Document ID:

MEMORANDUM

To:	Rhys Francis, Policy Analyst
From:	Erik Button, Land and Soil Scientist
Date:	06/05/2024
Subject:	Provisions for setbacks to limit agrichemicals entering waterways

Name	Role	Date Completed
Markus Dengg	Water Quality Scientist	24/05/2024

Purpose (recommended)

The Science Team were engaged to answer questions relating to the use and provisions for setbacks to minimise agrichemicals (pesticides, herbicides, fungicides) entering waterways. These were:

1. Are the findings from Zhang et al. (2010) scientifically robust and can they be used to inform the development of provisions for agricultural setbacks as outlined in Appendix 1 (of the draft Land and Water regional plan). Is there other literature that should be included in the decision making?
2. Are the draft LWRP provisions in Appendix 1 consistent with scientific evidence?
3. Is there scientific evidence that supports exemptions to the setback provisions proposed in Appendix 1?
4. Is there any other information you think is appropriate? Is there a better approach?

Discussion

Are the findings from Zhang et al. (2010) scientifically robust and can they be used to inform the development of provisions for agricultural setbacks as outlined in Appendix 1 *(of the draft Land and Water regional plan).* Is there other literature that should be included in the decision making?

By analysing data from multiple study sites across a wide geographic area together, the meta-analysis has superior statistical power compared to a single study site due to the large data pool. Thus, the confidence in the assessment of buffer strip efficacy is generally greater with this type of study. However, importantly, of the studies included in the analysis, all sites were in North

America (30) or Europe (9) with only one site outside of these regions (China) and none from the southern hemisphere. The explanatory factors (such as climate, management practices, pesticide, vegetation, and soil types) that are represented by the included studies may not be relevant to Otago. As such, it is difficult to gauge how appropriate the study results are to form the basis of a framework for Otago-based setback provisions for agrichemical use.

In addition, Zhang et al. (2010) identified relevant uncertainties in the model predictions as:

1. The area of the field, which is the source of the runoff; rainfall amount (simulated/irrigation or natural); duration of the studies; and age and/or seasonality of the vegetation in the buffers were unaccounted for by the model.
2. Considerable variations in environmental and management factors between the study sites weaken the predictions as the factors driving the results are more difficult to discern.
3. None of the studies on pesticides had information on the slope of the buffer strips which would help explain additional variation in the data and determine the relationship between slope and buffer efficacy.
4. Agrichemicals that adsorb to organic carbon or fine soil particles (which many do), were not accounted for by the model. These pesticides can be more easily intercepted by the buffer and so would suggest removal efficacy may be even higher than predicted.

With the above in consideration, the authors found robust evidence in support of buffer width for the removal of pesticides, with buffer width the strongest predictor in pesticide removal (60%) and a strong relationship between buffer width and pesticide removal efficacy (Fig. 1). The model predicts a buffer strip of 5 m, 10 m, 15 m, 20 m and 30 m to remove 62%, 83%, 90%, 92% and 93% of pesticides, respectively. As can be seen by the plotted data points in Figure 1, there is considerable variation in efficacies relative to the modelled line.

