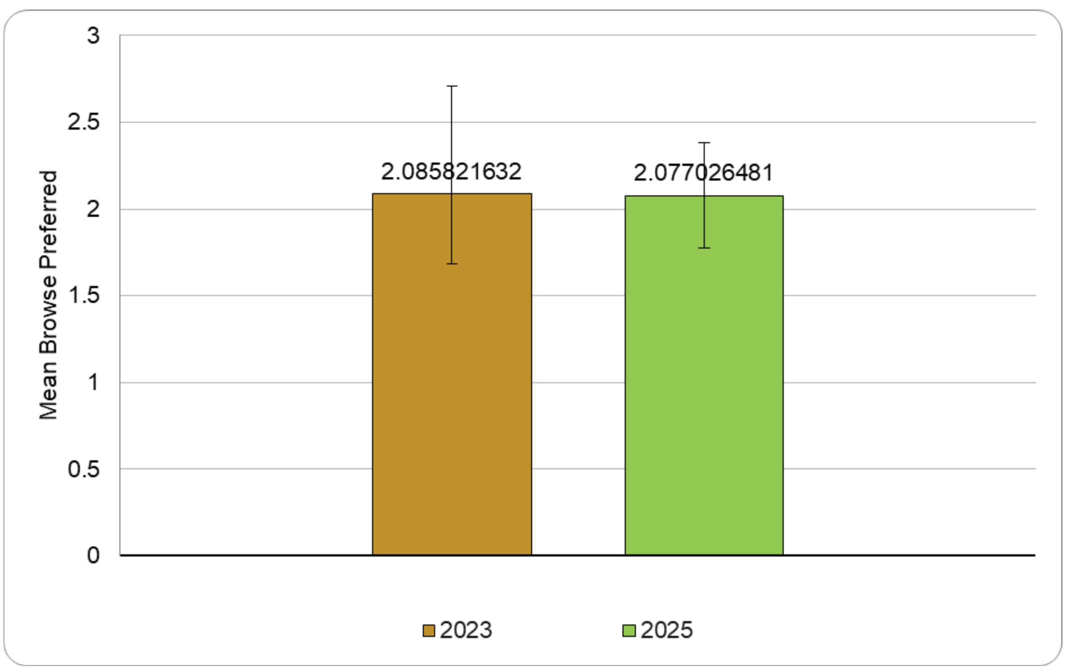


Figure 7. Mean Browse score for 'Preferred' species groups across all transects inside the Reserve in April 2023 and March 2025. Error bars show standard deviation.

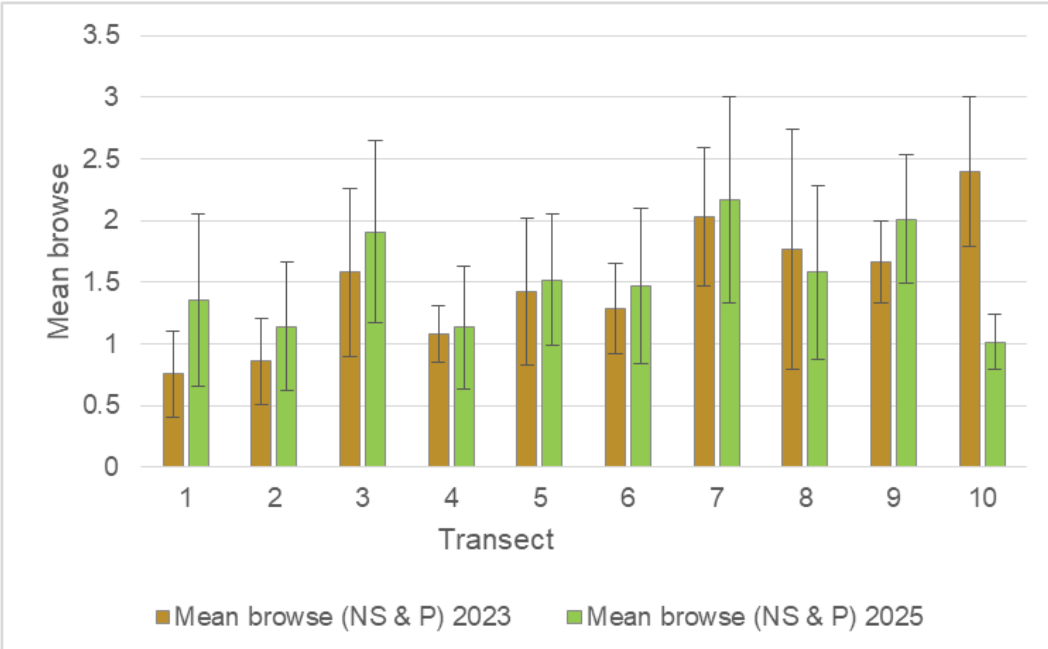


Figure 8. Mean browse per transect for Preferred and Not selected species across all transects inside the Reserve April 2023 and March 2025. Error bars show standard deviation.

HMWCG Results (Private Land)

Initial measurement of the transects established on the HMWCG forest remnants in February 2026 show a mean browse score of .89 for Preferred species, .46 for Non-selected species and .66 for Avoided species.

Mean browse of Preferred and Not Selected species across transects in March 2026 show values ranging from .36 to 1.09, with the highest mean browse score occurring on the PA3 transect in the southern Stoney Hill gulley. Results are shown in Figures 9 and 10.

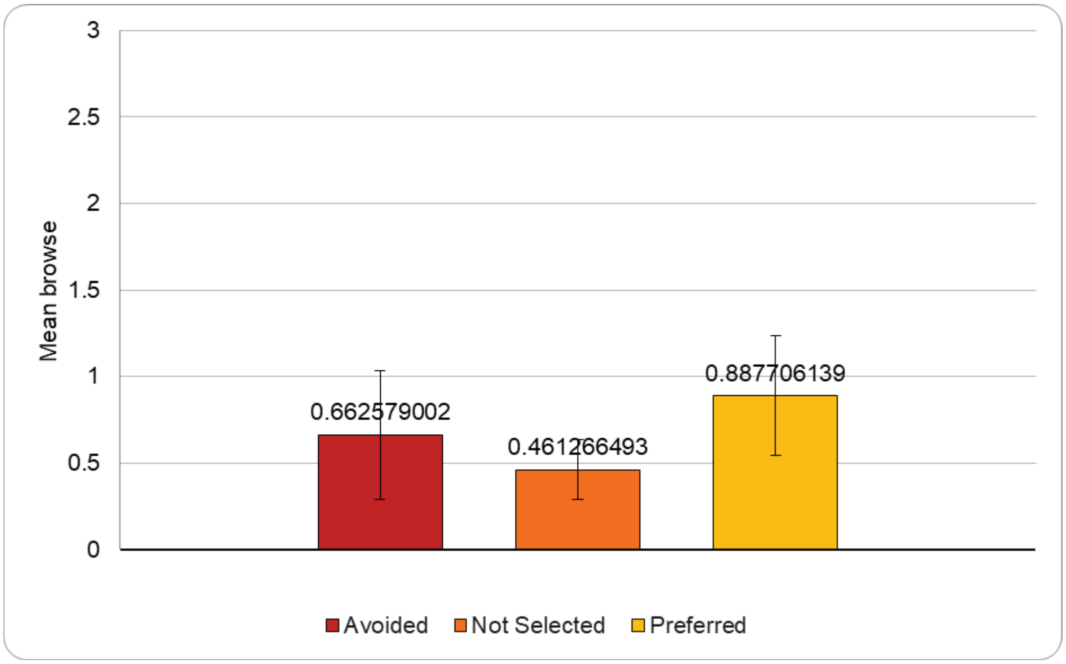


Figure 9. Mean browse score for ‘Avoided’, ‘Not Selected’ and ‘Preferred’ species groups across all Private land transects in Feb 2026. Error bars show standard deviation.

