



Department of  
Conservation  
*Te Papa Atawhai*



# Aerial insights to characterise and develop indicators of coastal active dune condition

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*Photo: Whatipu Beach, Auckland*



# We need to monitor indicators of active dunes to know if restoration is working

- Active dunes provide vital services to people, yet extent is declining the world over.
- There are relatively few quantitative studies
- Remotely sensed imagery can improve monitoring coverage and accuracy



Active dunes



Stabilised dunes





Can indicators be developed from aerial imagery for monitoring coastal active dune condition?

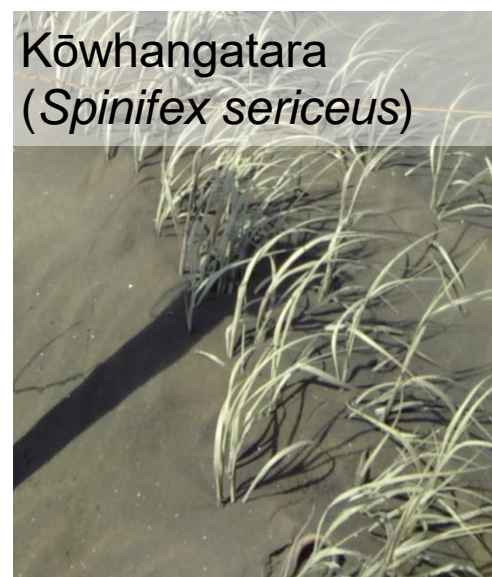
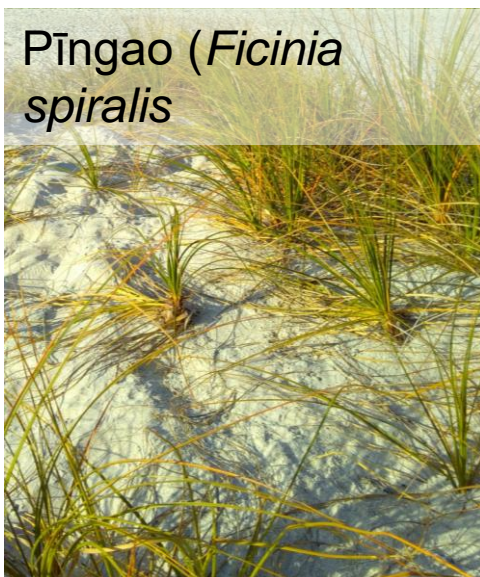
A case study from Aotearoa New Zealand



# Candidate indicators: NZ active dunes

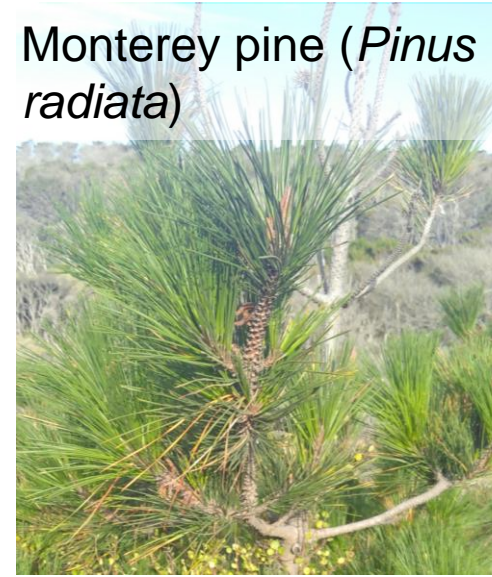
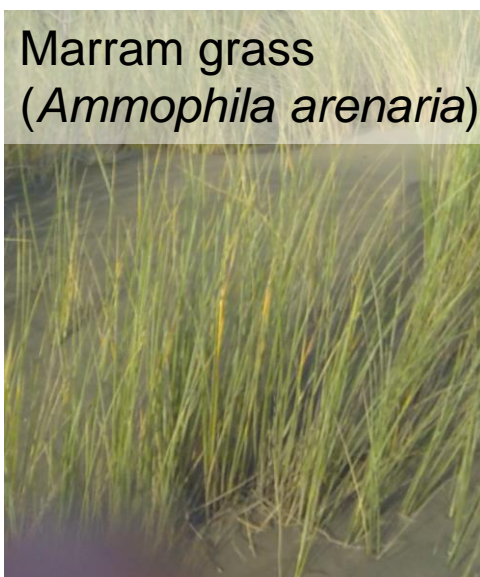
ACTIVE

