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# SSPND –Support System for Phosphorus and Nitrogen Decisions – modeling of management practices can guide the way ahead

Simon Neville

David Weaver
*Department of Agriculture and Food, Western Australia*

Rebecca Ovens

Nardia Keipert

Robert Summers
*Department of Agriculture and Food, Western Australia*

*See next page for additional authors*



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## Authors
Simon Neville, David Weaver, Rebecca Ovens, Nardia Keipert, Robert Summers, and Martin Clarke

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# SSPND –Support System for Phosphorus and Nitrogen Decisions – modeling of management practices can guide the way ahead.

Simon Neville[1], David Weaver[2], Rebecca Ovens[1], Nardia Keipert, Robert Summers and Martin Clarke[3]

[1] Ecotones and Associates, 9 Bell Rd, William Bay, Western Australia 6333.
*email: ecotones@westnet.com.au
[2] Department of Agriculture, Western Australia. 444 Albany Hwy, Albany, Western Australia, 6330. Centre for Ecohydrology, University of Western Australia
[3] Department of Agriculture, Western Australia, 120 South West Highway, Waroona, Western Australia, 6215., Centre for Ecohydrology, University of Western Australia

## Abstract

Algal blooms in rivers and estuarine waters in south west Western Australia are a symptomatic response to excess nutrient input. Whilst a range of Best Management Practices (BMPs) are available to reduce the causes of phosphorus (P) and nitrogen (N) pollution, most investment has been directed towards symptoms. In order to treat nutrient pollution causes effectively, possible nutrient reductions and the likely adoption costs of a range of BMPs require evaluation. Catchment-scale evaluation of implementation scenarios offers insights not possible through long term on-ground implementation and performance monitoring, and assists community groups and government to respond to pollution issues through ad-hoc funding or programs.

The Support System for Phosphorus and Nitrogen Decisions (SSPND) is a risk based tool used in south west Western Australia to estimate costs and benefits of implementing conventional BMPs. It is an adaptation of a P indicators approach which combines source factors, transfer factors, and delivery factors.

Model estimates for the Geographe Bay and Peel-Harvey catchments indicate that the net effect of catchment nutrient management to date has been to reduce P loss by 5-10%. SSPND indicates that a further 50% reduction is possible, with approximately half coming from P fixing soil amendments applied to sandy soils in these catchments. For N the picture is similar, but the major management options are riparian fencing and planting, with reduced applications of fertiliser and the use of non-legume species such as perennial pastures being significant also.

For the Geographe Bay catchments, a 20yr plan of targeted investment could see significant reductions of nutrient in the Geographe Bay catchment, over 40% for P and 30% for N. However even over a 20-yr timeframe, and with an investment of over $20M, the resulting nutrient load reductions are unlikely to meet water quality targets in most catchments.

SSPND provides a range of outputs which assist in the development of management plans for nutrient reduction, and can be used to target nutrient BMP implementation on the basis of water quality, cost/benefit or nutrient reduction. It is currently providing direction in the development of the Geographe Bay Water Quality Improvement Plan.

**Keywords:** SSPND, Best management practices; cost-effectiveness; nutrient management; nutrient risk, modelling, WQIP

## 1. Introduction

Agricultural development in the south-west of Western Australia (WA) over the latter half of the 20th century has contributed to increased nutrient export to waterways [3]. Whilst both P and N are linked to eutrophication of regional waterways, P has been identified as the nutrient which influences algal blooms the most in this region. Previous research has identified nutrient sources and delivery processes [4], [5], and the nutrient attenuation efficiency of actions such as vegetated stream buffers [6]. Until recently, assessments of the costs and catchment-wide nutrient reductions arising from the implementation of management actions had received little attention [7].

Management of these nutrients at source in a systematic and guided manner is important to achieve cost effective water quality improvements.

There is an increased need for community groups and government to respond to degradation issues, sometimes through ad-hoc funding or programs, which has heightened the importance of evaluating the cost effectiveness of improved management so that limited resources can be better targeted. Catchment-scale evaluation of implementation scenarios offers short term insights not possible through long term on-ground implementation and performance monitoring.

Evaluation of alternative Best Management Practice (BMP) adoption strategies is an important component of an adaptive management approach [8], [9] where strategies are refined over time through focussed experimentation and feed-back monitoring.