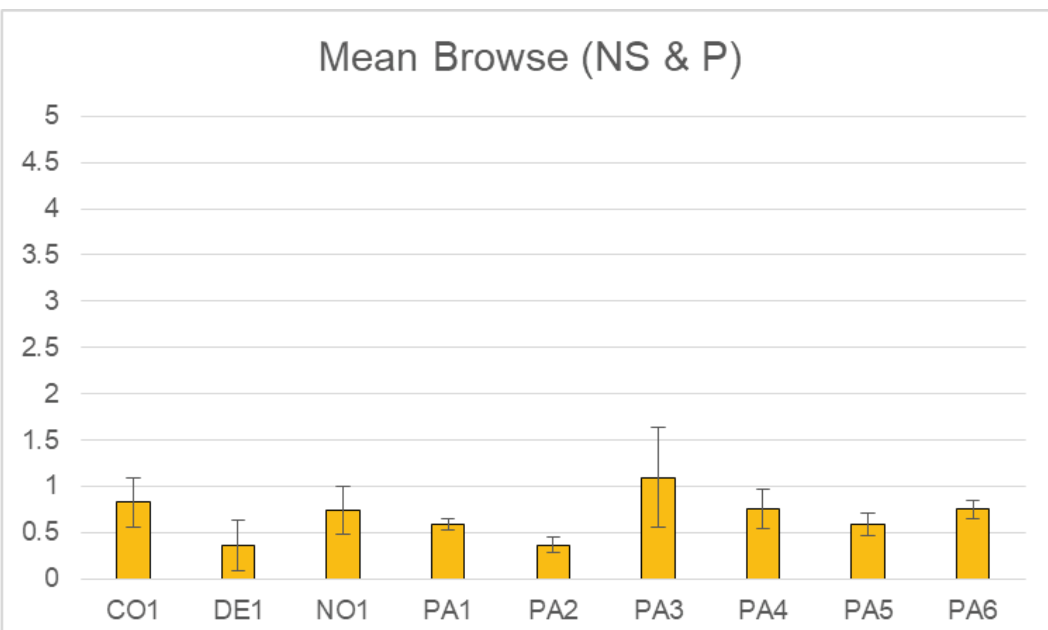


Figure 10. Mean browse per transect for preferred and Not selected species across all transects outside the reserve Feb 2026. Error bars show standard deviation.

Pig and Pellet Index Data

DCC Results (Inside Reserve)

Initial measurements of the transects established in April 2023 show a large variation in pellet presence or absence between transects (Figure 11). There is a general positive correlation between ungulate pellet abundance and browse across the transects. A higher proportion of plots per transect contained deer and goat pellets on the western side of the reserve (especially transects 9 and 10).

Remeasurement of the reserve transects in March 2025 show variation in pellet abundance between transects, but less variation than in 2023 (Figure 12). There is a less defined correlation between ungulate pellet abundance and browse across the transects than in 2023. A higher proportion of plots per transect contained deer and goat pellets on the western side of the reserve (transects 7-10).

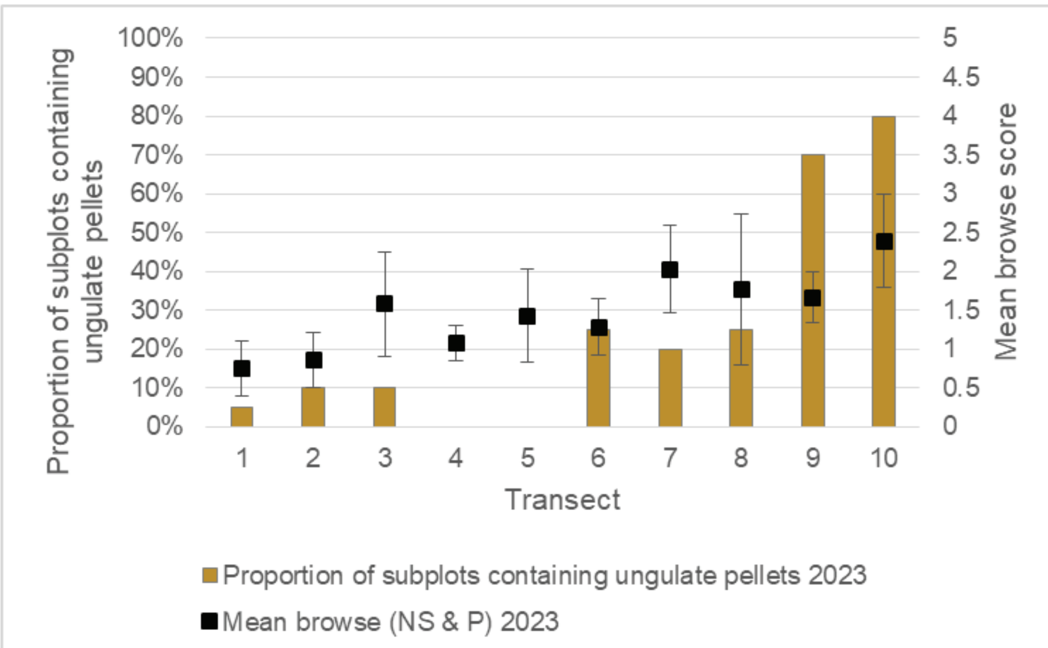


Figure 11. Proportion of plots per transect containing ungulate pellets compared to mean browse score for Preferred and Not-selected species within each transect April 2023. Error bars for Mean browse show standard deviation.

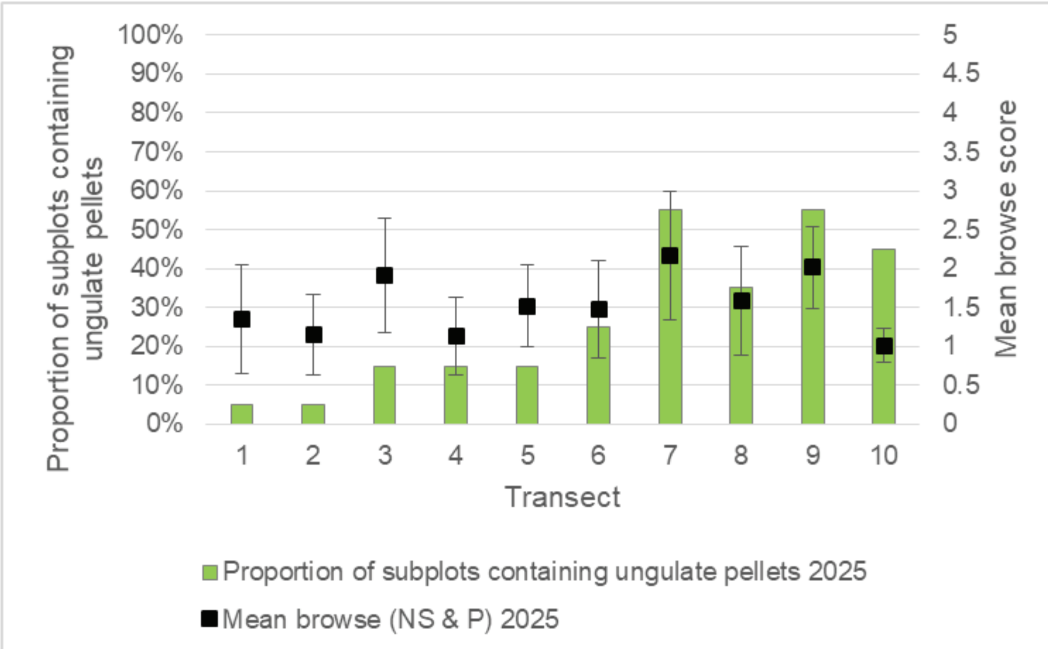


Figure 12. *Proportion of plots per transect containing ungulate pellets compared to mean browse score for Preferred and Not-selected species within each transect March 2025. Error bars for Mean browse show standard deviation.*

In 2023, pig root measures on subplots also showed variation of pig disturbance between transects. The average pig root score was below 1 (<25% of subplot area impacted) for 7 of the 10 transects. A higher amount of pig activity was measured on transect 2 with an average score of 2.5 (63% of subplot area impacted) and on transect 10 with an average score of 1.7 (43% of subplot area impacted). Notably, no pig rooting was recorded within subplots measured on transects 5,8 and 9.

In 2025, pig root measures on subplots showed less variation of pig disturbance between transects. The average pig root score was below 1 (<25% of subplot area impacted). 3 transects recorded pig activity above 1(>25% of subplot area impacted) including transect 2 with an average score of 1.1 (28% of subplot area impacted), transect 7 with an average score of 1.3 (33% of subplot area impacted), and transect 9 with an average score of 1.5 (38% of subplot area impacted). Notably, pig rooting was recorded within subplots on all 10 transects compared to only 7 in 2023.

Comparison of 2023 to 2025 results are shown in Figure 13.