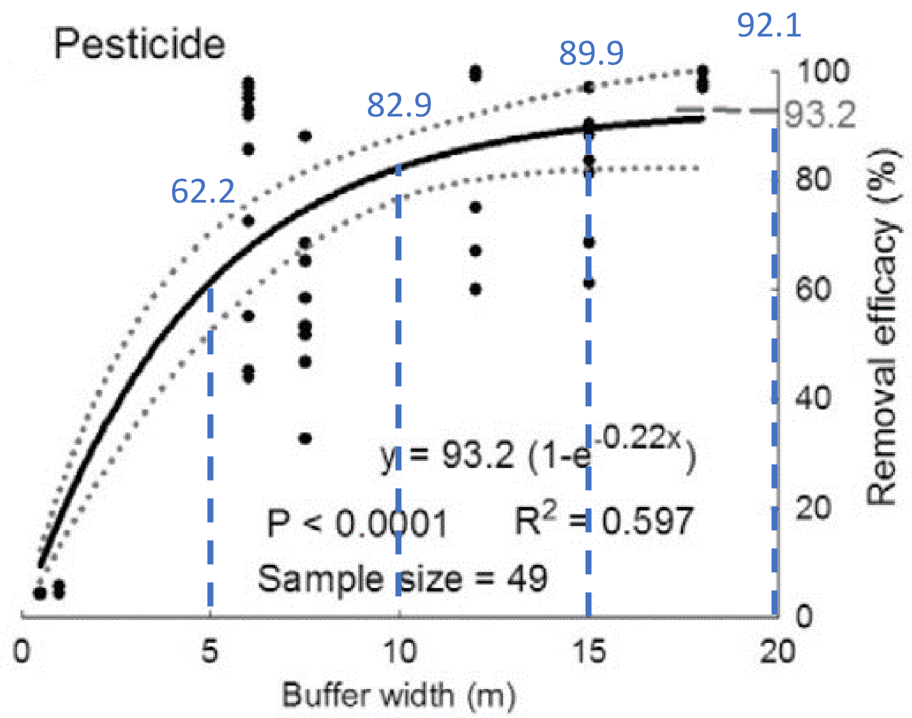

Fig. 1 The relationship between the width of a vegetated buffer and the removal efficacy of pesticides (Zhang et al., 2010). The solid and dotted lines are the model prediction and 95% confidence bands. The grey dashed line and number represents the removal efficiency at 30 m buffer width. The added blue dashed lines and values are the model predictions for different buffer widths.

A review of scientific evidence by Manaaki Whenua Landcare Researchers Fenemor & Samarasinghe (2020), which was commissioned by Tasman District Council to provide guidance on suitable setback distances can be an additional source for supporting decision-making. While this is not as systematic or statistically powerful as the Zang et al. (2010) work, the interpretation of the available evidence in the New Zealand environmental, agricultural, and legislative contexts makes this particularly relevant to the questions posed herein.

Fenemor & Samarasinghe (2020) make setback recommendations based on the evidence reviewed at a catchment scale in relation to the preservation of six riparian functional objectives from degradation by sediment, pesticide, nitrogen, phosphorus, and *E. coli* (Table 1).

Table 1. Riparian setback recommendations for the six functional objectives

Riparian functional objective	Minimum setback recommendations	Applicability
Reduce nutrient and other contaminant inputs	10 m	For land with slope <10°. Aim is to filter out >80% sediment and pesticide, >70% nitrogen and phosphorus in overland flow, and remove c90% groundwater nitrate in fine shallow riparian sediments
	20 m	For steeper land than 10°
Improve light exposure and water body temperature	10 m	Mature trees needed for shading; buffer width should exceed mature tree height and channel width. Even a single line of trees is beneficial.
Freshwater ecosystem health, terrestrial and aquatic habitat diversity	15 m	To sustain macroinvertebrates, fish, terrestrial biodiversity using a range of riparian vegetation. Riparian biodiversity is easier to sustain with a 15 m setback; smaller setbacks and weedy buffers require more management
Improve channel and bank stability	10 m	Equivalent to the root-mass diameter of a mature riparian tree
Pass and attenuate flood flows	None	Base the riparian setback on the flood characteristics of specific catchment and river reach
Recreational, cultural, aesthetic and landscape values	20 m	A balance of ecosystem service benefits achieved in the longer term

To conclude, the model predictions of Zhang et al. (2010) are scientifically robust due to the design and sample size, and despite the limitations the results can give general indications of possible reductions that can be expected from buffers of varying widths. However, due to the limitations mentioned above, the results alone may not be appropriate for use as a framework for provisions in Otago. The paper by Fenemor & Samarasinghe (2020) builds on work by Zhang et al. (2010) including relevant evidence from New Zealand and interpreting the results in a New Zealand context for the purpose of providing guidance to a Regional Authority (Tasman District Council). As such, Table 1 may be used as guidance for informing setback choices that achieve riparian functional objectives in conjunction with the results from Zhang et al. (2010) and the considerations that are raised in the answer to the next question.

Are the draft LWRP provisions in Appendix 1 consistent with scientific evidence?

Based on evidence from the meta-analysis, the proposed provision of increasing the setback from 5 to 20 m will most likely reduce the volume of agrichemicals entering waterways (Zhang et al., 2010; Prosser et al., 2020). This relationship between buffer width and pesticide reduction is similar in New Zealand (Fenemor & Samarasinghe, 2020).

Due to the shape of the relationship between buffer width and pesticide removal (Fig. 1), where the increase in removal efficiency tapers off at the higher end of buffer widths (consistent with other studies, such as Prosser et al., 2020), a consideration is whether a lower buffer width (<20 m) could be effective in preserving water quality whilst balancing the potential socioeconomic impacts of restricting some primary industry activities from the vicinity of waterbodies (Jorneaux 2019; MfE, 2020).