Modeling approaches such as compartment flux models, process based models such as CREAMS, AGNPS and ANSWERS have been used to estimate nutrient load reductions from BMP implementation. Geographical Information Systems have been

employed to estimate catchment nutrient loss [10]. Decision Support Systems and Expert Systems offer alternative approaches in identifying possible causes of nutrient pollution, and may be used to recommend management practices for critical source areas [11].

Many of these modelling approaches can be complicated, and their widespread use may be restricted by computational complexities and the time required to develop data, particularly in landscapes that are spatially and temporally heterogeneous. Further, few of the models provide information to guide management investment, except WINCMSS [12] which enables assessment of costs and nutrient exports from land management and planning decisions, and land use change. Despite its relative simplicity, WINCMSS provides a useful basis to evaluate the costs and benefits of scenarios that can result in reduced nutrient loads, an approach suggested elsewhere [10]. The output can assist managers to be more targeted when investing limited resources in management actions.

This paper describes an adaptation of the approach of [12] to develop the Support System for Phosphorus and Nitrogen Decisions (SSPND). This model has been developed and used in a range of projects and catchments (Figure 1), including but not limited to the Coastal Catchments Initiative (CCI), a federally-funded program to reduce the discharge of nutrients, particularly P and N, to the waterways of important coastal catchments. SSPND has recently been used to evaluate the costs and benefits of adopting different levels of BMPs in the Geographe Bay catchment, and this paper describes the outcomes of that project. The SSPND model and approach complements process-based models such as SQUARE, a water quality model based on LASCAM (Kelsey and Zammit, 2003 [13]). The two models have been used in an integrated approach in the Geographe Bay catchments.

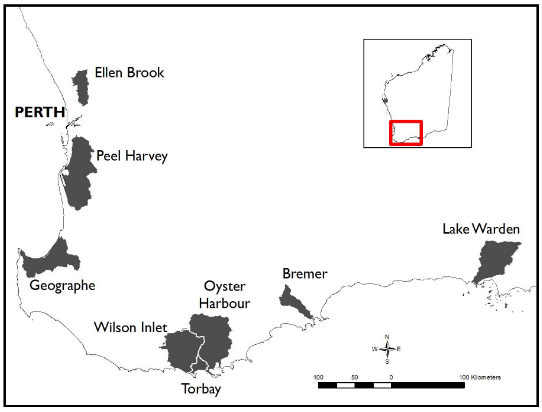


Figure 1. Model Catchments in South West Western Australia.

The modeling approach provides indicative and relative information to guide decisions on nutrient management and whilst its aim is not to definitively quantify nutrient loads produced from certain areas or land uses, it does so in order to provide outputs on the effectiveness of management scenarios.

## 2. Methods

### 2.1 Nutrient Risk Model

A risk based DSS [1] was adapted to examine nutrient management scenarios for P and N reduction in the Geographe Bay catchments (Figure 1). The DSS framework is an adaptation of the P indicators approach [2] which combines source factors (nutrient inputs and soil mineralisation), transfer factors (effective rainfall and erosion risk), and delivery factors (land drainage or hydrological connectivity).

Source factors were represented by P and N surplus data sourced from farm-gate nutrient balances for agricultural land uses [14], [15]) or derived from published work for urban land uses [13], [16]). Transfer factors were represented by an existing framework for P loss risk for WA soils, and a new framework for N loss risk [17]. These loss risk frameworks weight the ability of soils to store, transfer, and deliver N and P based on soil and landform qualities [15]. Delivery factors were described by nutrient assimilation functions [18], [19] based on the Bransby-Williams formula. The method used considers both assimilation within each sub-catchment where nutrients are generated, as well as subsequent assimilation as nutrients pass through downstream catchments and other significant hydrological features.

The underlying nutrient model has been developed for monitored catchments in the Geographe Bay, and the resulting loads compared to the estimated monitored loads, as shown in Figure 2. A process of calibration has been undertaken to ensure that the SSPND model loads are consistent with the best available monitoring data. This data takes two forms, LOESS-generated median loads for P and loads produced from the monitoring data with the SQUARE model for P and N. Post-calibration SSPND produces good results for P ($R^2$ 0.649, $P$<0.05,$R^2$ 0.994, $P$<0.05) for the LOESS and SQUARE data respectively. The correlation for N load is lower but still strong ($R^2$ 0.87, $P$<0.05). Given that the SSPND aim is to provide indicative and relative results, this level of load prediction is more than adequate.

