MOLECULAR APPROACHES TO IDENTIFY BENIGN DENITRIFICATION IN SHALLOW GROUNDWATERS

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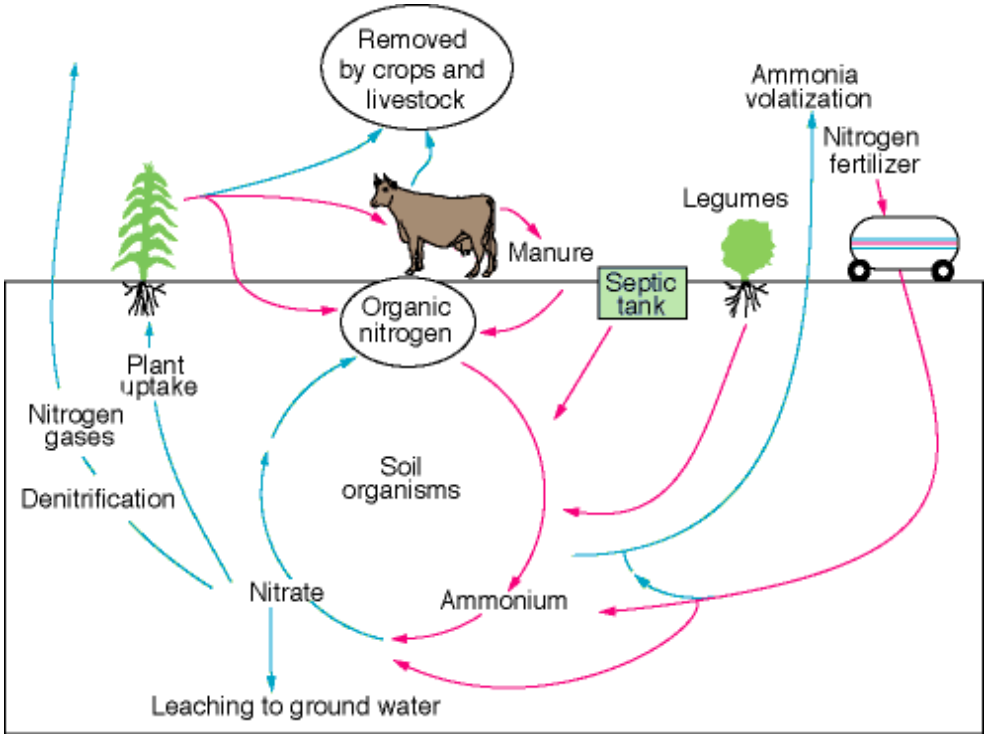
Intensification of agricultural activities

Nitrate discharge in waterways

Water pollution, GHG emissions



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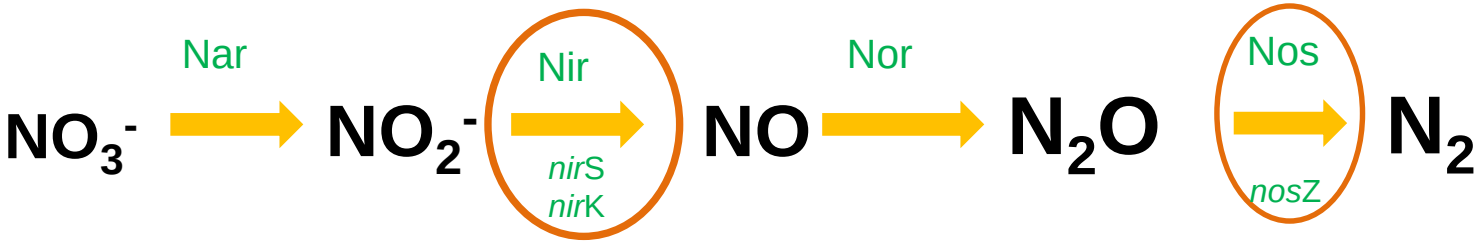
SUBSURFACE DENITRIFICATION



BENIGN DENITRIFICATION

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OBJECTIVE

To identify environmental and hydrogeological conditions leading to benign subsurface denitrification in agricultural catchments