Native  
sandbinders

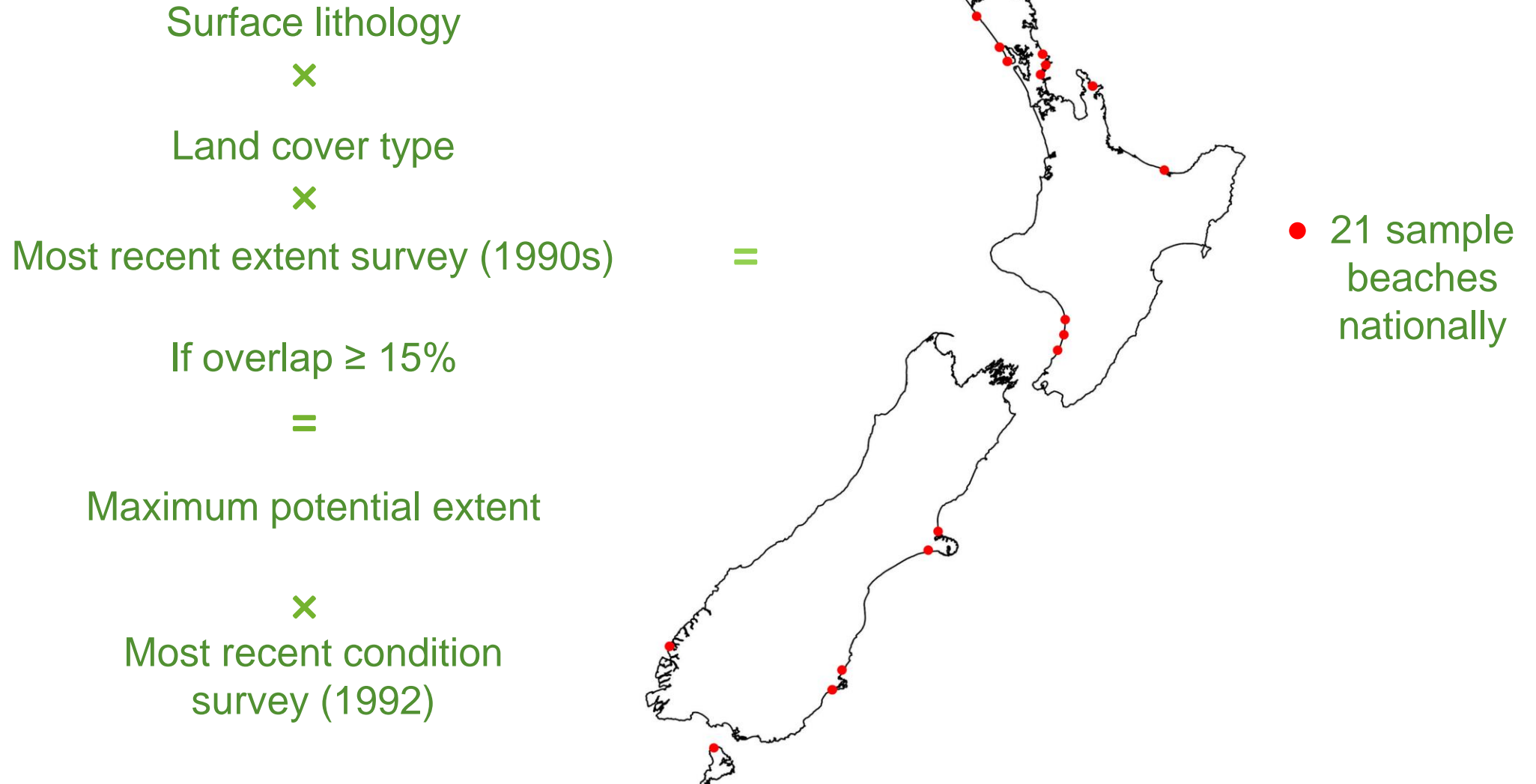


STABILISING

Invasive  
species

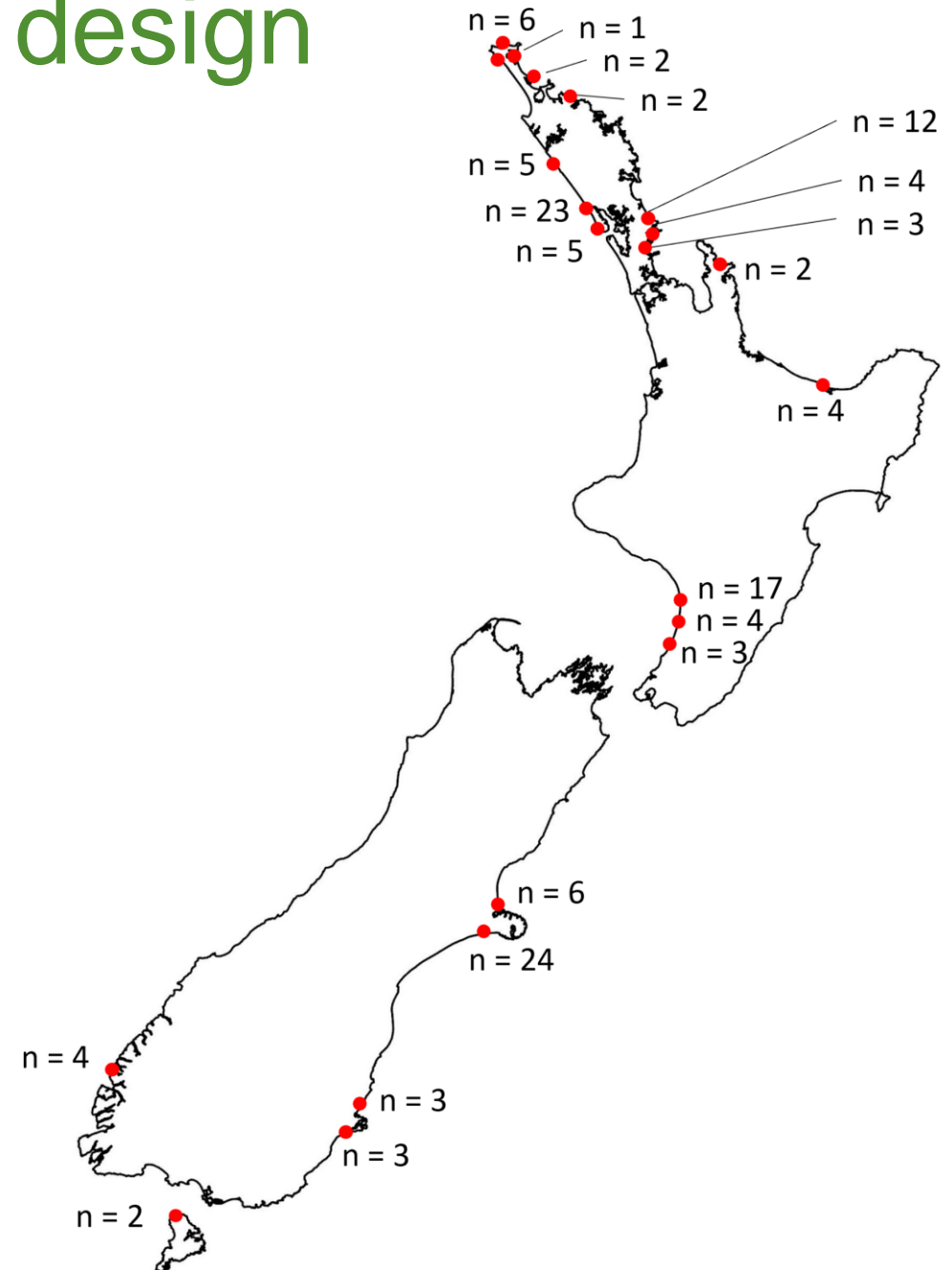


# Using geospatial tools to estimate where