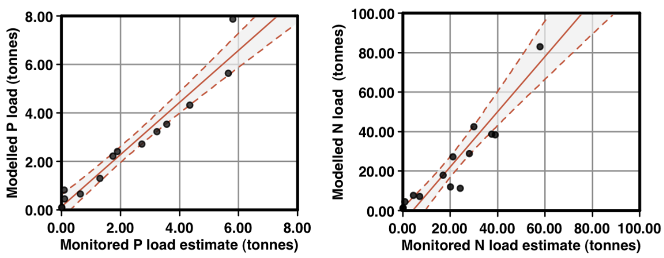


Figure 2. SSPND P and N loads compared to monitored catchment load estimates (SQUARE), solid line shows regression, dotted lines 95% confidence belt.

The SSPND risk model provides detailed mapping of P and N surplus, loss to waterways and export to

endpoints. One component of this – P export risk – is shown in Figure 3.

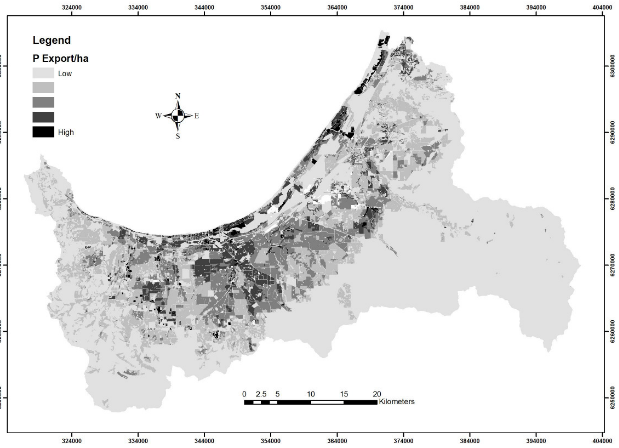


Figure 3. P export risk map for the Geographe Bay catchments. Dark shades indicate greater export risk.

### 2.2 Best Management Practices

The major features of BMPs that are accounted for in SSPND are applicability, context, implementation costs and benefits, and estimated N and P reductions.

BMPs are grouped into landuse (applying to a specific landuse), soil (applying to a specific soil type or characteristic) or catchment BMPs (applying to specific stream orders). Applicability is the landuse, soil type or stream order where the BMP can be applied. Context is the place in a treatment train where the BMP acts and is critical when applying estimated reductions. The implementation costs and benefits and estimated N and P reductions are established from existing research for the various BMPs.

Some BMPs (Table 1) have been field tested to determine potential nutrient reductions and costs of implementation. These BMPs vary in effectiveness for different locations and conditions. For example VSB have been reported to reduce nutrient loss by up to 90% [20], however research on the south coast of WA showed moderate N reductions, and little P reduction due to specific nutrient transport pathways in that region [6]. Research in the Peel-Harvey showed P reductions of 30-60% that were difficult to attribute to the use of riparian buffers due to experimental anomalies [21]. Therefore a number of actions were evaluated across a range, but where possible locally derived data on costs and effectiveness was used to evaluate BMPs.

Alkaloam™ is an alkaline residue from bauxite processing and has significant P retention properties whilst providing production benefits [22]. The capacity of Alkaloam™ to reduce P loss ranges between 30 and 60% depending on application rate and is expected to require replacement about every 10 years. N reductions are far less. NUA is a similar product more suited to the Geographe Bay catchments due to proximity of supply.

Perennial pastures appear to offer an opportunity to reduce nutrient loss whilst increasing farm productivity through high water use, deeper rooting systems [23] and lower nutrient requirements [24]. More recent unpublished research [25] suggests that payback time for perennial implementation is far longer than originally thought, thus productivity improvement and attractiveness is less than previously published [1]. Previous research has compared perennial systems and their attendant nutrient losses [26], however no research has compared nutrient losses from annual and perennial pasture based systems. Productivity returns are more certain, but nutrient export reductions of around 20-30% are expected.

Effective fertiliser use considers the lowest and the most effective use of nutrients in farming. It includes soil and tissue testing to determine nutrient requirements, nutrient specific deficiencies, and the selection the most appropriate fertiliser, rates, timing and locations (eg exclusion of firebreaks, use of fertiliser buffers). Surveys indicate that fertiliser applications are made independently of soil test results [5] and many farms could forgo a fertiliser application for at least one year. Given the dependence on P based fertilisers in the catchments under study it is expected that P reductions of around 5-10% are possible.