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APPROACH

SITE SELECTION

Six Contrasting Site- Reducing and non-reducing

Palmerston North

Santoft

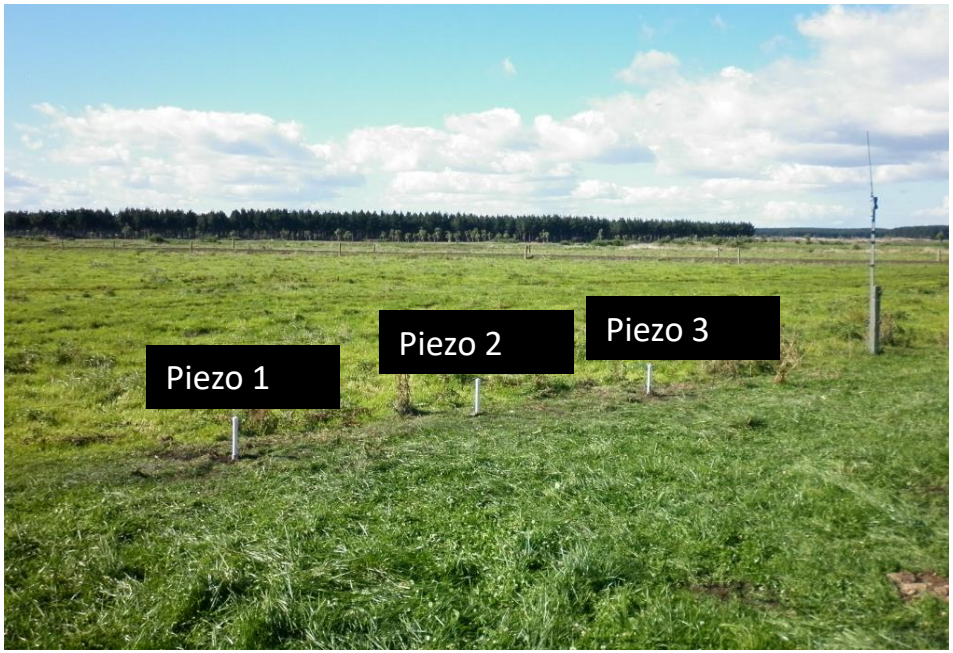
Dannivirke

Woodville

Pahiatua – two sites

Monthly Groundwater Sampling

- Six Sites- Manawatu and Rangitikei Catchment
- Three Piezometers Each
- Three Replicates



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Analytical Measurements

- Redox Parameters- In field and standard laboratory practice
- Dissolved gases (N_2O and N_2) – Denitrification Dynamics Gas Chromatograph
- Denitrifier genes abundances- qPCR techniques

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RESULTS

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REDOX PARAMETERS

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Redox parameters in groundwater samples collected from Manawatu and Rangitikei catchments from Aug 2017 to Sep 2018

Redox Parameter	Range (min-max)	
	Anoxic	Oxic
Dissolved Oxygen **(O_2) (mg L^{-1})**	0.13 to 1.31	3.36 to 7.81
Nitrate **(NO_3^--N) (mg L^{-1})**	0.02 to 1.50	3.17 to 6.93
Iron **(Fe^{2+}) (mg L^{-1})**	0.23 to 5.62	0.02 to 0.13
Manganese **(Mn^{2+}) (mg L^{-1})**	0.03 to 0.52	0.02 to 0.10
Sulfate **(SO_4^{2-}) (mg L^{-1})**	0.32 to 18.38	4.32 to 11.60
Dissolved organic carbon **(mg L^{-1})**	0.00 to 27.06	0.05 to 3.37

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DISSOLVED GASES

Dissolved nitrous oxide in groundwater samples collected from Manawatu and Rangitikei catchments from Aug 2017 to Sep 2018