active dunes could be





# Sample design



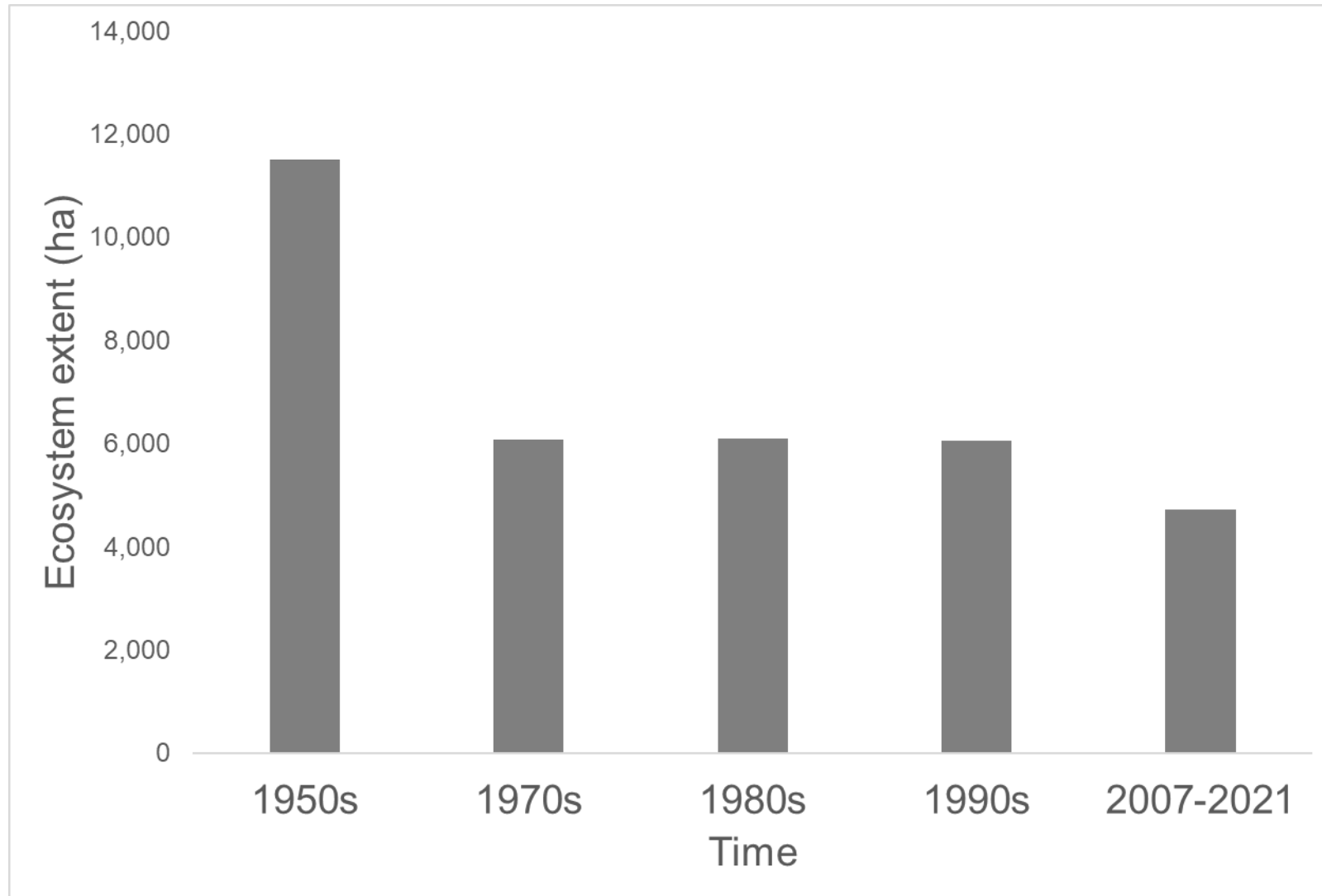
- Most recent, high resolution, RGB aerial imagery
- 135 x c.1 ha plots
- 1 km apart
- over 21 beaches

