

REPONSES OF USERS OF ECOSTATUS MODELS TO ONLINE QUESTIONNAIRE

Summary

In 2007 and 2008 the Department of Water Affairs and Forestry published a series spreadsheet models that aimed to quantify river health. The models were developed for the express purposes of quantifying the ecological Reserve and "... *critically, to determine the current EC, resulting from implementation of the Ecological Reserve specifications, and to compare it with REC*" (Kleynhans 2008). The series comprised models for EcoClassification, geomorphology (GAI), physico-chemistry (PAI), aquatic macroinvertebrates (MIRAI), fish (FRAI), riparian vegetation (VEGRAI) and Habitat Integrity. The models have been applied in Reserve determinations and assessments of river health, as well as Water Use Licence compliance monitoring. In 2017 Nepid Consultants undertook an online survey of the views of anonymous users that had used one or more of the Ecostatus Models. The survey focussed on the scientific validity of the models and their application for compliance monitoring. The online survey found that sixteen users (42%), consider Ecostatus Models to be appropriate for compliance monitoring; eleven users (29%) indicated that the models may be applicable for compliance monitoring under certain circumstances; while eleven users (29%), indicated that Ecostatus Models should not be used for compliance monitoring.

Detailed Responses

Q1: Please indicate who you are by selecting one of the options below

- Academic
- Student
- Government Employee
- Consultant
- Other

Responses:

• Academic	5 (13%)
• Student	0
• Government Employee	6 (16%)
• Consultant	25 (66%)
• Other	2 (5%)
Total	38

Q2: The Ecostatus models were designed for ecological classification during ecological Reserve studies, so do you feel there may be value in using them for other purposes, such as monitoring of Water Use License compliance?

Response 1: Yes

Response 2: Possibly. It would depend on how clear the relationship between the licensed activity and bio-indicator response could be demonstrated to be; would require scientific justification that could survive legal scrutiny - easier said than done.

Response 3: No. Have only used VEGRAI so can only comment on that basis. It is unlikely that VEGRAI would detect any unlawful usage other than an extremely excessive usage, and even then other factors along the river could be responsible.

Response 4: No. The backbone and inputs that these models have been built on are very important for biomonitoring. However biomonitoring is typically focused around specific sites located up and downstream of potential impacts and not river reaches. As a result the models are misused, I have seen FRAI done at 16 points within a 17km stretch of the Highveld. The general thinking in putting these models into WULs is that they provide more information, rather than having a holistic view of the system and really looking at the drivers and issues that are potentially having an impact to the larger system cumulatively or downstream. The people reviewing these reports (DWS) do often not have the capacity or knowledge to review or make decisions based on these results.

Response 5: Yes

Response 6: Yes, I think so. It is important to have consistent use of methods so that results can be comparable. At this stage the Ecostatus models present us with the best opportunity to accomplish this

Response 7: No. The models don't work well as a single point monitoring (most often the case in WULs) tool and are most appropriate for assessment at reach level. Also, assessments are designed to take reach level changes into account and provide little focus on local (short term) impacts.

Response 8: Yes

Response 9: Yes, and for river management plans. They can be used to set TPC's etc./

Response 10: Possibly. The SASS 5 methodology is a good tool but as for the ecostatus models it has not proven to of value, the models are not standardised and its credibility is suspect concerning the health of a river

Response 11: No. Needlessly time consuming, therefore no-longer providing rapid assessments.

Response 12: Possibly. There would need to be very good reasons/justification for requiring Ecostatus models to be used for Water Use License Compliance. This is because the Ecostatus models tend to be far more complicated to run and sometimes to interpret, they require more time in the field and give similar results to quicker & easier methods available. The Ecostatus methods can also be very subjective.

Response 13: No. In order to use the EcoStatus model to determine the overall PES of a site you need vegetation data. Vegetation assessment is not always included in biomonitoring programmes. The aim and objectives of Ecological Reserve studies are very different to that of biomonitoring programmes so it does not make sense to be forced to use one set of tools when there are an array of tools developed internationally for use in biomonitoring programmes. EcoStatus tool development has been focussed on determining flow requirements as a long term goal within Reserve assessments, this is not the long term goal of biomonitoring.