An effluent management strategy for dairy sheds involves effluent containment, solids separation, and controlled fertigation according to a nutrient recovery plan on the property. Nutrient reductions apply only to the shed effluent, and not to the entire Dairy operation.

Table 1**.** Percentage reductions of P & N and Capital and Net on-going costs or (benefits) for different BMPs

| BMP | % N reduction | % P reduction | BMP Capital Cost | #Net Cost or (Benefit) $yr^{-1}$ |
|---|---|---|---|---|
| Riparian management* – | | | | |
| 1st order streams | 50 | 30 | $9,460 $km^{-1}$ | $250 $km^{-1}$ |
| 2nd order streams | 50 | 30 | $8,560 $km^{-1}$ | $150 $km^{-1}$ |
| 3rd order+ streams | 50 | 30 | $7,800 $km^{-1}$ | $50 $km^{-1}$ |
| Perennial pastures | 20-40 | 20-40 | $100 $ha^{-1}$ | ($35) $ha^{-1}$ |
| Dairy Shed Effluent management | 40-80 | 40-80 | $32,500 $shed^{-1}$ | ($17,700) $shed^{-1}$ |
| Effective fertiliser use | 5-10 | 5-10 | $10.00 $ha^{-1}$ | ($21) $ha^{-1}$ |
| Alkaloam/NUA soil amendment (5-20 tonnes $ha^{-1}$) | 5 | 20-60 | $70-$280 $ha^{-1}$ | ($40-80) $ha^{-1}$ |

*Riparian management is fencing, revegetation with trees and grasses, stock control/exclusion, off stream watering, crossings.

#Benefits are shown in parenthesis. Net benefits or costs are an annual value excluding capital costs

Expected P and N reduction, capital costs of individual BMPs and a net cost or benefit per year are shown in Table 1. Capital costs and expected on-going or maintenance costs are combined with expected productivity benefits to estimate net on-going costs or

benefits. This is important where high capital costs are offset over time with benefit from productivity increases. Nutrient reductions, costs and benefits (productivity returns), costs per kg, and net costs or benefits (implementation and on-going (maintenance) costs minus productivity returns averaged over 10 years) were derived. Reductions and costs were compared to a base level of no management and were assessed in the context of the asset being protected from nutrient inflows (eg inlets, estuaries, harbours) rather than the farm gate. Other external costs and benefits (such as amenity or ecosystem services) were not accounted for.

### 2.3 Application of SSPND

SSPND has been used to estimate how costs and water quality benefits of different BMPs (perennial pastures, soil amendment, fertiliser, riparian and effluent management) compare when implemented in SSPND individually at 100% adoption, or in combination. Following on from previous work [27], [1] these are combined into scenarios to test outcomes such as the current nutrient reduction BMP uptake (Status Quo), the highest possible nutrient reduction BMPs, and the most cost effective nutrient reduction BMPs. In addition to selecting certain BMPs in a scenario, SSPND can be used to apply a scenario to specific catchments and subcatchments.

The SSPND modeling is being undertaken in concert with the development of a Water Quality Improvement Plan (WQIP) for the Geographe Bay catchments. Water quality targets for N and P have been set by the Western Australian Department of Water, and translated to specific load reductions for the various WQIP catchments. Not all catchments require load reductions, allowing a further refinement of SSPND scenarios. For the Geographe catchments, a 20-yr Target scenario has been developed comprising BMPs and uptake levels considered feasible over a 20-year period, for specific WQIP catchments requiring load reductions, and further refined to ensure that an arbitrary cost per kg of reductions for N and P at the subcatchment scale is below $300.

SSPND output is available in many forms, and communicates simple and effective information to stakeholders in the form of relative and indicative maps and tables of best practice options (Figure 4). This provides an effective way to assist in targeting funds for amelioration in threatened catchments.

Output is also available in tabular form, showing nutrient reduction and scenario cost/benefit information at catchment, subcatchment and landuse scales (Figure 5 shows catchment-scale results).