Modern pesticides commonly adsorb to fine particles in the soil (Fenemor & Samarasinghe, 2020). Importantly, the model used by Zhang et al. (2010) did not account for this and so likely underestimated the pesticide removal efficacy. Glyphosate, the most used herbicide in New Zealand and an active ingredient in a substantial proportion of all pesticides, adsorbs strongly to soil (Hermansen et al., 2020). Managing these pesticides can, therefore, largely be addressed using the same approach as for managing sediment loss to waterways (Zhang et al., 2010). The relationship between sediment removal efficiency and setback width varies between different studies but many show a ≥10 m setback to remove >80% of sediment (Fig. 2).

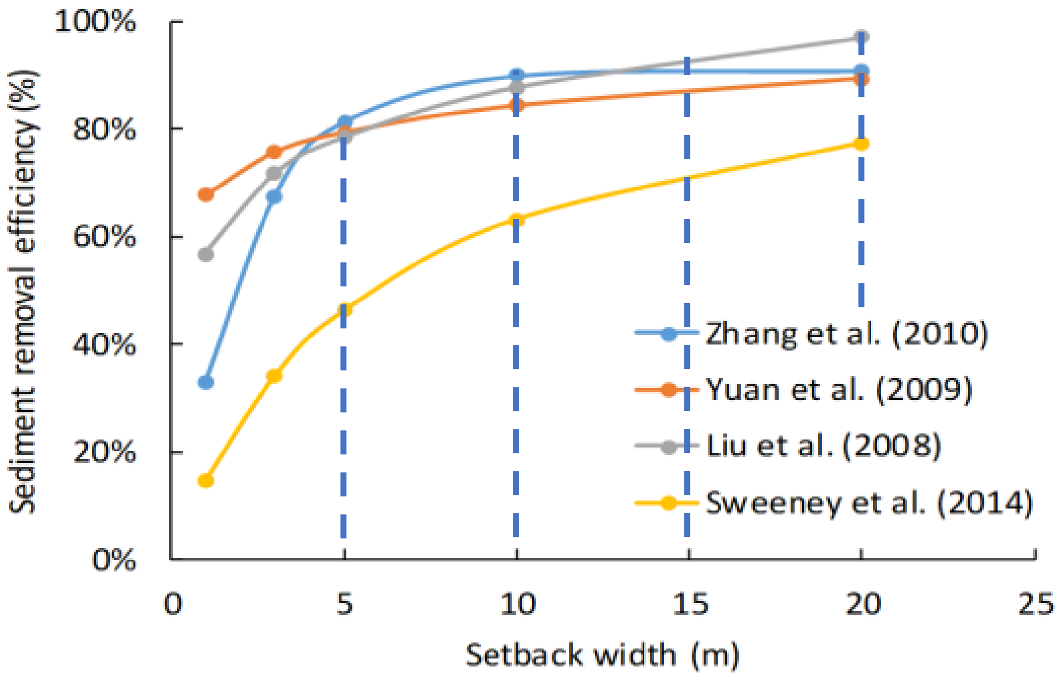

Fig. 2 The best fits of sediment removal efficiencies of riparian setback widths from four studies (MfE, 2020). The added blue dashed lines highlight the removal efficiencies for different widths.

Setback exceptions are discussed under the next question.

Is there scientific evidence that supports exemptions to the setback provisions proposed in Appendix 1?

Freshwater Farm Plans (FWFP; 4, Appendix 1)

FWFPs aim to document, manage, and reduce the impact of farming practices on freshwater. They are certified and audited by a qualified person for consistency and reliability. FWFP requirements include the need to map areas where agrichemicals are used and stored (MfE, 2023) but it is not clear how pesticide use near waterways is managed via FWFPs. In addition, the Government intends to change the FWFP system to be less restrictive and so changes are likely to occur. As of April 2024, implementation of FWFPs in Otago has been paused as changes in regulations are awaited (ORC, 2024). As such, how pesticides will be managed through FWFPs is not known and it is not possible to support an exemption of FWFPs from setback provisions before more information is available.

Pests, pest agents, unwanted organisms, or *organisms of interest* (3di, Appendix 1)

These proposed exceptions are formally defined organisms in the Biosecurity Act (1993) or the Regional Pest Management Plan (2019) that wholly fall under organisms that are managed for biosecurity. Therefore, the management of the spread of these organisms is a regional and national priority and should not be restricted by setback provisions. However, minimising pesticides entering waterways by way of good management practices (such as those in ORC, 2009) should be central to all biosecurity operations.