# Results: Decline in extent (close up at one beach)



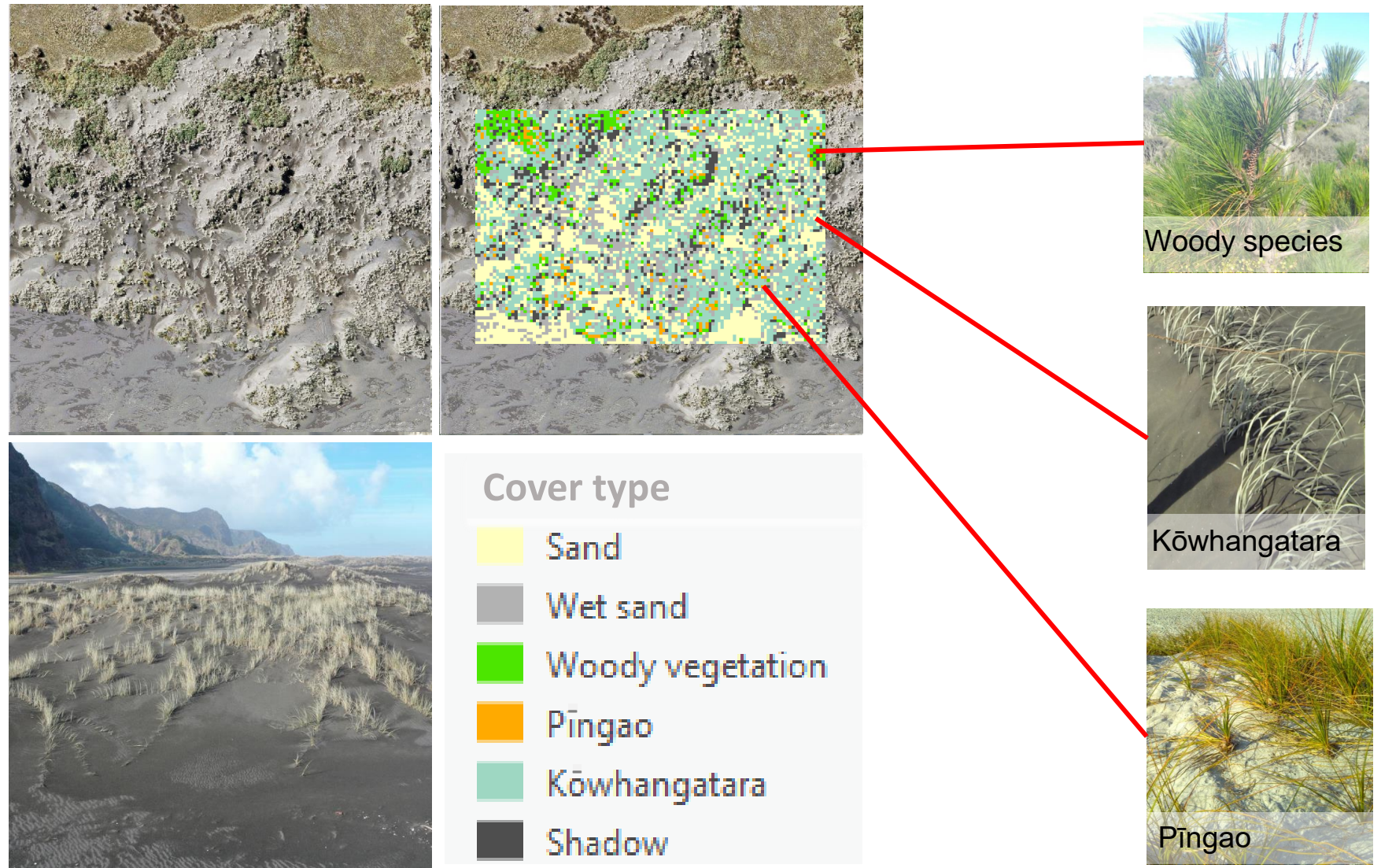
Example of the mapped extent for one active dune ecosystem 1950 – 2019