Response 14: Yes. Though the EcoStatus models are very useful and therefore of value, there are other tools which may be of greater value to measuring compliance against WUL. Some of the models are very technical and not easy to use, which may count against their usefulness for an application such as monitoring for compliance. It is however understood that when EcoStatus needs to be determined, these are useful and valuable models.

Response 15: Yes.

Response 16: Possibly. Not all of the models will be relevant, MIRAI, FRAI and IHI might be relevant but are rather onerous for routine monitoring.

Response 17: Yes.

Response 18: Possibly. Aspects or components of the tools are useful for other purposes, but they can't be applied too prescriptively in these cases

Response 19: No. There is no component to the models that enables negotiation of water volumes which is what is urgently needed by officials on the ground

Response 20: Possibly. Many of the licences are applicable to ephemeral stream which are not suitable for eco classification. there is thus no way to use the models to determine compliance to licence conditions / to determine the impact of the activities

Response 21: Possibly. Limited within reserve (water quantity/flow) monitoring (Ecospecs) but not a useful "water quality" monitoring tool (such as required for WUL compliance monitoring).

Response 22: No. The models are not based on empirical data but on gut feel. Models like this are useful and can be filled in once empirical data has been collected at a site but cannot be used as stand alone vehicles for ecological condition assessments. Since most of the background calculations are hidden the models also prevent the user from gaining access to adjustments, often necessary to calibrate models of this nature to site specific and regional differences. Monitoring would best be achieved by measuring physical and biological characteristics of rivers (channel depth, width, sediment particle size, components of water quality, riparian and aquatic species composition, SASS (and potentially macroinvertebrate species assemblage), fish species abundance etc. If this is done then the models can be filled in after the fact more confidently and used to summarise the data if required.

Response 23: Yes.

Response 24: Yes. The EcoStatus models were not only designed for ecological Reserve studies - their application is far broader, for example they are currently included in national monitoring programmes, among others. In using them in WUL compliance, it becomes rather tricky, as to where and how the models can/may be used. I, personally, do not think it is a good idea to use them in WUL compliance, UNLESS, strict guidelines can be developed on how and when to use them WUL compliance. Furthermore, I do not think that there is currently adequate understanding of these models to be able to use them in WUL monitoring.

Response 25: Possibly. I am only really familiar with the PAI model for water quality. Intelligent interrogation of the PAI model would indicate what WQ parameters are likely to be a problem in a given reach of river and what should be monitored. For example toxins may be an important (and likely) contaminant in an area but because these are expensive to monitor they would not need to be monitored in all rivers.

Response 26: Possibly. One would need more insight than I have into the functioning of the ecostatus models and the requirements of water use licence compliance, or any other proposed application.

Response 27: Possibly. The efficacy needs to be shown, and they need to be used on systems that they were designed for (ie not on wetlands and ephemeral systems). Careful interpretation of results needs to be made in context of the ecosystem and the needs/uses of the WUL.

Response 28: Yes. I am using them already for the WULA.

Response 29: No.

Response 30: No. The problem is that the index score for a site or river reach can be manipulated up or down by (a) changing the expected reference condition for that site or reach, and (b) manipulating the scoring of metrics. Both of these are possible because there is a fair degree of subjectivity in defining the reference condition (specifically in MIRAI and VEGRAI, and to a lesser extent on FRAI) and in scoring the metrics. Subjectivity and excessive interpretation are not compatible with compliance assessments which require much more certainly and defined targets.

Response 31: Yes.

Response 32: No.

Response 33: Yes. The officials writing the models however expect drastic PES changes example, stated in the WUL an increase of MIRAI PES from C to B, however the lower PES score was due to lack of "stones" habitat

Response 34: No. The ecostatus models are highly subjective, with final results varying between "experts"

Response 35: Yes. There is value in using the ecostatus models in biomonitoring but as a complement to scientifically robust statistical analyses

Response 36: Yes. The tools are designed to evaluate the wellbeing of components of river ecosystems which are very useful in other water resource management monitoring programmes etc. However this may results in the abuse of the tools and misuse of the outcomes.