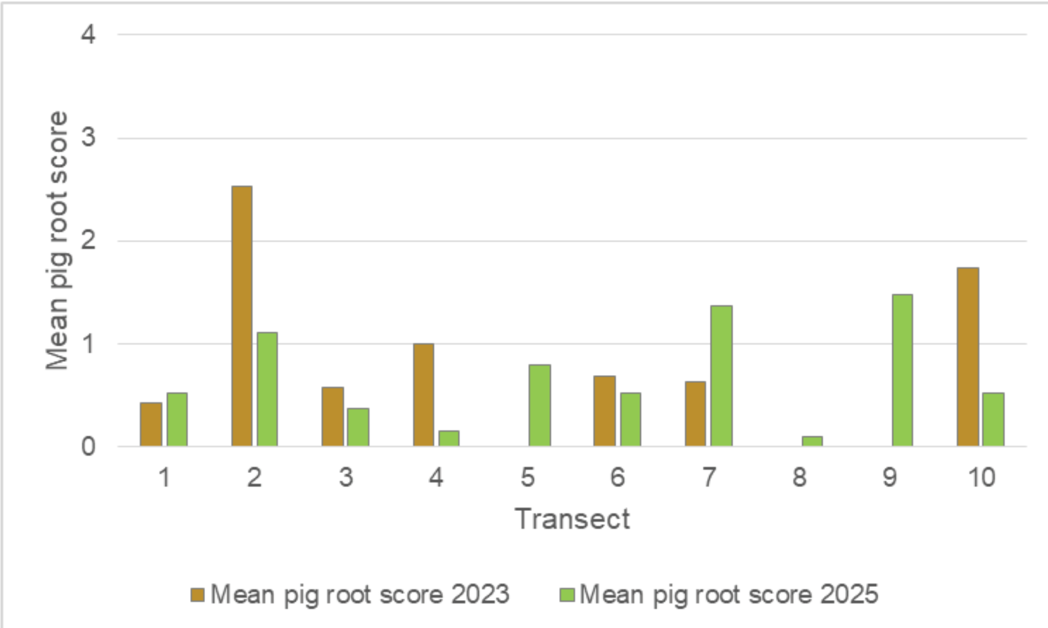


Figure 13. Mean pig root score per transect inside the reserve April 2023 and April 2025.

HMWCG Results (Private Land)

Initial measurements of the transects established on the HMWCG private land in February 2026 show a large variation in pellet presence or absence between transects (**Figure 14**). PA3 had both the highest pellet score and browse score of the private land transects. Interestingly, lines NO1, PA1 and PA2 had no pellets detected on subplots, but had comparable browse scores with most of the lines and even higher browse scores than some lines that did detect ungulate pellets. This may indicate that browse prevalence remains somewhat consistent even when there are fewer and more transient ungulates moving through the landscape.

Pig root measures on subplots showed relatively low variation of pig disturbance between transects (**Figure 15**). The average pig root score was below 1 (<25% of subplot area impacted). No line exceeded 1 (>25% of subplot area impacted). A higher amount of pig activity was measured on PA lines south of the Waikouaiti river. No pig rooting was recorded on the NO1 line on Zac Noone's property that is enclosed in pig exclusion fencing.

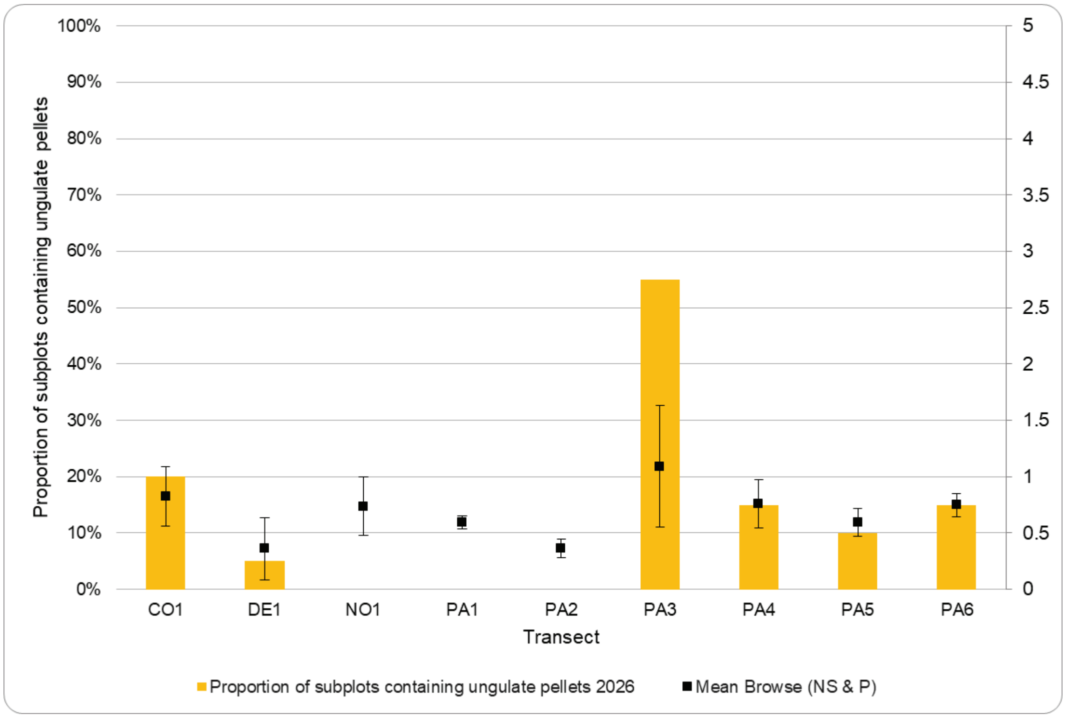


Figure 14. Proportion of plots per transect containing ungulate pellets compared to mean browse score for Preferred and Not-selected species within each HMWCG transect Feb 2026. Error bars for Mean browse show standard deviation.

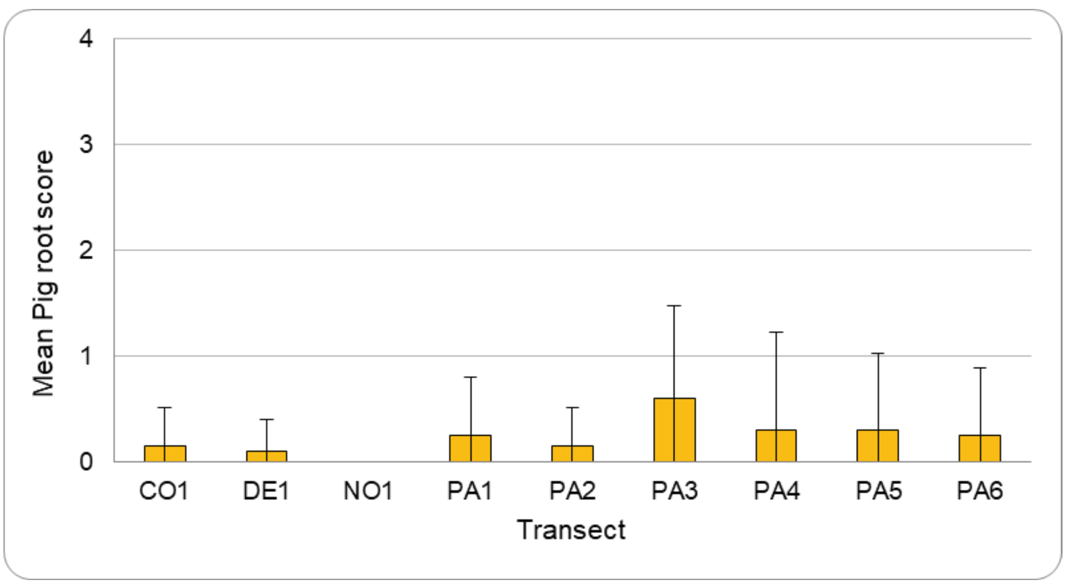


Figure 15. Mean pig root score per transect on private land Feb 2026. Error bars show standard deviation.

Combined DCC & HMWCG Comparative Summary Tables for SRI Transect Monitoring

Table 5 summarises the 3 key monitoring metrics collected from the Dunedin City Council (DCC) scenic reserve in 2023 and 2025, and from HMWCG-managed private land in 2026 by MCU. These surveys were undertaken in different years and across different parts of the Hikaroroa / Mt. Watkin area and should therefore not be interpreted as direct comparisons. Differences between datasets may reflect variation in habitat, vegetation composition, management history, seasonal conditions, or natural year-to-year variation.

Despite these limitations, the datasets provide valuable snapshots of forest conditions across the wider Hikaroroa landscape. Considered collectively, they offer useful context for understanding broad patterns in regeneration, browsing pressure, and ungulate activity, and provide an early indication of how ecological conditions may vary across the management area.