Handheld devices (3dii, Appendix 1)

The use of handheld spraying devices is often for the purpose of biosecurity and is typically in low volumes in a localised and targeted approach. The potential quantity of pesticide that may enter waterways is likely to be minimal. Allowing this exception can further support biosecurity outcomes and positive environmental management (such as weed control to support native riparian plant establishment). However, minimising pesticides entering waterways by way of good management practices (such as those in ORC, 2009) should be central to the use of handheld spraying devices.

Is there scientific evidence for other practises, other than setbacks, that ensure pesticides do not contaminate waterways?

From a science perspective, setting setback requirements based on the best available evidence that is relevant to the location of interest is the most appropriate way for minimising contamination of waterways. In addition, good management practices (such as those in ORC, 2009) should be followed when using pesticides where setbacks do and do not apply.

Recommendation or Conclusion (required)

In conclusion, answers have been given in the discussion based on an appraisal of different scientific information sources relevant to the questions asked.

References

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Appendix 1:

OTH-R1 – Agrichemical *discharges* to land

OTH-R1-PER1

The *discharge* of an *agrichemical* onto or into *land* in circumstances where a *contaminant* may enter water is a permitted activity if all of the following conditions are met:

(1) the agrichemical is approved for use under HSNO, and its use and discharge is in accordance with all the conditions of the approval; and

(2) the discharge is undertaken in accordance with any manufacturers' directions and the following sections of NZS8409:2021 Management of Agrichemicals:

(a) Part 4: Storage and supply of agrichemicals

(b) Section 5.2 of Part 5: Safe use of plant protection products; and

(c) Part 6: Disposal of agrichemicals and containers; and

(3) the discharge does not occur within

(a) a *drinking water protection zone*; or

(b) 20m of a *bore*, other than a monitoring *bore*; or

(c) until 31 May 2027, the discharge does not occur within 5m of the bed of a river or lake, a natural inland wetland, a modified watercourse, an artificial watercourse, or coastal water; or

(d) from 1 June 2027, 20m of the bed of a river or lake, a natural inland wetland, a modified watercourse, an artificial watercourse, or coastal water, unless:

(i) the *discharge* is for the primary purpose of managing *pests, pest agents, unwanted organisms,* or *organisms of interest*; or

(ii) the discharge is undertaken using *handheld appliances*; and

(4) condition (3) does not apply if:

(a) the discharge is undertaken in accordance with a certified Freshwater Farm Plan that addresses discharges of agrichemicals to land; and

(b) the certified Freshwater Farm Plan includes that the farm operator intends to rely on the certified Freshwater Farm Plan to meet the requirements of this rule; and

(c) a certifier has certified, in accordance with APP[FWFP], that the [risk of] adverse environmental effects is no greater than that allowed for by condition (2); and

(d) where the Freshwater Farm Plan has been audited, the most recent report of the auditor's findings show that the farm achieves compliance with the certified Freshwater Farm Plan as it relates to discharges of agrichemicals to land; and

(5) no mixing or diluting of *agrichemicals*, *occurs* within:

(a) a *drinking water protection zone*; or

(b) 20m of the *bed* of a *river* or *lake*, a *natural inland wetland*, a *modified watercourse*, an *artificial watercourse*, *coastal water* or a *bore*, other than a monitoring *bore; or*

(c) 5m of the *bed* of a *river* or *lake*, a *natural inland wetland*, a *modified watercourse*, an *artificial watercourse*, *coastal water* or a *bore*, other than a monitoring *bore*; if

(i) the mixing or dilution takes place within a sealed, bunded system that will contain a volume of at least 110% of the largest spray tank to be filled; or

(ii) the mixing or dilution is for a hand-held application technique or method; or

(iii) If the water used for mixing or dilution is being abstracted from a surface waterbody or groundwater, a backflow prevention system is in place to prevent the agrichemical from flowing back into the source water; or

(6) the *discharge* does not result in the physical removal of indigenous vegetation or *vegetation clearance,* unless that vegetation is primarily pests, pest agents, unwanted organisms, or organisms of interest or invasive exotic pest plants; and

(7) if undertaking aerial application, aircraft pilots (including drones and unmanned aerial vehicles (UAVs)) hold the following ratings in accordance with the Civil Aviation Rule Part 61 Pilot Licences and Ratings:

(a) Subpart P Pilot Chemical Rating.

OTH-R1-DIS1

Unless provided for by OTH-R1-PER1, the discharge of an *agrichemical* onto or into *land* in circumstances where a *contaminant* may enter water is a discretionary activity.