Response 37: Yes. Compliance monitoring is essential for correct implementation of license conditions, comparing baseline with status quo is the only way of measuring the success of the magnitude of paperwork that goes into a project in the planning phase. Maybe this is the motivation that consultants and officials (of all environmental departments) need to streamline future planning processes and make recommendations more site specific.

Response 38: Possibly. The Ecostatus models was mainly designed for ecological classification during Reserve studies. In some cases their use for WUL can be justified but in many instances it cannot. This is especially true where multiple sites and as such FRAI scores are calculated for limited river reaches. In those cases the use of FRAI is difficult and in many cases could be providing erroneous results. When the FRAI index are used on larger study areas with adequate sampling sites within river reaches the FRAI becomes more reliable. In many cases WUL rely to heavily on these indices to assess compliance. A more detailed assessment of the ecosystems are often required to adequately look at the impact of an activity on rivers. This is especially true in priority rivers and catchments within South Africa.

Q2: Please rate the Ecostatus Models as a whole in terms of the following criteria that characterise scientific validity: Testable/tested; Consistent/Repeatable; Simple; Evidence based; Peer Reviewed.

Response 1: Bad to Good.

Response 2: Good to Excellent. Because key parameters of sensitivity (e.g. SASS taxon scores, FRAI fish habitat preferences/intolerances) are based primarily on expert opinion, this leads them open to legal challenge if used in compliance enforcement, despite a good record of peer-review.

Response 3: Poor to Mediocre. VEGRAI 4 relies on some knowledge of life traits of key species, and this is only known for a few well-studied species on particular rivers.

Response 4: Bad to Good

Response 5: Good to Excellent

Response 6: Poor to Mediocre. I do think there is a need for training users in the use of these models. Except for MIRAI, very few training opportunities, that I am aware of, exist. Unfortunately not a lot has been published scientifically about the Ecostatus, which is something we could address. the models have been tested, and works presumably well, in some systems (and some more than others), but not in others situated in different ecoregions.

Response 7: Poor to Mediocre. As far as I am aware the ecostatus models have not been published in a properly peer reviewed journal. Several of the tools bend towards subjectivity given variations in site specific characteristics of the water body. The responses to the particular criteria being rated are also strongly influenced by the user's subjective understanding of the criteria.

Response 8: Bad to Excellent.

Response 9: Mediocre to Good.

Response 10: Poor to Excellent.

Response 11: Poor to Mediocre

Response 12: Poor to Good. I think that the core of the Ecostatus models is a move towards the development of standardised methodologies for sampling a range

of drivers. As such the Ecostatus models have a noble intention and are needed within the country. I think the data collected to inform the Ecostatus models is useful, testable and repeatable. However, I find the models very difficult/cumbersome to use in their current state and it is frustrating that multiple iterations/updates are released, as each version has its own intricacies which need to be figured out. The front end is not polished and can be very confusing for people using them for the first time. I find the scoring and assumptions inherent in the models to be very subjective at the best of times. While several people have been involved in the development of the tools, I don't consider them to have been truly peer reviewed /scrutinised on the same level as scientific

Response 13: Bad to Mediocre. Some of the models are updated on regular basis, but specialists and consultants are not informed of these changes. This is problematic. There are one set of manuals available from the WRC on applying the EcoStatus models. The models are specialised and training is needed for inexperienced specialists. The EcoStatus models are restrictive in terms of species and habitat type that are used to populate the models, and leaves little room for interpretative results based on site specific problems. Within the new national biomonitoring programme for rivers designed by Water Affairs - REMP - data sources and databases are cumbersome, difficult to interpret and just not user friendly. The input data for any EcoStatus model is based on very site specific data e.g. rapid, riffle areas, which is not always the available habitat that can be surveyed in the field during biomonitoring. The EcoStatus models do not aid in determining triggers or potential problems in an river system

Response 14: Mediocre to Excellent. The models have been widely used for many years. The repeatability can only be determined through long-term monitoring using the models, although evidence at present shows that models are repeatable (within an acceptable margin of error, of course). The models are not all simple to use, although quite usable for someone with the appropriate training and expertise. Models have been peer-reviewed in terms of SA literature, numerous reports and many studies.