Table 5. Summary of key forest regeneration and ungulate impact indicators for the Dunedin City Council (DCC) Scenic Reserve (2023 and 2025) and HMWCG-managed private land (2026). Tables present mean Seedling Ratio Index (SRI) values (-1 to 1) by palatability class , mean browse scores (0-5) by palatability class, and indices of ungulate activity including the proportion of SRI subplots containing ungulate faecal pellets (%) and the Pig Rooting Index (0-4).

a) Mean SRI Summary Table

Palatability class	DCC 2023	DCC 2025	HMWCG 2026
Avoided	0.09	-0.07	-0.01
Not Selected	0.36	0.11	0.03
Preferred	-0.24	-0.2	-0.23

b) Mean Browse Summary Table

Palatability class	DCC 2023	DCC 2025	HMWCG 2026
Avoided	0.51	0.99	0.66
Not Selected	1.04	1.02	0.462
Preferred	2.10	2.09	0.89

c) Mean Pig & Pellet Summary Table

Index Type	DCC 2023	DCC 2025	HMWCG 2026
Proportion of subplots containing pellets	29%	27%	19%
Average proportion of Pig Root across plots	19%	18%	6%

Ungulate Camera Index Data

Initial camera surveys for ungulates between December 2025 & Feb 2026 collected data on animal detectability across the DCC Hikaroroa / Mt. Watkin Scenic Reserve and HMWCG forest on private land (**Tables 6 -8** show DCC HMW results, and **Tables 9-11** show results for HMWCG private land).

DCC Results (Inside Reserve)

Table 6. Summary of species triggering cameras (1 count per ungulate detection).

DCC HMW SCENIC RESERVE			
Camera number	**Deer**	**Goat**	**Pig**
1	10	15	102
2	31	73	28
3	8	2	85
4	1	2	1
5	8	51	38
6	33	16	16
7	22	0	35
8	53	0	5
9	4	0	80
10	21	12	1
11	0	0	0
Average Detections per camera	19	17	39
Total Detections	190	169	390

Table 7. Summary of detections per 1000 camera hours (CH1000) for each species.

DCC HMW SCENIC RESERVE			
Camera number	**Deer**	**Goat**	**Pig**
1	4.3	6.4	43.8
2	13.2	31.0	11.9
3	3.4	0.8	35.8
4	0.0	0.0	0.0
5	3.4	21.7	16.2
6	14.2	6.9	6.9
7	9.4	0.0	14.9
8	22.8	0.0	2.1
9	1.8	0.0	35.8
10	8.9	5.1	0.4
11	0.0	0.0	0.0
Mean CH1000	8.1	7.2	16.8

Table 8. Summary table of metrics presented in **Tables 6 & 7**. Note Mean CH1000 index has been rounded to whole numbers.

DCC HMW SCENIC RESERVE			
Metric	**Deer**	**Goat**	**Pig**
Average detections per camera	19	17	39
Total Detections	190	169	390
Mean CH1000 Index	8	7	17

At Hikaroroa / Mt. Watkin Scenic Reserve, feral pigs had the highest detectability of three ungulate species with 390 total detections and an average of 17 detections per 1000 camera operating hours. This was more than twice the detectability of deer which were the next most detectable species with 190 detections and an average of 8 detections per 1000 camera operating hours.

Goats had the lowest detectability of the 3 species with 169 total detections and an average of 7 detections per 1000 camera operating hours, which was only slightly less than deer.

All three species were detected all cameras except for camera 11, which only saw hares. Camera 4 unfortunately was placed in too windy of a spot and the SD card was filled after 48 hours, it did see a couple goats and a deer in that period but it has been excluded from summary totals and CH1000 calculations as the extremely short survey period disproportionately affects that data. Both camera 4 & 11 should be moved to better locations for any future surveys.

HMWCG Results (Private Land)

Table 9. Summary of species triggering cameras (1 count per ungulate detection).

HMWCG Private Land			
Camera number	**Deer**	**Goat**	**Pig**
PAC01UM	27	0	20
PAC02UM	10	40	3
PEC03UM	13	47	31
PAC04UM	18	2	17
PAC05UM	4	3	2
PAC06UM	21	3	64
DEC01UM	7	0	0
NOC01UM	1	0	0
COC01UM	0	0	10
Average Detections per camera	11	11	16

Total Detections	101	95	147

Table 10. Summary of detections per 1000 camera hours (CH1000) for each species.

HMWCG Private Land			
Camera number	**Deer**	**Goat**	**Pig**
PA01	12.6	0.0	9.4
PA02	4.7	18.7	1.4
PA03	9.8	1.4	30.0
PA04	1.9	1.4	0.9
PA05	3.3	0.0	0.0
PA06	8.3	0.9	7.8
DE01	6.1	22.0	14.5
NO01	0.5	0.0	0.0
CO01	0.0	0.0	4.6
Mean CH1000	5.2	4.9	7.6

Table 11. Summary table of metrics presented in **tables 9 &10**. Note that Mean CH1000 index has been rounded to whole numbers.

HMWCG Camera Monitoring			
Year	**Deer**	**Goat**	**Pig**
Average detections per camera	11	11	16
Total Detections	101	95	147
Mean CH1000 Index	5	5	8

At HMWCG Private land forest remnants, feral pigs had the highest detectability of three ungulate species with 147 total detections and an average of 8 detections per 1000 camera operating hours. This was ~38% higher detectability than deer, which were the next most detectable species with 101 detections and an average of 5 detections per 1000 camera operating hours.

Goats had only slightly lower detectability than deer on private land with 95 total detections and an average of 5 detections per 1000 camera operating hours.

Deer were detected on 8/9 of the cameras. Pigs were detected on 7/9 cameras. And goats were detected on 5/9 cameras. This indicates that ungulates are not necessarily evenly dispersed across the private landscape.

Ungulate Control Data

Ungulate control data collected from Mana Wild Game Solutions Ltd. (ground hunting), High Country Contracting (Rentokill) (ground hunting with dogs) and Contract Wild Animal Control Ltd (aerial hunting) show that 94 ungulates were removed from within and directly adjacent to the reserve in the 25/26FY (Table 12). An additional 50 ungulate kills were recorded by MCU field staff and HMWCG landowners on the private land surrounding the reserve. Together there have been a total of 143 confirmed ungulate kills in the Hikaroroa area this year. Additional ungulate kills from local hunters on private land have not been consistently reported and thus this number is underrepresenting the true numbers removed from the landscape.

Table. 12 Summary of ungulates observed and removed by 4 operational groups in the 25/26 FY.

Ungulate Kills / Obs 2025-26 FY								
	KILLED				OBSERVED			
Operator	**Deer**	**Pig**	**Goat**	**TOTAL**	**Deer**	**Pig**	**Goat**	**TOTAL**
Mana Wild Game Solutions	5	24	27	56	18	40	30	88
High Country Contracti	1	3	16	20	1	4	0	5
Contract Wild Animal Control	0	7	10	17	3	0	0	3
HMWCG	5	17	28	50	20	97	35	152
Total Ungulate Kills				**143**	**Total Ungulate Observatio**			248

Note 1: Kill data has been graphed in subsequent figures; Observed data reported here in table form only.

Note 2: HMWCG data comes from volunteer reporting, either through TrapNZ or on volunteer timesheets. Some interpretation of data has been needed to fully quantify the observations. Unless clearly indicated, the following rule has been applied: “goat” = 1, “goats” = 2, “mob of goats” = 4; “pig” = 1, “pigs” = 3; all “deer” were interpreted as 1 unless exact figure noted.

Figure 16 shows a comparison of hunting time to the number of animals removed during ground hunting operations by Mana Wild Game Solutions. Mana Wild Game Solutions hunting data provides the most informative hunting information to base inferences of ungulate trends on as this operator works more consistently across the year averaging about 31 hunting days annually over the past five years, compared with HCC/CWAC that operate over short intensive time periods and thus whose kill data may be more affected by variables such as time of year and animal movement patterns across the wider landscape. The graphs show that time spent hunting appears to roughly follow the trend of how many animals are removed.

Figures 17 and 18 show the hunter effort index (kills/time) from the data presented in Figure.16. Note the marked change in trend that begins in 2021. From 2017-2020 the kill rate was increasing, whereas it has been trending downwards since 2021. Figure.18 has excluded 2016 and 2026 data as these years only include partial data that may be artificially inflating kill rates (2026 is only part way through, but 22 goats have been killed in a single hunting day, surpassing the annual kills from the previous year. The number of goats shot in the remainder of 2026 will inform whether trends are truly increasing in 2026 or if this is an anomalous event).