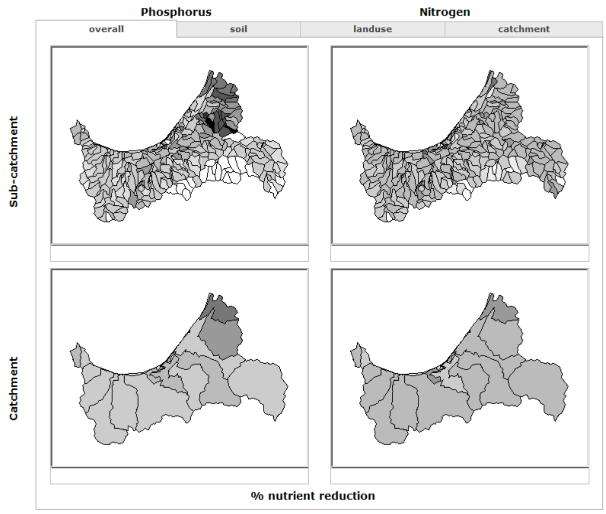


Figure 4. Screen output of modeled nutrient reduction maps from the Geographe Bay, showing relative results for the 20 Year Scenario at catchment and subcatchment scale. Darker shades show greater reductions

**Overall**

| | P | N |
|---|---|---|
| Initial Load (kg) | 55,681 | 437,109 |
| Overall reduction (kg) | 22,768 | 188,282 |
| Landuse BMPs reduction (kg) | 10,382 | 81,692 |
| Soil BMPs reduction (kg) | 4,996 | 3,491 |
| Catchment BMPs reduction (kg) | 7,390 | 103,099 |
| Overall reduction (%) | 40.9% | 43.1% |
| Landuse BMPs reduction (%) | 18.6% | 18.7% |
| Soil BMPs reduction (%) | 9.0% | 0.8% |
| Catchment BMPs reduction (%) | 13.3% | 23.6% |
| nYear benefit Overall ($) | $-32,133,129 | |
| nYear benefit Landuse BMP ($) | $-7,335,186 | |
| nYear benefit Soil BMP ($) | $15,491,255 | |
| nYear benefit Catchment BMP ($) | $-40,289,198 | |
| nYear benefit Overall ($/kg) | $-71 | $-9 |
| nYear benefit Landuse BMP ($/kg) | $-35 | $-4 |
| nYear benefit Soil BMP ($/kg) | $155 | $222 |
| nYear benefit Catchment BMP ($/kg) | $-273 | $-20 |
| Capital Overall ($) | $58,398,472 | |
| Capital Landuse BMP ($) | $41,238,786 | |
| Capital Soil BMP ($) | $1,044,525 | |
| Capital Catchment BMP ($) | $16,115,160 | |

XLS export all results

Figure 5. Screen output of modeled nutrient reductions, costs and benefits for the Geographe Bay, showing tabular catchment results for the 20 Year Scenario

## 3. Results and Discussion

SSPND has previously been applied in the Peel-Harvey catchment, and currently in Geographe Bay, Bremer Bay and Lake Warden catchments. Over a 10 year period in the Peel-Harvey, the net cost of the best-performing BMP scenarios appeared budget positive, resulting in a net benefit to land managers [27], while providing theoretical reductions in P loads up to 68%.

The Geographe Bay modeling results are somewhat different, as seen in Table 2. The Status Quo scenario indicates that current uptake of a range of management measures has provided modest reductions; 4.9% for P and 8.7% for N, for an estimated capital cost of $5.9M. This is a similar result to that for P in the Peel-Harvey, and in the light of the reductions required to meet water quality indicates that management has a long way to go.

The theoretical P reduction (60%) is similar for the Highest Possible scenario, but the net cost is very high ($160M). Unlike the Peel-Harvey, a budget-positive result is only indicated for the Cost-Effective scenario, with lower reductions of 19.5% for P and 11.8% for N, and the Highest Possible and 10 Yr Feasible scenarios have large net costs over 10 years. The big difference in Geographe Bay is as a result of changes in the implementation costs and on-going returns of perennial pastures, and a far lower area of soils suitable for soil amendments like Alkaloam. The 20 Year Target scenario returns a net benefit, in part as the implementation avoids subcatchments where the cost/benefit is poor, and in part as the 20 year timeframe means that all agricultural BMPs have moved beyond the nominal pay-back period.