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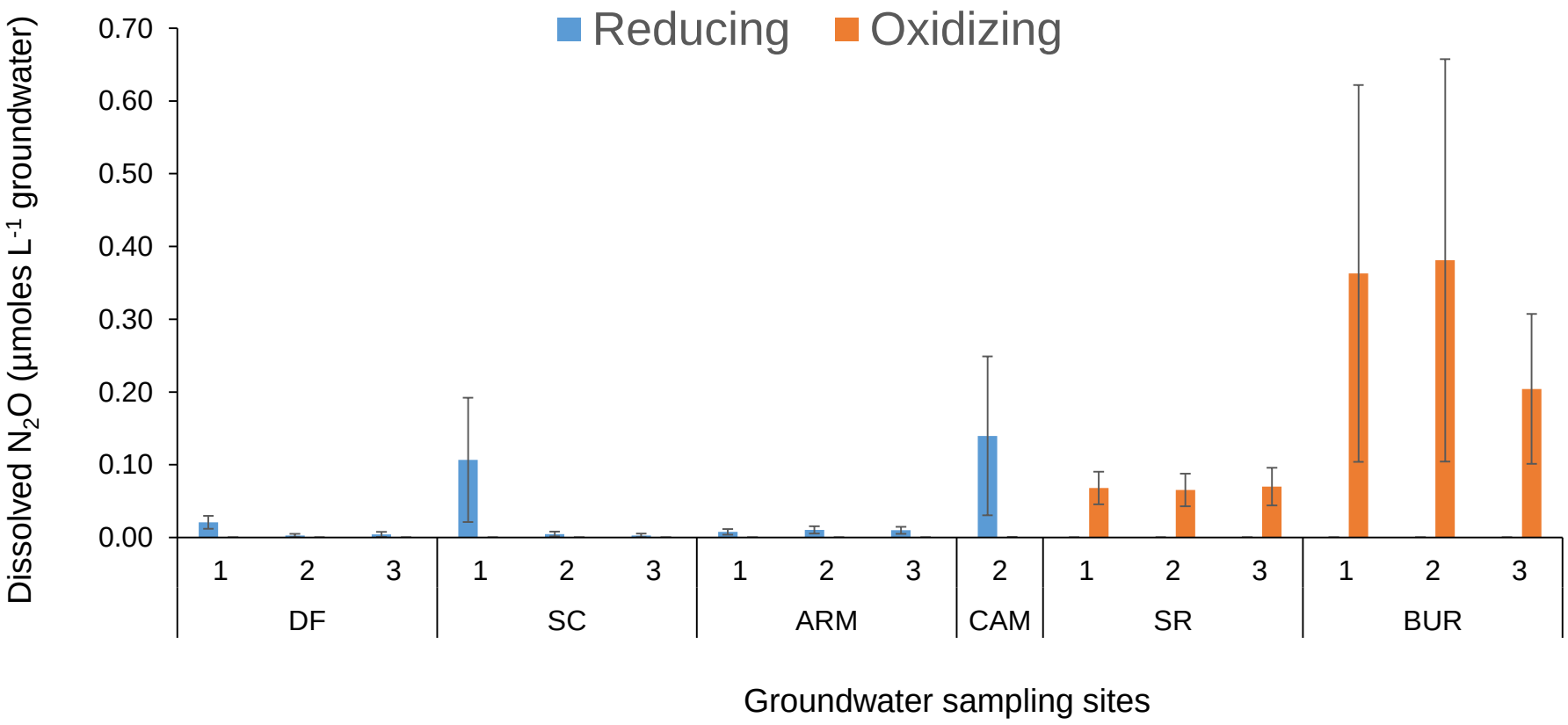
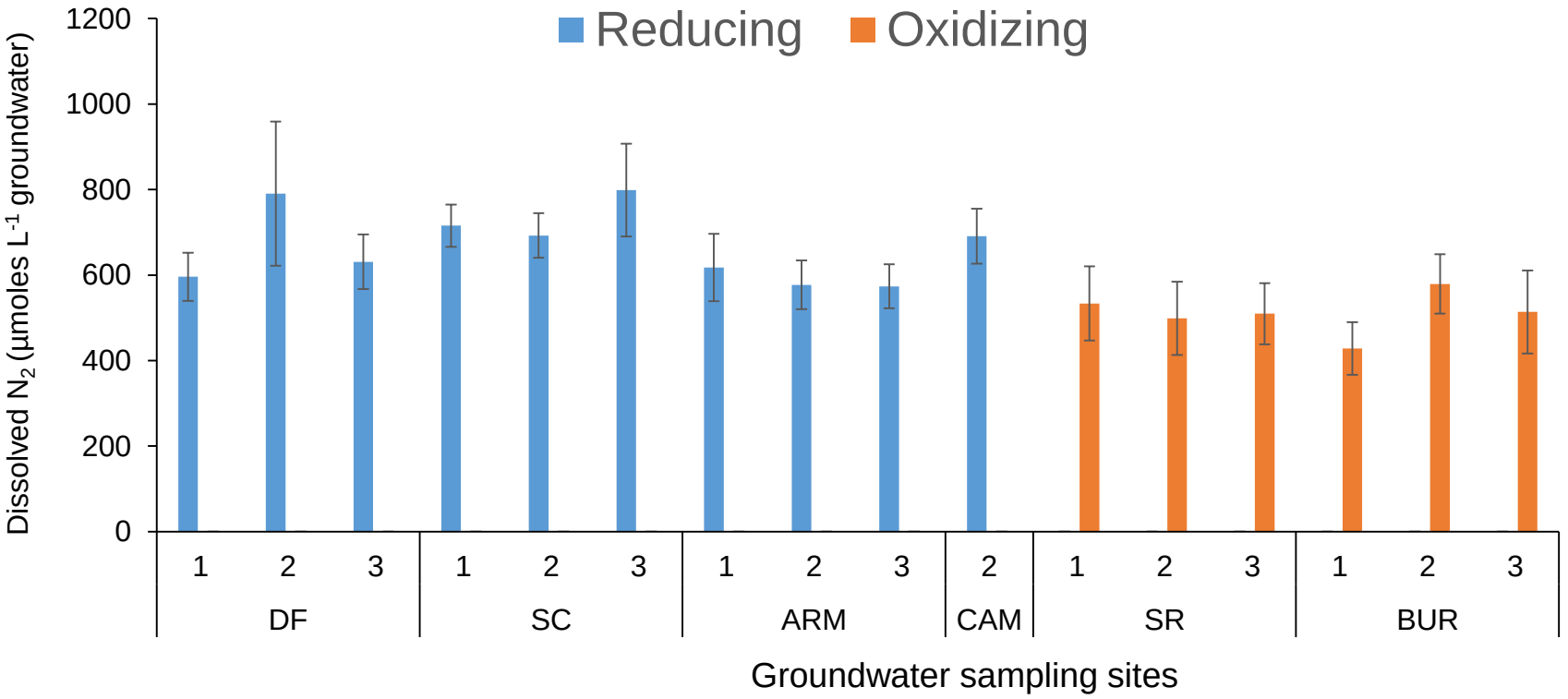