# Results: Decline in extent – all beaches





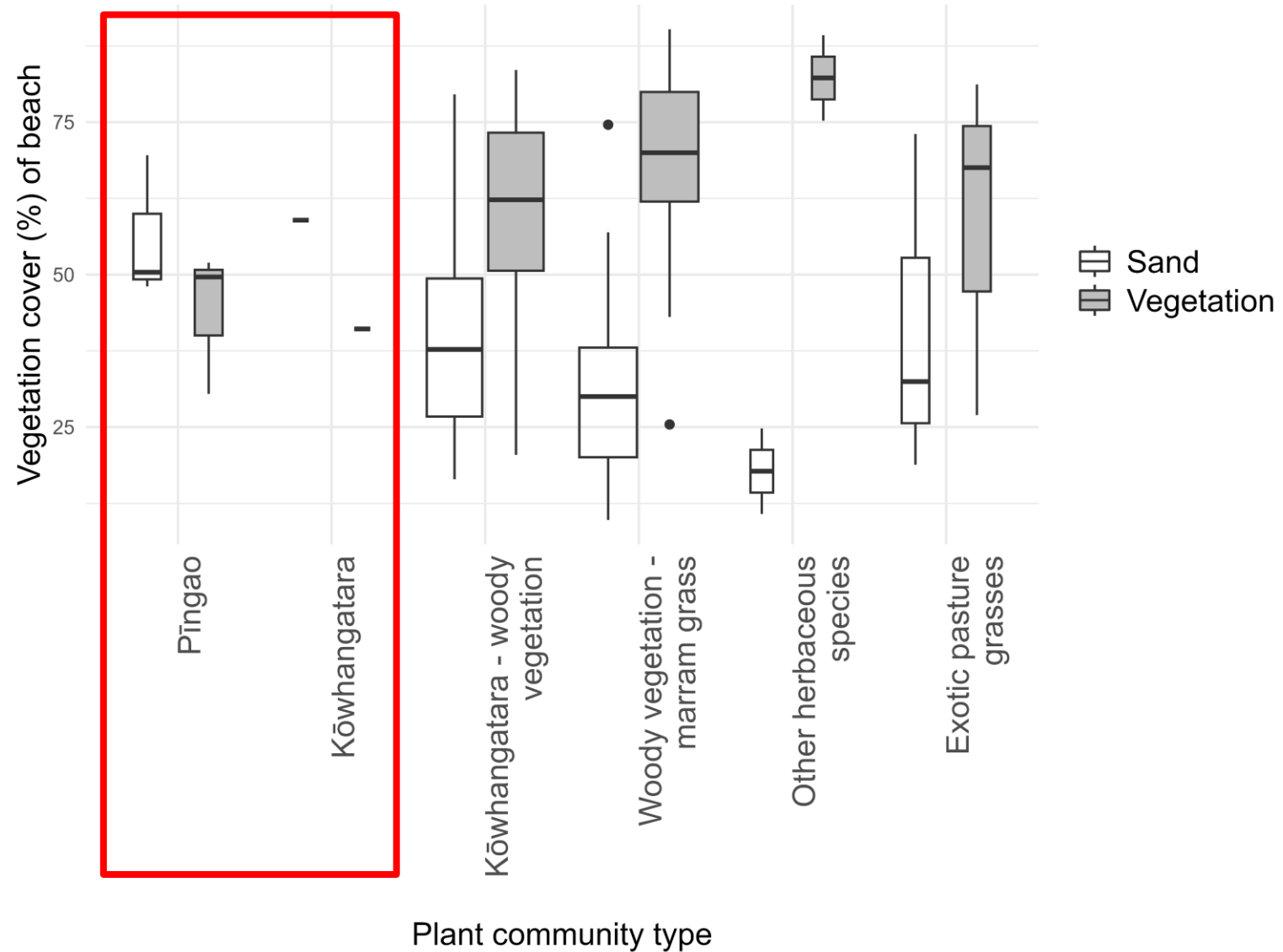
# Results: Image classification - cover types