Table 2. Example SSPND results for different scenarios in the Geographe Bay catchment.

| Scenario | Status Quo | Highest Possible | Cost Effective | 10 Yr Feasible | 20 Year Target* |
|---|---|---|---|---|---|
| Aggregate P reduction (%) | 4.9 | 60 | 19.5 | 41 | 42 |
| Aggregate N reduction (%) | 8.7 | 67.4 | 11.8 | 43 | 32 |
| $ $kg^{-1}$ P | 86 | 480 | (292) | 180 | (166)# |
| $ $kg^{-1}$ N | 6 | 54 | (61) | 22 | (15)# |
| Capital Cost ($M) | 5.9 | 137.9 | 3.7 | 58.4 | 24.6 |
| Net cost (benefit) 10 yrs ($M) | 2.3 | 160 | (31.7) | 41 | (21.7)# |

*20 Yrs target is Recovery & Intervention WQIP catchments only, threshold implementation (<$300/kg) at subcatchment scale.

#Costs over 20yrs

These reductions may be reassuring to land managers, but we must remain aware of the theoretical nature of all scenario results, in particular the theoretical maximum scenario. Even the 10yr "feasible" and 20yr target scenarios remain hypothetical; being our impression of what is feasible from an implementation standpoint.

From the modeling shown in Table 2, the only scenario to meet virtually all the WQIP catchment targets is the Highest Possible, which is not considered likely in any circumstance, not least due to the huge costs. Its purpose is to provide a reference point as being the upper limit for reductions.

The Cost-Effective scenario would fail to meet P load reduction targets in all 6 WQIP catchments, and only meet N load reduction targets in one of the 11 WQIP catchments where reductions are required. Clearly it will not be sufficient to simply pursue BMPs which are understood to return financial benefits to the affected community if load reductions are to meet water quality targets.

We note that landuse change may increase exports of nutrient in ways that cannot be compensated for with management, and recognise that the modeling presented here is explicitly in the absence of landuse change, or climate change.

Successful implementation of any BMPs will require two further components: financial support for the measures, and the necessary changes in behaviour. It is not the intention of this paper to speculate on the necessary incentives for change, but we are aware that a range of options are available, from education through incentives to regulation and enforcement. The decisions on the course taken will be substantially political. However they are attempted, both 10yr feasible and 20yr target scenarios represent very large investments of funds over long periods, matched with a willingness to change not yet seen in this catchment.

### 3.1 Targeting catchments

Notwithstanding these considerations, the model results described here suggest substantial nutrient reduction is possible. To further assist managers, the 20-yr target scenario has been assessed in terms of achieving water quality target load reductions, as shown in Table 3. The SSPND model can identify those catchments where water quality targets may be achieved over a 20-yr timeframe with what are considered feasible management changes. We estimate that target P reductions would be achieved in only 1 catchment for P (out of 6) and 3 catchments for N (out of 11). Good progress (>75% of target reduction) will be made in 2 of the 6 catchments for P and 3 of the catchments for N. This may be considered a good result, or as requiring a larger effort or funding expenditure. Either way, it assists managers in allocating funds: if load reduction targets are not considered achievable, funding may be re-directed. It also provides justification for pursuing and expending public funding where modeling suggests targets can be reached.

Table 3. Progress towards catchment load reduction targets under 20yr Target Scenario

| Catchment Name | % P Reduction Required | % of P Target Achieved | % N Reduction required | % of N Target Achieved |
|---|---|---|---|---|
| Abba River | 0 | | 51 | **80** |
| Annie Brook | 0 | | 35 | **116** |
| Buayanup River | 0 | | 26 | **161** |
| Five-Mile Creek | 69 | **75** | 70 | **52** |
| Gynudup Brook | 67 | **87** | 61 | **74** |
| Jingarmup Brook | 0 | | 38 | **41** |
| Lower Vasse River | 41 | **111** | 19 | **289** |
| Ludlow River | 68 | **63** | 55 | **79** |
| Toby Inlet | 0 | | 34 | **30** |
| Vasse River / Upper Sabina | 52 | **68** | 43 | **86** |
| Lower Sabina | 68 | **57** | 73 | **48** |

### 3.2 Catchment BMP recommendations

Based on how each catchment's current average loads compare to target load reductions, a classification scheme has been used to identify catchments as 'Protection' (meets N and P targets), 'Intervention' (fails N but meets P targets) and 'Recovery' (fails both N and P targets). From the modelling of individual BMPs, we are in a position to recommend specific BMPs for the different catchment classifications, shown in Table 4.