Dissolved dinitrogen in groundwater samples collected from Manawatu and Rangitikei catchments from Aug 2017 to Sep 2018



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DENITRIFIER GENE ABUNDANCE

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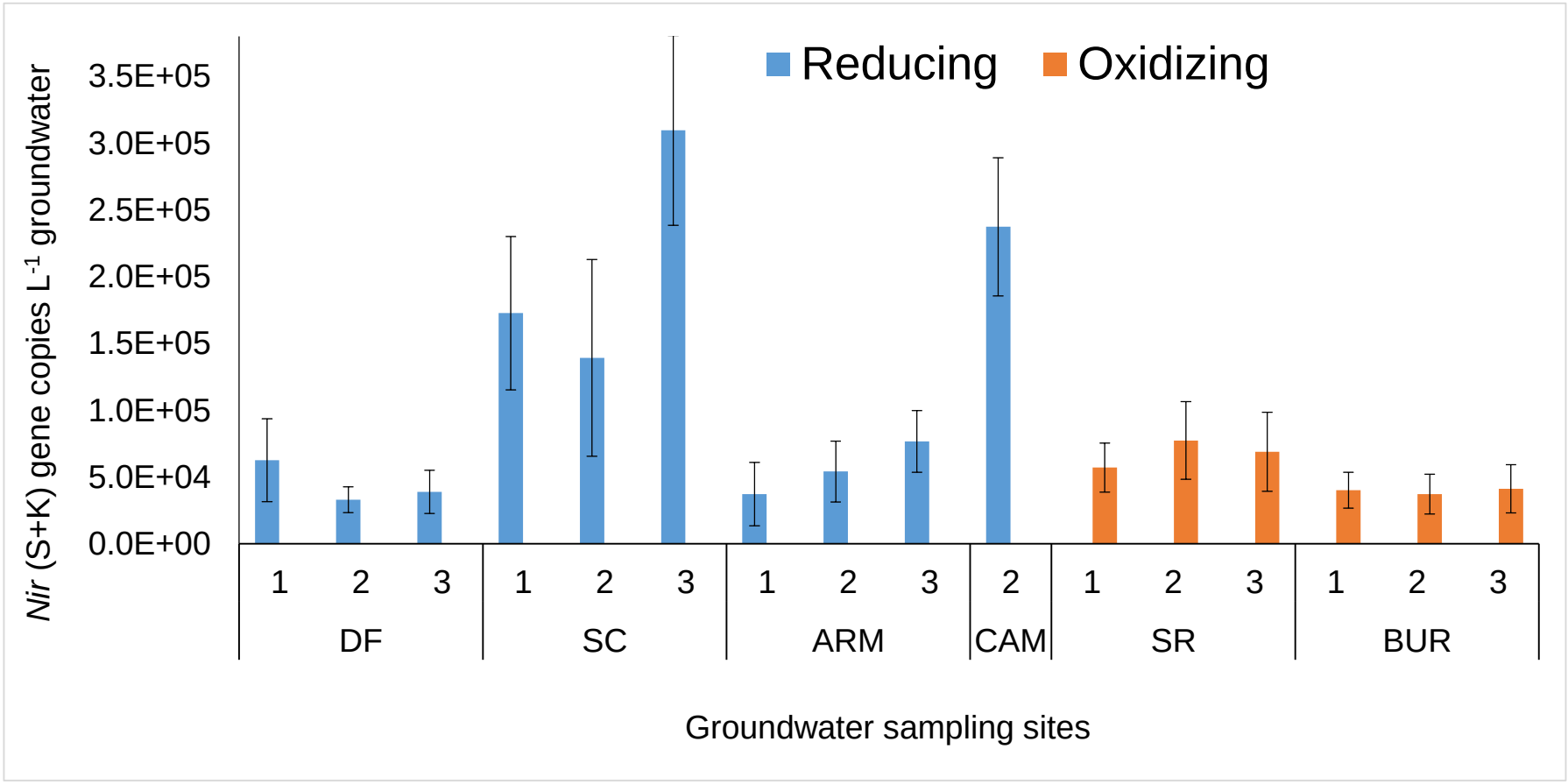
Nir (S+K) gene abundance in groundwater samples collected from Manawatu and Rangitikei catchments from Aug 2017 to Sep 2018