- 21 cover types, aggregated into 9 broad types

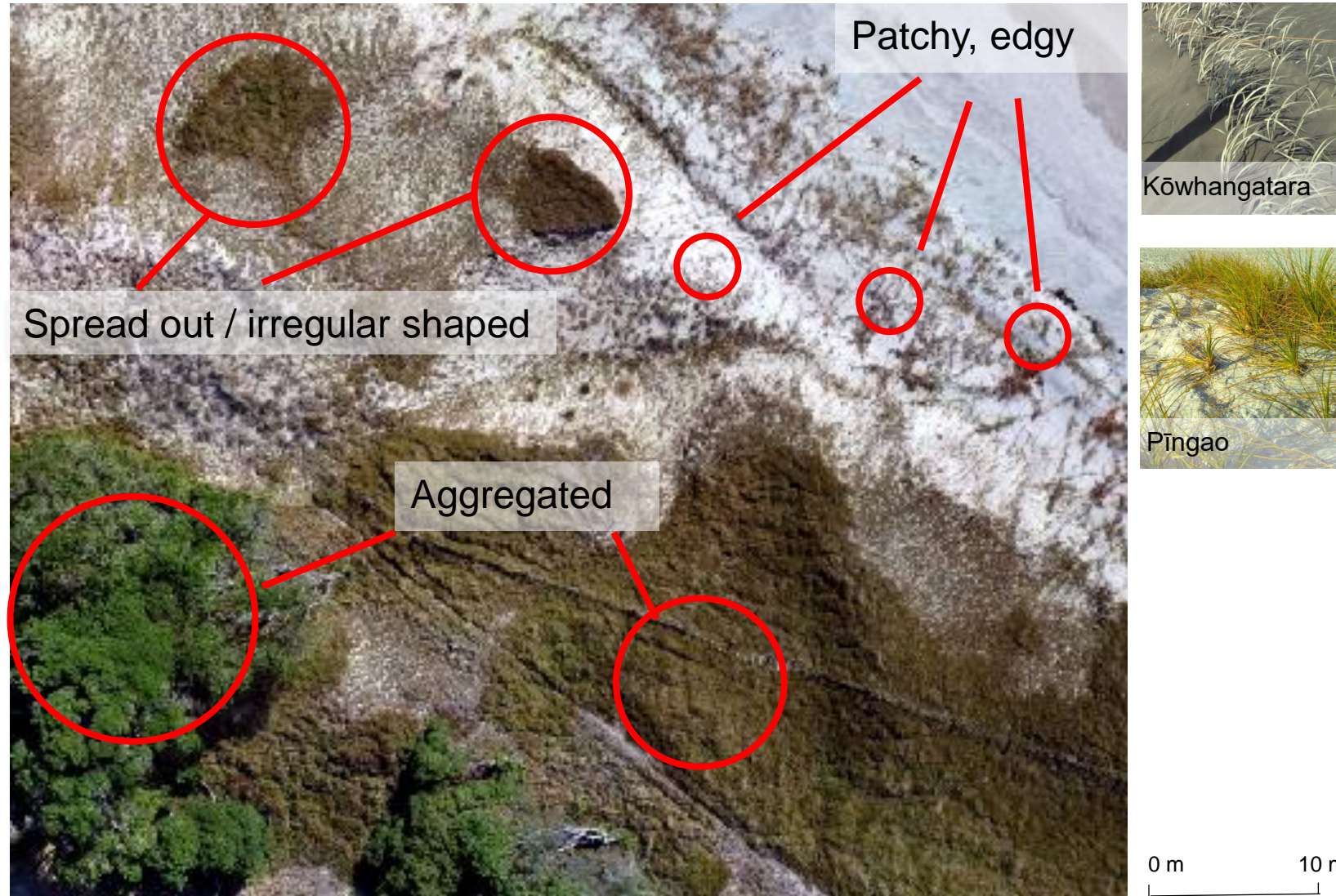


# Results: proportion of sand to vegetation indicates **active** dunes



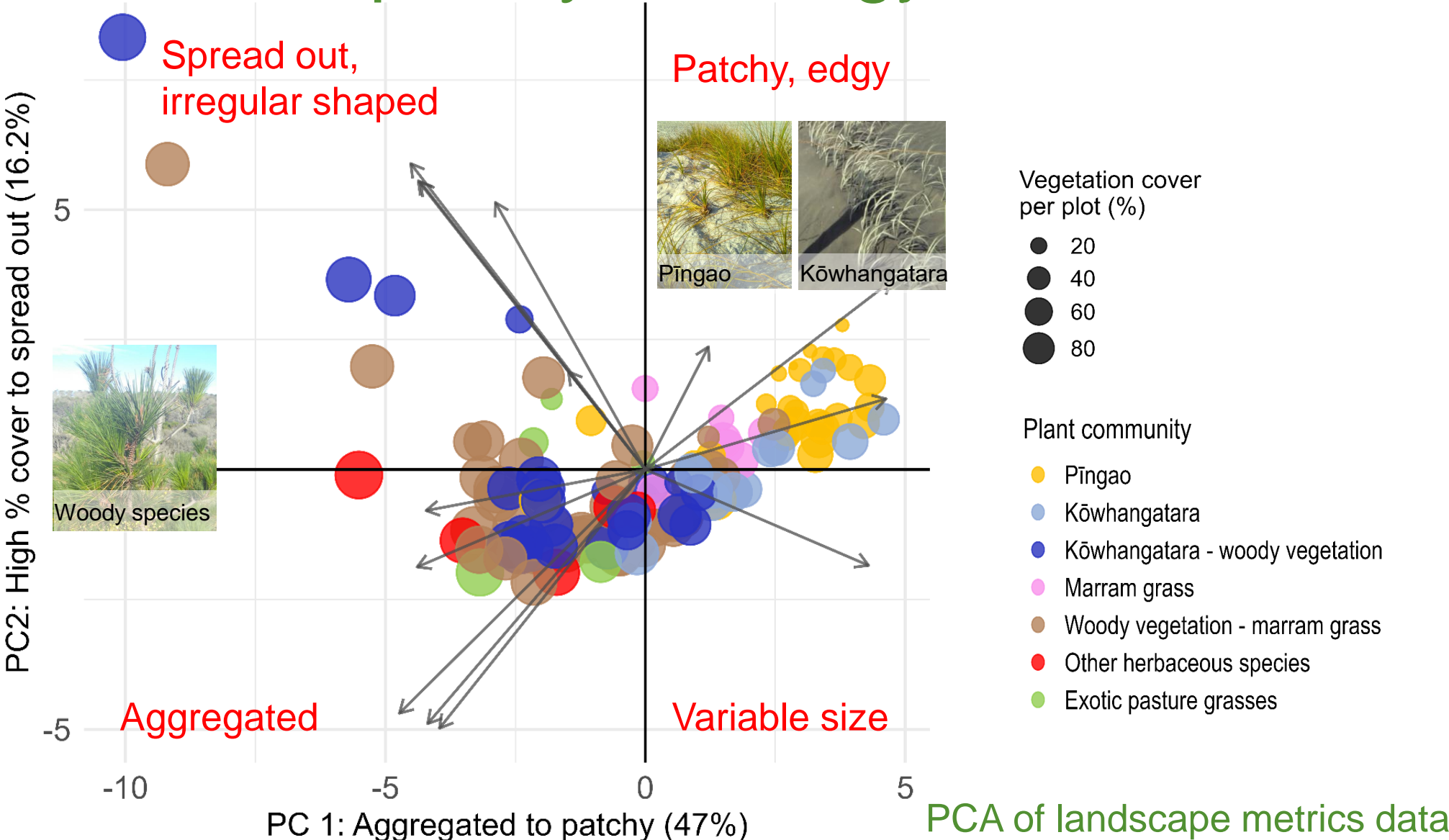


# Spatial pattern of vegetation as an indicator of ecosystem structure

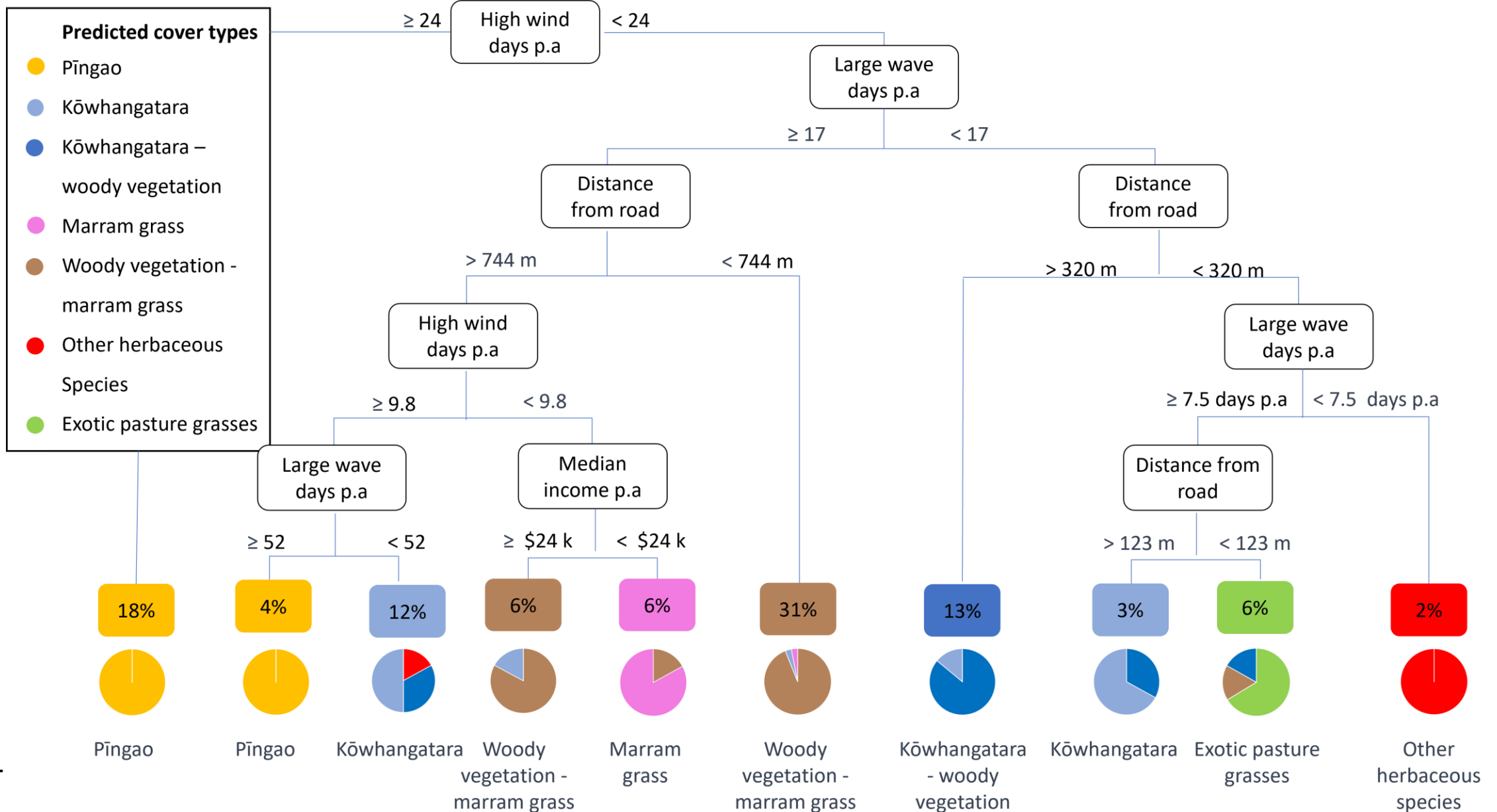




# Results: Native sandbinder vegetation is more patchy and edgy



# Human influence affects vegetation type





# Summary

- Aerial imagery provides information at large spatial scale about dune condition, such as:
  - Ecosystem extent
  - Community composition as an indicator of how active dunes are
  - Vegetation spatial pattern as an indicator of ecosystem structure
- Future applications:
  - The basis of a method for data - scarce areas
  - Input to ecosystem assessments
  - Monitoring of temporal dynamics, e.g., ecological restoration, disturbance, impacts of invasives



# Questions?

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Ryan, C., Case, S.B., Bishop, C.D, Buckley, H.L. (2023). Ecosystem integrity of active sand dunes: A case study to implement and test the SEEA-EA global standard, from Aotearoa New Zealand. *Ecological Indicators*, Volume 149. <https://doi.org/10.1016/j.ecolind.2023.110172>