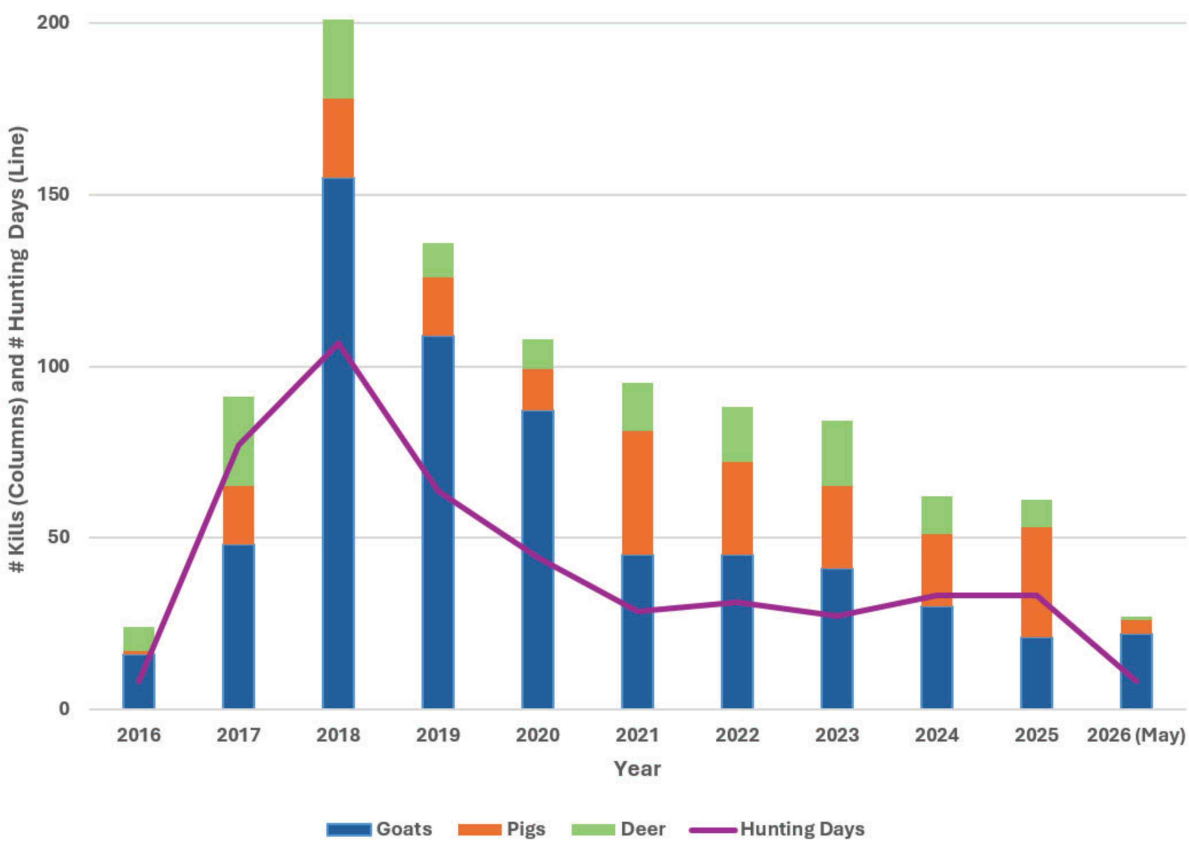


Figure 16. Ground Hunting Results. Total annual kills by species from Mana Wild Game Solutions, with the number of Hunting Days (total hunting hours divided by 8 to represent an 8-hour day) super-imposed over the columns. On average, goats comprise 60.8%, pigs 23.3% and deer 15.9% of all kills.

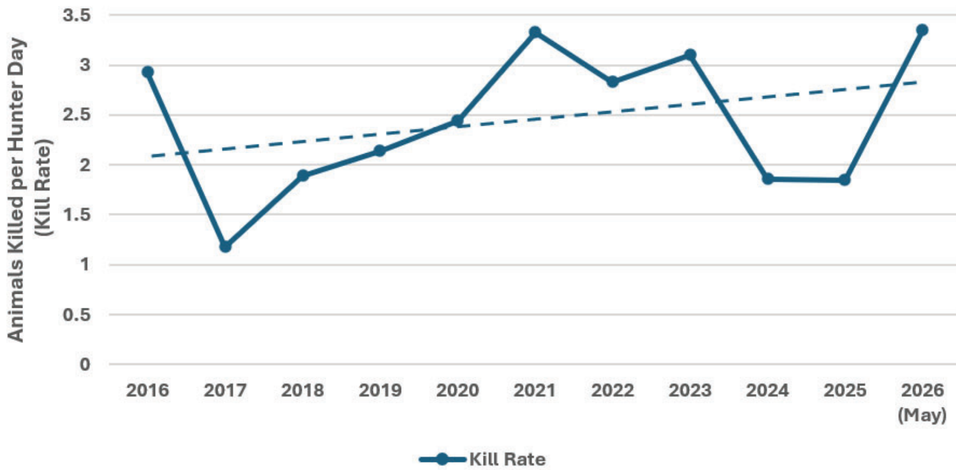


Figure 17. Hunting Effectiveness. Mana Wild Game Solutions' kill rate is calculated as the number of animals killed per Hunter Day (8hrs). Note that while annual hunting days have become quite stable over the past 5 years, averaging 31 days per year 2021-2025 (see Figure 16), the Kill Rate appears to be trending upwards (this may be adjusted when final 2026 numbers are in). Kills average 2.4 kills per hunting day (2016-2020), with the rate increasing to 2.6 kills per hunting day since 2021 (including the 2026 partial year).

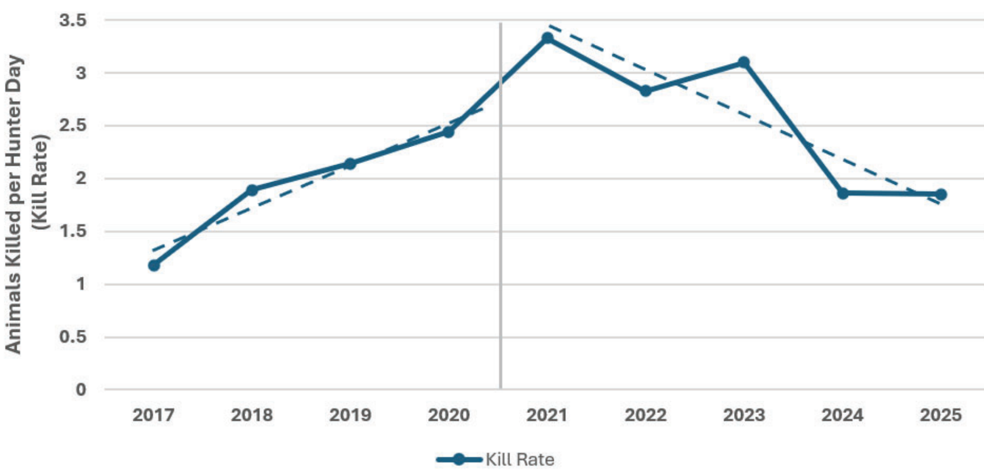


Figure 18. Hunting Effectiveness over 2 time periods. To gain a more nuanced view of hunting effectiveness, the Kill Rate has been re-evaluated using only full year data (data from both 2016 and 2026 represent partial years). Trendlines have been added for 2017-2020 and 2021-2025 date ranges, to better evaluate Kill Rates in the past 5 years when hunter days have been relatively stable. Using this approach, average Kill Rate in the 2017-2020 period was 1.9 kills per hunting day, and 2.6 kills per hunting day from 2021-2025 (dropping from a 2020 high of 3.3, to 1.85 kills per hunting day in 2025).

Figure 19 provides a timeline of DCC ungulate culling operations by CWAC and HCC, based on information shared with MCU. DOC operations and potentially a 2025 aerial operation are missing from the timeline, and will need to be confirmed in the future by DCC and DOC records. Data gaps make it challenging to create hunter effort indices from these control operations at present moment, but they could be analyzed in the future to create trends. Nevertheless, the timeline provides useful context to operations reported in more detail in this report. It is worthwhile noting that both operators have reported reduced goat activity compared to earlier operations.

August 2022

CWAC Aerial hunt

- 5 goats shot, out of 25 total goats seen

August 2023

CWAC

- Aerial pig survey for TB control

April 2024

CWAC Aerial hunt

- "did not see much at all, especially up in the main part of Mt. Watkin, compared with last time"
- "goat numbers are down…did not see many deer, whereas last time they were everywhere"
- Adjoining farmers indicated "quite a bit of hunting had been taking place on their properties, so hopefully this has been a help"

June 2025

HCC Ungulate Control

- A small-scale operation targeting animals in remote and difficult terrain, with goats the primary target species; informed planning for 2026 operation
- 40 goats removed
- 3 pigs removed
- 2 deer removed

May 2026

CWAC Aerial hunt

- 10 goats removed
- 7 pigs removed
- 1 deer removed, 3 additional deer spotted

February 2026

HCC Ungulate Control

- Focused on hot-spot areas identified in 2025
- Overall numbers appear reduced, although residual population suspected
- Neighbouring landowners indicated moderate goat numbers, on the true right of the Waikouaiti River North Branch
- Obsvervations suggest pig population is increasing in the Reserve
- 16 goats removed
- 3 pigs removed
- 1 deer removed

Figure 19. Timeline of other contracted culling efforts in the DCC HMW Scenic Reserve.