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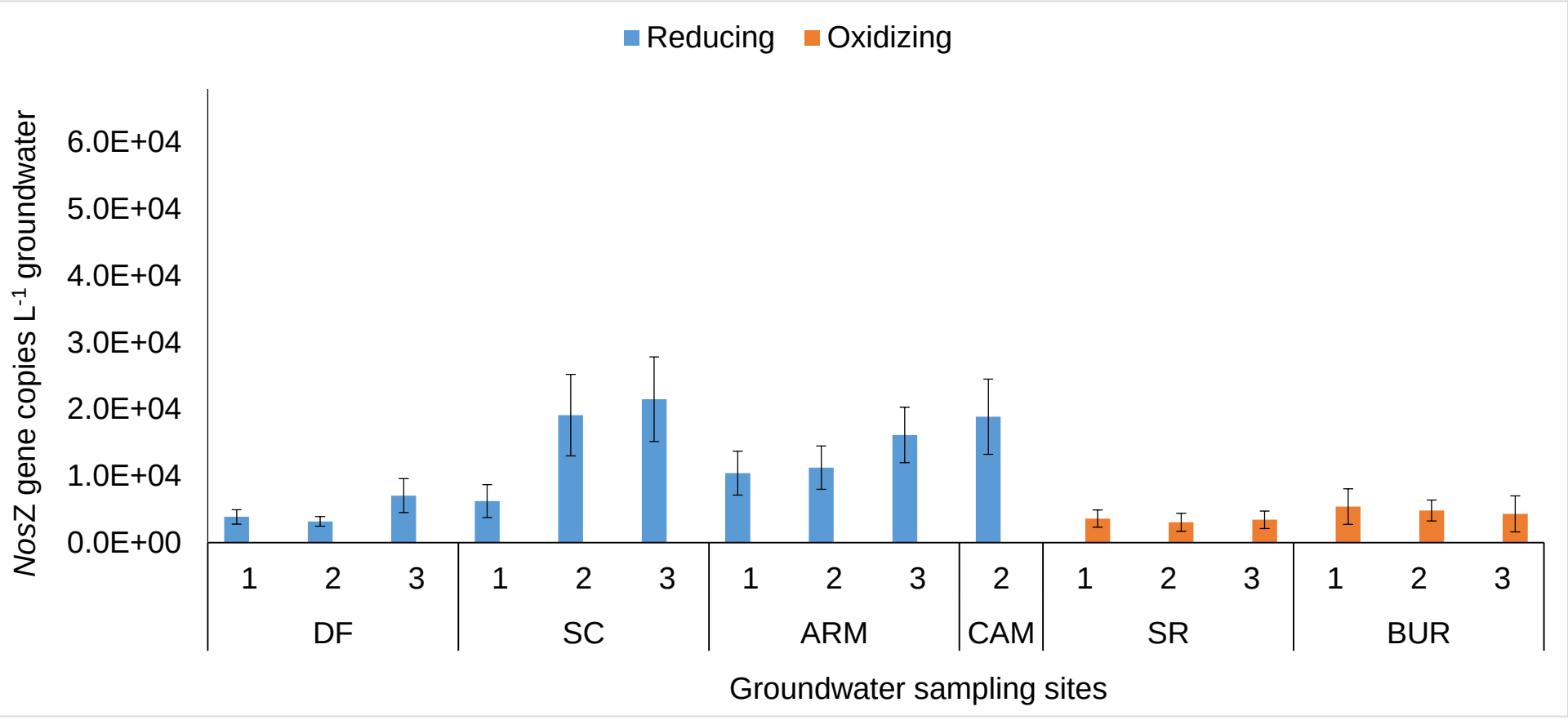
Nos Z gene abundance in groundwater samples collected from Manawatu and Rangitikei catchments from Aug 2017 to Sep 2018



Pearson's correlation coefficient ($P<0.05$) among the measured parameters

	DO	Fe^{2+}	Mn	SO_4^-	NO_3-N	DOC
DO	*	-0.660	-0.474	ns	0.705	ns
Fe^{2+}	-0.660	*	ns	ns	-0.662	0.472
Mn	-0.475	ns	*	ns	ns	ns
SO_4^-	ns	ns	ns	*	ns	0.556
NO_3-N	0.705	-0.662	ns	ns	*	ns
DOC	ns	0.472	ns	0.556	ns	*

Pearson's correlation coefficient (P<0.05) among the measured parameters

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	N_2O	N_2	DNA	*Nir*S+K	*Nos*Z
N_2O	*	ns	ns	ns	ns
N_2	ns	*	0.558	0.638	0.579
DNA	ns	0.558	*	0.731	0.708
*Nir*S+K		0.638	0.731	*	0.441
*Nos*Z	-0.778	0.585	0.752	0.753	*

Comparison of sites based on reducing conditions

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	Anoxic Sites	Oxic Sites
Nitrate Content	Low	High
Fe^{2+}	High	Low
Nitrous Oxide	Low	High
Excess N_2	Low	Marginally High
*Nos*Z gene	High	Low
Nir gene	High	Low

Conclusions

- Oxic sites (DO> 2 mg L^{-1}) shows partial subsurface denitrification of available nitrate
- Anoxic sites (DO< 2 mg L^{-1}) indicates relatively more benign subsurface denitrification (lack of N_2O)
- Relatively higher abundance of *nos*Z gene in the anoxic sites indicates benign subsurface denitrification
- Hydrogeological conditions and more abundant denitrifier or the presence of electron donor such as Fe leads to complete denitrification of nitrate in selected anoxic sites.

Acknowledgements

Our Land and Water- National Science Challenges FLRC Massey University, Horizons Regional Council, Manaaki Whenua-Landcare Research and our support staff

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Thank You