Response 15: Good.

Response 16: Poor to Good. Difficult to accurately rate as the various models fall into different categories for the various criteria provided above.

Response 17: Good to Excellent.

Response 18: Poor to Mediocre. Very little testing and validation carried out before they were released for widespread use

Response 19: Bad to Mediocre. The models are intractably complex. Much simple, more quantitative approaches could have performed the same task more efficiently and accurately. User-bias is a major problem.

Response 20: Mediocre to Excellent

Response 21: Bad to Mediocre.

Response 22: Poor to Mediocre.

Response 23: Good.

Response 24: Mediocre to Good.

Response 25: Poor to Mediocre.

Response 26: N/A

Response 27: Good to Excellent.

Response 28: Mediocre to Good.

Response 29: Bad. Based on the authors experience. Not quantified.

Response 30: Poor to Mediocre.

Response 31: Good to Excellent.

Response 32: Good.

Response 33: Bad to Excellent

Response 34: Bad to Poor. I have seen considerable differences in final results between various experts, which highlights the subjectivity of the model in its application. The models are certainly not rapid

Response 35: Bad to Excellent. Overall my perspective on the EcoStatus models is that they are, depending on the model, subjective to varying degrees and are largely based on expert judgement. The models pertaining to biota would be more useful subsequent to determining the relationships between the relevant biota and environmental drivers per sample site/system using statistical analyses. These relationships, if any, could be used to inform the ratings and rankings of the model.

Response 36: Bad to Good. There is allot of validation work still to do to ensure that the outcomes are representative of the issues we are dealing with in the field. Too little interest in the testing/validations and monitoring of the success/failures of the tools affected their national/international recognition.

Response 37: Mediocre to Good.

Response 38: Poor to Good.

Q7: Please rate the scientific validity of the Macroinvertebrate Response Assessment Index (MIRAI)

Response 1: Good.

Response 2: N/A

Response 3: N/A

Response 4: Mediocre. The MIRAI requires a large amount of scientific knowledge and data inputs. Reference lists are not freely available and need to be site/location specific. Weighting of criteria is subjective. Requires a greater understanding of the taxa with regards to life history traits, including WQ/ Flow/ Habitat, and for a more diverse community (number of taxa).

Response 5: Good.

Response 6: N/A

Response 7: Mediocre. I have limited experience, but the MIRAI reference dataset is also limited in terms of number of samples and variations in size and local characteristics of streams / rivers would mean results become more subjective and less repeatable.

Response 8: Good.

Response 9: Good.

Response 10: Mediocre.

Response 11: Mediocre.

Response 12: Mediocre. This model uses SASS at its core, so already there is a level of subjectivity and some limitations to its use in different habitats/ecoregions across the country. While SASS is straightforward to conduct and report on, far more effort is needed to populate the MIRAI model. SASS is also tried and tested and has a stronger scientific backing. While certain updates (such as distribution maps for families) have made a valuable improvement to the overall running of the MIRAI model, I think the flow preferences calculated for families are still somewhat crude as is the reference condition scoring process. Operator experience/knowledge of the region is still the most important aspect to obtaining a true indication of the condition of the system being measured. In working with others, I have also found that sometimes MIRAI scores for the same site can vary quite considerably - much of which is as a result of ratings applied - which can be quite subjective.

Response 13: N/A

Response 14: Good. The MIRAI is to my knowledge scientifically valid, although it is difficult to make this assessment if one is not a macroinvertebrate specialist. It is known that this is one of the more technically difficult models to run (particularly developing the reference condition component), but as it was developed specifically for Reserve assessments and integral to the assessment is monitoring against a reference state, it is not easily possible to

simplify the model. This is a model that should be run, or at least overseen, by a specialist. There are other tools, however, that can be used for monitoring of compliance against a WUL.

Response 15: Excellent.

Response 16: Good. Good historical data for many systems throughout the country, being based of family level identification adds robustness as does the new coverage data available from Dr Thirion. Still subjective to an extent. Reference data needs to take into account site specific conditions and habitat availability, this is subject to the ability/knowledge of the user.