Ryan, C., Buckley, H.L., Bishop, C.D., Hinchliffe, G., Case, S.B. (in press). Quantifying vegetation cover on coastal dunes using nationwide aerial image analysis. *Remote Sensing in Ecology and Conservation*.





Supplementary

# Combined sites accuracy assessment

Cover class	Sand	Woody vegetation	Water	Other	Exotic pasture grasses	Pīngao	Kōwhangata	Marram grass	Other herbaceous species	Total	User's accuracy
Sand	1376	73	0	6	30	24	78	62	25	1674	0.82
Woody vegetation	60	1352	0	26	36	5	20	76	33	1608	0.84
Water	9	27	11	0	3	0	0	0	0	50	0.22
Other	56	120	0	200	1	4	12	8	1	402	0.50
Exotic pasture grasses	17	21	0	1	343	0	2	37	0	421	0.81
Pīngao	50	27	0	6	0	163	4	0	0	250	0.65
Kōwhangata	111	50	0	4	19	2	462	24	16	688	0.67
Marram grass	10	35	0	0	9	0	9	334	2	399	0.84
Other herbaceous species	80	43	0	0	3	0	7	13	240	386	0.62
Total	1769	1748	11	243	444	198	594	554	317	5878	0.00
Producer's accuracy	0.78	0.77	1.00	0.82	0.77	0.82	0.78	0.60	0.76		
Overall accuracy											0.76
Kappa											0.70

Fig. 6. Aggregated confusion matrix for the nine aggregate cover classes across all beaches. The cover classes assigned to each validation segment through image classification were compared to those assigned visually using reference sources. Diagonal shaded cells represent the number of correctly classified