Discussion and Comparisons

Regeneration Transect Monitoring: SRI, Browse, Pellets and Pig Rooting

In an area where the ungulate population is unmanaged, seedling ratios of 'Preferred' and 'Not selected' species would be expected to be below zero or declining, indicating poor regeneration potential, while 'Avoided' species would be expected to have positive, near zero, or increasing seedling ratios. After control or removal of ungulates, 'Preferred' and 'Not selected' species would be expected to increase towards or above zero indicating increasing regeneration potential for these species in the understory. Browse scores would be expected to decrease with lower ungulate abundance.

Overall, the SRI results show that introduced ungulates are negatively impacting the ability of the most palatable forest species to regenerate. A mean SRI value of -0.22 for 'Preferred' species is not desirable and indicates limited regeneration potential for these species within the reserve and on surrounding private forest remnants.

A relatively high and consistent mean browse score was recorded for preferred species (2.1) and average ungulate pellet presence of 28% of subplots in the DCC Reserve between 2023 and 2025 points towards the limited regeneration potential shown for preferred species being due to browsing pressure by ungulates.

Interestingly, HMWCG 2026 monitoring showed much lower browse scores (0.89) compared to the DCC Reserve and only 19% of subplots containing pellets. However, the lower browse and pellet scores did not translate to a better SRI score comparatively to the Reserve. This may indicate other factors influencing regeneration potential, a delay in response between ungulate suppression and measurable regeneration, or a non-linear relationship between ungulate presence and regeneration potential (ie. lower ungulate presence doesn't necessarily result in increased regeneration at current densities).

In the DCC Reserve, 'Not selected' species had an SRI of 0.36 in 2023, higher (less impacted) than might be expected in an area impacted by ungulate browsers. In 2025, this number decreased to .11, a still positive score but significantly lower. In 2026 on HMWCG land, this palatability class had a lower score (.03) compared with inside the Reserve. This apparent decrease may represent data deficiency and overall it is positive that this palatability class is hovering at or above 0 SRI in the Hikaroroa landscape. It may indicate that although browse pressure by ungulates has been negatively impacting regeneration of 'Preferred' species, that ungulate density is not high enough to persuade them to heavily browse 'Not selected' species. Another possibility is the presence of nearby exotic scrub, pasture, and crop paddocks on farmland habitat may provide enough preferable food sources and may reduce pressure on less palatable 'Not selected' native species in the forest.

Mean browse scores for the different palatability categories follow the expected trend of most browse being found on 'Preferred' followed by 'Not selected' and 'Avoided' species in both the 2023 and 2025 DCC surveys. However the difference between browse scores on 'NS' and 'A' in 2025 was much smaller. HMWCG 2026 results broke this expected trend with 'NS' species having a higher browse score (.66) than 'NS' species (.46). Several factors may explain this pattern. Browse scores represent browsing of plants that are present rather than true dietary preference, and may therefore be influenced by long-term depletion of more palatable species, differences in seedling abundance, or opportunistic browsing behaviour. The mixed farmland habitat also provides a diverse range of exotic forage which may alter browsing behaviour compared with closed native forest. Furthermore, the published palatability classifications were developed largely from studies of deer, whereas browsing pressure at Hikaroroa has historically included substantial goat populations, which are known to utilise a broader range of woody species. Continued monitoring will help determine whether this pattern represents natural variation or indicates that some species should be reassigned to more appropriate palatability classes for this site.

A mean browse score of 2.1 for 'Preferred' species across both DCC and HMWCG lands is fairly high and is comparable to highly browsed central and western catchments of Fiordland (G. Ledgard personal communication, 14 August 2024).

The proportion of subplots containing ungulate pellets and pig-rooting disturbance remained fairly consistent, with slight reductions at the DCC Reserve from 2023 to 2025 with a 2% and 1% reduction respectively. Pellet counts on HMWCG land were somewhat lower per transect with an average of 19% (compared to 29% and 27% in the reserve). Pig rooting across subplots was substantially lower on private land with only an average 6% of subplot area affected by pig rooting (compared to 19% and 18% in the Reserve). This is expected because surrounding land owners utilize pig dog teams and electric exclusion fencing to limit pig numbers on their farms.

Pellet data from the DCC Reserve shows relatively widespread ungulate distribution, but with higher pellet presence on the western side of the reserve. Pig rooting was variable but widespread. On HMWCG private land, variation was higher but identified PA3 as a hotspot for both ungulate pellet and pigroot detectability.

Ungulate Camera Monitoring

On both DCC and Private land during the 25-26 ungulate camera survey, pigs had the highest detectability followed by deer then goats. This is an interesting finding as hunting efforts and observations have predominantly detected goats. This is likely due to the behavioral crypticness and hunting ease of goats compared with deer and pigs. It should also be noted that these camera surveys have also occurred after several years of intensifying goat control and thus these ratios may be an indication of post-operational ratios rather than historical ratios. Nevertheless, it provides valuable information to land managers about the relative ungulate levels in the native forest of the Hikaroroa area and where future efforts should be placed.

Because this camera survey happened at the same time across the DCC and HMWCG land parcels it does provide the opportunity to compare ungulate relative abundance between the sites. Camera-based CH1000 indices indicate that all three ungulate species were relatively more abundant within the DCC Scenic Reserve than on the surrounding HMWCG private land. Mean deer indices were approximately 60% higher within the reserve (8 vs. 5 CH1000), goat indices were around 40% higher (7 vs. 5 CH1000), while pigs showed the greatest difference, with mean abundance in the DCC Scenic Reserve more than double that recorded on private land (17 vs. 8 CH1000).

These results are consistent with expectations that the large, contiguous forest habitat of the reserve provides a refuge for ungulates, while surrounding farmland experiences greater levels of human disturbance and hunting pressure.

The camera monitoring identified clear spatial variation in relative ungulate abundance across both the HMWCG private land and the DCC Scenic Reserve, with distinct hotspots evident for each species.

Within the DCC Scenic Reserve, deer and pig activity was fairly widespread. Goat activity was dominated by Camera 2 (31.0), with another major hotspot at Camera 5 (21.7), while lower levels of activity were recorded at Cameras 1, 6 and 10.

On the HMWCG private land, deer activity was highest at cameras PA01 (CH1000 = 12.6) and PA03 (9.8), with moderate activity also recorded at PA06 (8.3) and DE01 (6.1). Goat activity was highly concentrated, with two cameras accounting for the majority of detections: DE01 (22.0) and PA02 (18.7). Pig activity showed an even stronger spatial pattern, with PA03 recording by far the highest relative abundance (30.0), followed by DE01 (14.5), PA01 (9.4), and PA06 (7.8). In contrast, cameras NO01 and CO01 recorded very little ungulate activity.

Several ecological patterns emerge from these results. Deer were relatively widespread across both monitoring areas, suggesting broad habitat use and larger home ranges than the other ungulate species. In contrast, goat activity was concentrated at only a small number of cameras, indicating the use of discrete areas of suitable terrain and habitat. Pig activity also showed spatial clustering, with a small number of cameras recording disproportionately high levels of activity. This likely reflects preferred rooting habitats, access to water, or regularly used travel corridors.

Identification of these 'hotspots' shouldn't be interpreted as where to necessarily focus hunting efforts as cameras were randomized and on a very lean network, but could instead be interpreted as rough trends in animal usage across the project areas.

Although the CH1000 index is a measure of relative abundance rather than absolute density, the consistent pattern across all three species suggests ungulate populations remain higher within the Reserve than on adjacent private land. This highlights the importance for continued coordinated landscape-scale management and collaboration on ungulate control efforts.

Ungulate Control Pressure

It is difficult to accurately estimate trends in ungulate density over time within the Reserve with the data available in this report. However, pellet counts, pig rooting scores, camera indices and the ungulate control data all point towards ungulates remaining to be relatively widespread and numerous within the reserve as well on the surrounding private land, though to a lesser extent. Trends in ground hunting data from the Reserve imply that numbers, especially of goats, were highest up until 2020, after which animals removed per year have declined despite consistent hunting effort, which normally would imply there are fewer goats. Numbers of pigs and deer seen and killed seem to have remained relatively stable since 2017.