Response 17: Good.

Response 18: Good. The approach is good, but more data are required for the development of "reference conditions" in different regions

Response 19: N/A

Response 20: Good.

Response 21: Poor. Uncertainty regarding reference conditions.

Response 22: N/A

Response 23: Good.

Response 24: Good. Some data from previous scientific research was used to develop MIRAI, but mostly specialist knowledge was used, specifically for macroinvertebrate preferences. It has recently been updated with the advent of C. Thirion's PhD. I do believe that a lot more is required and can certainly be done in order to validate macroinvertebrate preferences, for example. However, as it currently stands, the MIRAI is a useful tool and provides information where previously this information was lacking with only SASS as a tool for use in ecological assessments etc.

Response 25: N/A

Response 26: Good. The MIRAI method appears to provide valid results, and is applied in many different riverine habitats. However, this is an impression, and as above, I rely on the judgement of specialists. What helps is that it appears to have good record of peer review in practical applications and journal publications.

Response 27: Mediocre.

Response 28: Good.

Response 29: Good. But reference conditions take tremendous amount of time

Response 30: Mediocre. The validity of the index relies greatly on the derivation of a suitable reference condition. Unfortunately, this is the MIRAI's biggest weakness. The method of derivation of the reference condition is too subjective and vaguely defined. As a practitioner I often don't feel confident that i have derived an appropriate reference condition.

Response 31: Good. Reasonably subjective.

Response 32: N/A

Response 33: Excellent. The better PES Ecostatus model as it uses more scientifically robust methods for baseline/ reference condition

Response 34: Poor. Ratings are subjective and not repeatable. It is gross over interpretation of an assessment originally developed as a rapid assessment tool. The assessment lumps assumptions based on family presence/absence, even though the ecological requirements within species are highly variable and in most cases unknown. All the assumptions are based on expertise, but the results and assumptions vary between "experts". Any subjective form of assessment is not repeatable, and definitely not scientific. SASS is a rapid assessment tool, and should only be used as such. If rapid assessments (e.g. SASS) red flag a potential problem, then further detailed studies focused at species level, specifically those species responding to known and specific environmental changes should be carried out.

Response 35: Good. Recent research by Dr. Christa Thirion has demonstrated the scientific validity of the MIRAI model.

Response 36: Good. Very good approach but poorly tested.

Response 37: Good. Takes habitat into account.

Response 38: Good. The improved recent version has gone a long way to improve the results from the MIRA

Q9: Please rate the scientific validity of the Fish Response Assessment Index (FRAI)

Response 1: Good

Response 2: Good. My limited exposure to this index leads me to believe that it is complex and nuanced enough to provide a robust assessment of fish community deviation from expected reference condition, particularly when used in conjunction with the Rapid Habitat Assessment Index to exclude expected species when their preferred habitat has not been adequately sampled. The scientific justification for the species-specific preference curves probably does require additional support through directed ecological research.

Response 3: N/A

Response 4: Mediocre. One of the large problems with these models is the fact that they change frequently. The FRAI has some very good information with regards to species intolerance and preferences built-in, however the adjusted and automated values with regards to things such as low flow and zero flow conditions as well as the physico-chemical conditions (toxins & nutrients) is subjective. Weighting of the different metric groups is also subjective and at a site level basis for monitoring often impractical.

Response 5: Good.

Response 6: Mediocre. Again, I think it gives good results in some systems, but I am uncomfortable with its results in especially the more arid systems.

Response 7: Mediocre. FRAI contains a fair degree of subjectivity with respect to species expected to occur. Insufficient data is available to provide a solid scientific basis for this. FRAI is also flawed as a monitoring tool since fish movement will introduce a level of inconsistency. Hence better used as it was designed to assess a reach, not a site.

Response 8: Mediocre.

Response 9: Good.

Response 10: Poor.

Response 11: Good.

Response 12: Good. I have somewhat limited experience with the model, but found it quite complicated and time consuming to run. The latest updated version from Niels which uses PES EI/IS makes the pre-population of expected species far easier and less reliant on expert knowledge - this helps a great deal. The linkages with google earth overlays also helps, as do the automated graphs. I do think that the model is still cumbersome and in my opinion has a lot of underlying assumptions - so caution should be applied when using it and interpreting end results. Overall not a bad model.