segments for each cover class. The off-diagonal cells indicate the misclassifications between different cover classes. Overall accuracy is the number of correctly classified segments divided by the total segments in the sample. Kappa is another misclassification measure that compares overall accuracy to a random classification.



# Sand binders – ecosystem engineers



*Pīngao* (<https://www.agefotostock.com> n.d)



*Carex pumila*, sand sedge ([wikimediacommons](https://commons.wikimedia.org/wiki/File:Carex_pumila.jpg), 2019)



*Kōwharatanga / spinifex* (Hinchliffe, G., 2021)



*Shore convolulus*, rauparaha (John Barkla CC BY)



# Shore birds



*NZ Fairy tern, National Geographic, 2010*



*NZ Dotterel nesting (DoC, n.d)*



*Black fronted tern with skink (Te Ara, n.d)*



# *Pericoptus spp.:* Ngungutawa, native sand binders and driftwood



Adult and larvae stage of *Pericoptus truncatus* (George V Hudson, 2016)



Ngungutawa, large sand scarab, *Pericoptus truncatus* (INaturalist image 58947605, by Shaun Lee)

# Skinks and geckos - seed dispersers



Shore skink, *Oligosoma smithi* ([reptiles.org.nz](http://reptiles.org.nz))



Pōhuehue fruits ([CitiSchHub](http://CitiSchHub), n.d)



# Katipō and native sandbinders



Image: Katipō spider, (Buckley, H., n.d)