Dog hunting and aerial culling operators have also consistently reported fewer goats compared with earlier operations. HCC, hunting with dog teams, have reported an increase in ground disturbance and pig observations between their operations, which is consistent with the high levels detected in the camera monitoring.

The ground hunting data we have analysed shows the UPHD was relatively stable trending slightly upwards until 2021, followed by a decrease in UPHD from 2021-2025, which is consistent with the increased aerial and dog team hunting operations. These trends suggest control efforts are beginning to significantly impact the goat population at Hikaroroa, though deer and pig numbers have likely been unaffected by hunting efforts. This is promising as these trends were not yet visible in the 2023 SRI report.

An SRI survey in 2028 across DCC and HMWCG land would be invaluable to understand if these trends reflect current goat suppression, as well as any additional ungulate control over that period, and whether we will see a change in palatable species regeneration. It should be noted that changes may not be significant unless control more completely addresses the whole suite of ungulate species at the Reserve.

Discussion of Limitations

The SRI and browse methods followed in this survey have some limitations in being able to report on the ability of a forest to regenerate itself, some of these are below:

- Points and bearings were randomly generated to determine the locations of transects and a number of these fell in areas where Kanuka (Kunzea ericoides) dominates the mature tree composition. Kanuka is not a preferred species to ungulates, so its regeneration potential is not expected to be strongly impacted by them, while some other forest types represented by more palatable species mapped within the Reserve are of more concern (see **Appendix 2** showing mapped vegetation types). Future surveys would be improved by replacing the kanuka dominated lines with lines which selectively span habitats known to contain more at-risk preferred species.

- The SRI method only accounts for species which are still present in this forest which has been browsed by stock and feral ungulates for the past ~>150 years (Wildlands 2008). Therefore, the approach does not necessarily represent all species that may have once been present. We have no pre-ungulate arrival data for the ecology of Hikaroroa, so can only guess at the species composition that might have existed there and impacts may not necessarily be reversible (Coomes et al. 2003).

- This method does not analyse the frequency of seedling presence/absence for any particular species (including those which may be of particular concern). The method only addresses how the aggregation of species within a palatability class compares in terms of tall to short seedling ratio. This analysis could be done if desired.

- It is possible that the palatability classes assigned in analysis of this data are not appropriate to the site, given that many of the studies which have informed the recommended classifications comprise quite different species compositions. Furthermore, many other SRI studies have focused on deer impacts while goats (more generalist ungulate) are likely representing a major browse pressure at Hikaroroa.

- A major limitation of the SRI method is that if a species is completely absent or browsed to the point that it is not counted in SRI plots then this missing data is not incorporated in the averages making browse scores appear lower than they are or SRI scores to be artificially inflated/deflated. Meaning, something cannot have a ratio of short to tall saplings if there is no regeneration happening whatsoever. MCU has proposed creating a canopy comparison for future SRI trends so that monitoring can detect any canopy species that may not be having any measurable regeneration.

Conclusions and Recommendations

Based on the data and discussions presented in this report, MCU makes the following recommendations to land mangers:

- Continue to increase targeted ungulate control in order to maintain ungulate at low numbers both within the Reserve and in its surrounding farmland. Aim to achieve <1 UPHD (G. Ledgard personal communication, 14 August 2024) which is the DOC WAM current standard for significantly reducing ungulate impacts. Both DCC and HMWCG should consider additional pig and deer control options.
- In order to accurately calculate ungulates per hunter day, any operations undertaking ungulate control should record and submit locations of kills and tracklogs of area searched, time spent and cost. This will also enable analysis of catch per unit effort (CPUE) metrics and thus allow better understanding of the specific needs for ungulate density management within the unique Hikaroroa ecosystem.
- DCC & HMWCG should both add their kill data to trap.nz for better record keeping and future spatial analysis. For DCC, this will mean putting contractor data onto the trap.nz post operations, or instructing operators to enter data directly as control is undertaken. For HMWCG, better buy in or systems for landowner and hunter reporting would help better understand control pressures on private land.
- Annual camera index monitoring should be continued by both DCC and HMWCG as a low cost quantitative metric for measuring ungulate detectability across the Hikaroroa native forest landscape. This method bypasses many of the limitations of the UPHD (hunter effort) metric and will be a better quantitative metric to use for determining the density impact function of ungulate pressure to forest regeneration potential.
- Aim to achieve a significant increase in SRI scores for P species (>0) and browse scores of <1 for all palatability categories.
- Ongoing density targets should be based on the CH1000 index level of the 3 ungulate species when these SRI and browse scores are achieved.
- Remeasure SRI transects in autumn 2028 on both DCC and HMWCG land. This will be a 3 year gap for DCC and a 2 year gap for HMWCG, but will synchronize the survey times so that they are more directly comparable moving forward.
- After 2028, continue to remeasure SRI transects every two years until the desired level of regeneration for all palatability categories are achieved, at which point change to a 5 yearly SRI remeasurement cycle.
- Remain vigilant as to the appropriateness of palatability classification for species as future surveys are completed and analysed as some of these classifications may not be appropriate for the particular ecology of the site. These can be adjusted to be more site appropriate if it seems palatability is varying from their current categorisation. Consider approaching the University of Otago Wildlife Management programme to conduct a site specific palatability survey.

- Remeasure permanent vegetation plots set up by Wildlands (2011) or incorporate canopy analysis into SRI transects. Use this data to draw further conclusions as to the forest's regeneration potential, especially to identify any canopy species that may not have any measurable regeneration. The addition of data from permanent vegetation plots, measured on a regular basis within the most valued forest types would aid in our understanding of patterns of long term forest regeneration and how it is being impacted by ungulate browsers (note that SRI and browse score are only indicators on a short / medium timeframe).
- Ungulate control can be a challenging topic in rural communities where hunting provides a significant recreation and food resource. Where possible, ungulate management should be conducted collaboratively and support Runaka mahika kai programs and leverage the local knowledge and skills of hunters. Initiatives like community supported pig trapping could be a practical means of increasing local pig control in and around the reserve while supporting local food resilience initiatives.

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References

Coomes D.A., Allen R.B., Forsyth D.M., Lee W.G. 2003. Factors preventing the recovery of New Zealand forests following control of invasive deer. Conservation Biology. 17:450-459.

Department of Conservation 2025. Seedling Ratio Index (SRI) Field Protocol, Wild Animal Monitoring Outcomes Pilot 2024-25 Version 3. 20 February 2025.

Ewans R.A. 2018. Seedling Ratio Index monitoring on Secretary Island: Monitoring vegetation outcomes of deer eradication between 2006 and 2017. Department of Conservation Te Anau area office internal report.

Forsyth D.M., Coomes D.A., Nugent G, Hall, G.M.J. 2002. Diet and diet preferences of introduced ungulates (Order: Artiodactyla) in New Zealand. New Zealand Journal of Zoology.29:323-343.

Krull C.R., Choquenot D., Burns B.R., Stanley M.C. 2013. Feral pigs in a temperate rainforest ecosystem: disturbance and ecological impacts. Biological Invasions 15: 2193–2204 (2013) https://doi.org/10.1007/s10530-013-0444-9.

Nugent G, Fraser W, Sweetapple P.J. 2001. Top down or bottom up? Comparing the impacts of introduced arboreal possums and 'terrestrial' ruminants on native forests in New Zealand. Biological Conservation 99:65-79.

Parkes J.P., Easdale T.A., Williamson W.M., Forsyth D.M. 2015. Causes and consequences of ground disturbance by feral pigs (Sus scrofa) in a lowland New Zealand conifer–angiosperm forest. New Zealand Journal of Ecology 39,1: 34-42.

Sweetapple P.J., Nugent G. 2004. Seedling rations: a simple method for assessing ungulate impacts on forest understories. Wildlife society bulletin.32: 137-147.

Sweetapple P.J., Burns B.R. 2002. Assessing the response of forest understoreys to feral goat control with and without possum control. Science for Conservation 201:33pp.

Wildland Consultants 2008. Ecological survey of Mt Watkin Scenic Reserve, East Otago, April 2008, Report no. 1933 prepared for Dunedin City Council.