Table 4. BMP recommendations for target catchments

| Category | BMPs targeting P Loads | BMPs targeting N Loads |
|---|---|---|
| **Protection** Maintain current good water quality. | ▪ Awareness-raising only. No major investment in BMPs | ▪ Awareness-raising only. No major investment in BMPs. |
| **Intervention** Stop P rising, reduce N to target. | ▪ Awareness-raising only. No major investment in BMPs<br>▪ Ag Fert Management<br>▪ NUA 20T/ha<br>▪ LWS P fertiliser | ▪ Targeted Riparian Management Assorted<br>▪ Perennial Pastures<br>▪ Ag Fert Management<br>▪ High level residential fertiliser management |
| **Recovery** Reduce N and P to targets. | ▪ Targeted Riparian Management Assorted<br>▪ Perennial Pastures<br>▪ Ag Fert Management<br>▪ NUA 20T/ha<br>▪ LWS P fertiliser<br>▪ High level residential fertiliser management | ▪ Targeted Riparian Management Assorted<br>▪ Perennial Pastures<br>▪ Ag Fert Management<br>▪ High level residential fertiliser management |

### 3.3 Implementation priorities

A number of different priorities are available when evaluating BMPs. The scale of nutrient load reductions required to meet catchment targets (as seen in Table 3) can provide one measure of priority. The SSPND results provide two additional measures of BMP priority: potential load reductions and potential cost/benefits. The determination of which priorities should take precedence is up to land managers or planners for a specific region, and will be affected by local understanding of issues, funding availability or scarcity and so on. It is significant though that SSPND provides the information to allow managers to understand what choices are available according to different priorities.

The SSPND data has been used to construct selection priority matrices to inform BMP priorities in various catchments, using different combinations of priority measures. The combinations used include catchment/cost benefit; catchment/load reduction, and load reduction/cost benefit. The combination of all three measures is shown in Table 5, and indicates which catchments are most suited to the four classes of BMPs shown: soil amendment, agricultural and urban landuse BMPs, and riparian works. If required, much more detailed information is available to show what underpins these simple priority rankings. This information is directly informing the development of a WQIP for the Geographe Bay catchments.

Table 5 - BMP Priority according to Catchment/BMP Cost Benefit/BMP P Load reduction

| WQIP catchment | Soil Amendment | Agricultural Landuse | Urban Landuse | Riparian Works |
|---|---|---|---|---|
| Abba River | HIGH | HIGH | NIL | MED |
| Annie Brook | LOW | MED | NIL | NIL |
| Buayanup River | MED | HIGH | NIL | MED |
| Carbunup River | NIL | MED | NIL | NIL |
| Coastal Fringe | NIL | NIL | LOW | NIL |
| Dunsborough Catchments | NIL | NIL | NIL | NIL |
| Five-Mile Creek | HIGH | HIGH | HIGH | MED |
| Gynudup Brook | HIGH | HIGH | NIL | MED |
| Jingarmup Brook | LOW | LOW | NIL | NIL |
| Capel River (Lower) | MED | MED | NIL | LOW |
| Lower Vasse River | HIGH | HIGH | HIGH | HIGH |
| Ludlow River | HIGH | HIGH | NIL | HIGH |
| Toby Inlet | LOW | NIL | NIL | NIL |
| Capel River (Upper) | NIL | NIL | NIL | NIL |
| Vasse River / Upper Sabina | HIGH | HIGH | HIGH | HIGH |
| Lower Sabina | HIGH | HIGH | LOW | HIGH |

## 4. Conclusion

The SSPND model is a further development of a number of nutrient management Decision Support Systems. The underlying model used provides nutrient export results consistent with current monitoring data. It provides estimates of nutrient reductions and costs for various BMP implementation scenarios based on best current information. For the Geographe Bay

catchments, large reductions are theoretically possible with maximum implementation of nutrient management BMPs. However the maximum scenario does not appear feasible and so more realistic implementation scenarios have been developed. It is suggested that a 20yr plan of targeted investment could see significant reductions of nutrient in the Geographe Bay catchment, over 40% for P and 30% for N. However even over a 20-yr timeframe, and with an investment of over $20M, the resulting nutrient load reductions are unlikely to meet water quality targets in most WQIP catchments. Even so, SSPND provides indications of where the greatest reductions can be made, and the most cost-effective BMPs to use in order to achieve reductions.

Decision support tools such as SSPND offer an opportunity to interface with catchment stakeholders over prioritisation of limited funding for BMP implementation. Tools such as SSPND assist in decisions over what BMPs provide the best water quality improvement, where, and at what cost.

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