Appendix 1: Palatability Index

Species	Species code used	Palatability class	Reference/rationale	Notes
Aristotelia serrata	ARIser	P	Forsyth et al. 2002	
Asplenium bulbiferum	ASPbul	P	pers. obs.	
Asplenium gracillimum	ASPgra	P	based on others in genus	
Lomaria discolor	BLEdis	A	Forsyth et al. 2002	
Brachyglottis sciadophila	BRAsci	NS	Forsyth et al. 2002 and pers obs (MCU)	
Carex species	CAREX	A	Forsyth et al. 2002	
Carmichaelia petriei	CARpet	P	Forsyth et al. 2002 based on others in genus	
Carpodetus serratus	CARser	NS	Forsyth et al. 2002	
Coprosma areolata	COPare	NS	based on others in genus	
Coprosma ciliata	COPcil	NS	pers. obs.	
Coprosma crassifolia	COPcra	NS	based on others in genus	
Coprosma linariifolia	COPlin	NS	based on others in genus	
Coprosma propinqua	COPpro	NS	based on others in genus	
Coprosma rhamnoides	COPrha	A	Forsyth et al. 2002	
Coprosma species	COPROS	NS	based on others in genus	

Coprosma rotundifolia	COProt	NS	pers. obs.	
Coprosma rubra	COPrub	NS	based on others in genus	
Coprosma virescens	COPvir	NS	based on others in genus	
Corokia cotoneaster	CORcot	NS	pers obs (MCU)	
Cyathea dealbata	CYAdea	A	pers. obs.	
Cytisus scoparius	CYTsco	NS	pers obs (MCU)	
Dacrycarpus dacrydiodes	DACdac	A	Forsyth et al. 2002	
Dicksonia fibrosa	DICfib	NS	Mitchell et al. 1987 and Forsyth et al. 2002 (based on others in genus)	
Fuschia excorticata	FUCexc	P	Forsyth et al. 2002	
Fuschia perscandens	FUCper	P	based on others in genus	Non- target species for SRI, climber
Griselinia littoralis	GRIlit	P	Forsyth et al. 2002	
Helichrysum lanceolatum	HELlan	NS	pers obs (MCU)	
Hoheria angustifolia	HOHang	P	Based on similar species	
Kunzea ericoides	KUNeri	A	Forsyth et al. 2002	
Leptospermum scoparium	LEPsco	A	Forsyth et al. 2002	
Leycesteria formosa	LEYfor	NS	pers. obs.	
Libertia ixioides	LIBixi	NS	pers obs (MCU)	
Lophomyrtus obcordata	LOPobc	A	pers obs (MCU)	

Melicytus alpinus	MELalp	P	Forsyth et al. 2002 (based on others in genus)	
Melicytus micranthus	MELmic	P	Based on other species in genus	
Melicytus ramiflorus subsp. Ramiflorus	MELram	P	Forsyth et al. 2002	
Melicope simplex	MELsim	P	Forsyth et al. 2002 (based on others in genus)	
Myrsine australis	MYRaus	P	Forsyth et al. 2002	
Myrsine divaricata	MYRdiv	NS	Forsyth et al. 2002	
Pennantia corymbosa	PENcor	NS	Forsyth et al. 2002	
Pittosporum eugenioides	PITeug	A	Forsyth et al. 2002	
Pittosporum tenuifolium	PITten	A	Forsyth et al. 2002	
Plagianthus regius	PLAreg	NS	pers observation (MCU)	
Podocarpus totara	PODtot	A	Forsyth et al. 2002	
Polystichum neozelandicum subsp. neozelandicum	POLric	NS	based on other spp in genus	
Polystichum vestitum	POLves	NS	Forsyth et al. 2002	
Prumnopitys taxifolia	PRUtax	A	Forsyth et al. 2002	
Pseudowintera colorata	PSEcol	A	Forsyth et al. 2002	
Pseudopanax crassifolius	PSEcra	P	Forsyth et al. 2002	
Pseudopanax ferox	PSEfer	NS	based on other spp in genus (PSElin NS by Richies pers obs)	

Raukaua anomalus	RAUano	NS	Forsyth et al. 2002	
Sambucus nigra	SAMnig	NS	Forsyth et al. 2002	
Scandia geniculata	SCAgen	A	pers obs MCU	
Schefflera digitata	SCHdig	P	pers obs MCU	
Solanum aviculare	SOLavi	A	pers obs MCU	
Sophora microphylla	SOPmic	NS	Forsyth et al. 2002	
Streblus heterophyllus	STRhet	NS	per obs MCU and based on pala of species with similar growth habit	
Tropaeolum speciosum	TROspe	A	pers obs MCU	Non- target species for SRI, climber
Ulex europeaus	ULEeur	NS	pers obs MCU	
Urtica ferox	URTfer	A	pers. obs.	
Veronica salicifolia	VERsal	NS	Forsyth et al. 2002 based on similar species in genus	
Ulex europeaus	ULEeur	NS	pers obs MCU	
Urtica ferox	URTfer	A	pers. obs.	
Veronica salicifolia	VERsal	NS	Forsyth et al. 2002 based on similar species in genus	

Appendix 2: Map of Vegetation and Habitats in Mt Watkin Scenic Reserve

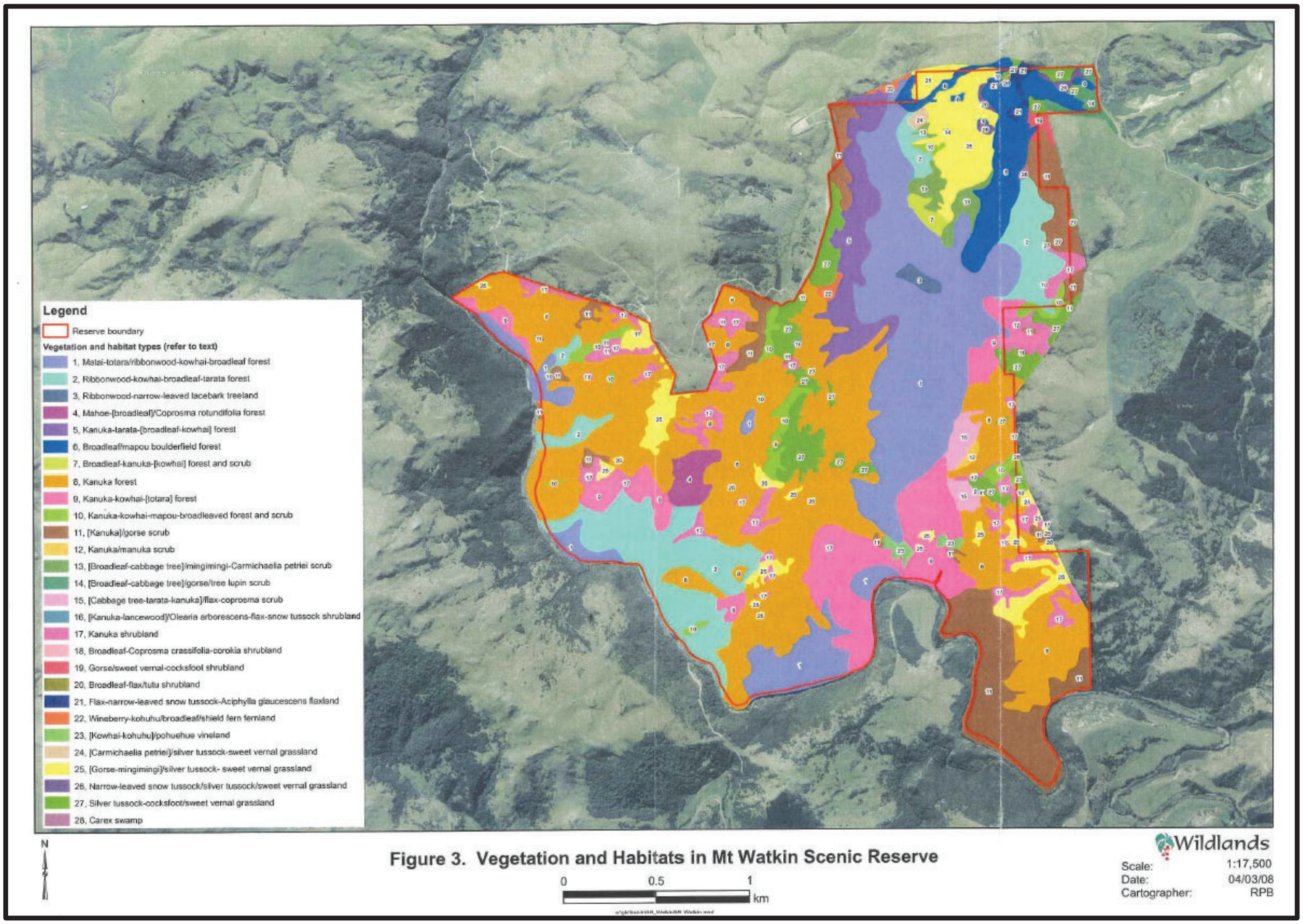

Figure 3. Vegetation and Habitats in Mt Watkin Scenic Reserve

Map produced by Wildlands, 2008