Response 13: Unrated. The FRAI does not provide an alternative for the presence of exotic species.

Response 14: Good. The FRAI is to my knowledge scientifically valid, although it is difficult to make this assessment if one is not a fish specialist. In assessing the validity of these models, it is important to remember the purpose for which they were intended. The use of fish models seems to be somewhat confusing at times, due to the number of model updates and streamlining that seems to be constantly taking place. As with the PAI, DWS (as the primary user of these models), should give some stability and direction to the use of fish models, as well as other tools available for fish monitoring and assessments.

Response 15: Excellent.

Response 16: Mediocre. Due to the rapid nature of this and the rest of the eco-classification models, it is difficult to get accurate species/community data from the often limited sampling time available. While historical data are available for many systems, the data are often widely distributed and assumptions are based on habitat availability and expected presence too often compared to actual fish found at a site.

Response 17: Good.

Response 18: N/A

Response 19: Poor. FRAI is unsuitable for using in Western Cape Rivers since most rivers are invaded by alien fish species meaning that links between flow/water quality are disconnected from the fish community. A subjective judgement call required on multiple drivers introduces operator bias. Often an operator will go

back and adjust the drivers to suite the score they expect to see. Fish communities are too variable in space and time to accurately reflect the health of rivers. A simple expected/observed ratio - combined with other simple indicators such as parasite loads and population size structure - would have been simpler and more effective.

Response 20: Good.

Response 21: Mediocre. Uncertainty regarding accurate reference conditions reduce/impact accuracy of final model results. Many uncertainties with application of model if not trained correctly or not applied by fish scientist. Poor repeat-ability between different users. Application of spatial frequency of occurrence (various sites within reach) problematic with application to single site (reality).

Response 22: N/A

Response 23: Good.

Response 24: N/A

Response 25: N/A

Response 26: N/A

Response 27: Good. Obviously does not apply to fishless systems.

Response 28: Excellent.

Response 29: Bad. Very subjective.

Response 30: Mediocre. The FRAI model has become very confusing. The original premise of the FRAI, as I understood it, was an evaluation of the potential of a site or river-reach to provide habitat for the reference fish assemblage. So it was not a biodiversity index, but an assessment of the state of habitat for native fish (whether they exist there or not). Because the presence of predacious invasive fish species means that the habitat can be completely intact, but the native fish are extirpated. Then why is there an invasive species metric? Surely if FRAI is just about habitat then when there are invasive fish at a site one relies completely on what habitat is observed and ignores what was sampled? Surely inclusion of an invasive fish metric means that the FRAI has now morphed into some kind of hybrid biodiversity/habitat index?

Response 31: Excellent. Use it often and results are repeatable.

Response 32: Excellent. Vast experience Hallo Rob, I think IHI should also be part of this survey. I am concerned with this survey as very few people are doing Ecostatus reports on large catchments and large scale as MTPA/IUCMA is doing it. The only other person that has done the RIVDINT is Colleen Todd. As far as I am concerned this is not really applicable to WUL etc.

Response 33: Excellent.

Response 34: Mediocre. Different experts have different results, mostly dependent on their own interpretation and "gut-feel". Gut-feels are highly unscientific and not defensible. Abundances of a specific species are not considered, but this data is important to interpret results.

Response 35: Bad. The model is largely based on expert judgement and usually ratings and rankings are based on the users level of knowledge and experience. The testing of the technique against more scientifically robust methods are lacking.

Response 36: Good. New versions keep on coming up to improve the approach. We need to have more input into the foundations of the tool and use of data.

Response 37: Good.

Response 38: Good. The assessment of the fish community is often the most difficult due to the inherent movement and sampling requirements of fish communities. Therefore the FRAI will always be more difficult to implement for a WUL as the time frames for monitoring are often too small to adequately assess the fish communities. The basics of the FRAI assessment are valid but more scientific background on the ecology of fish are needed especially for selected species within certain parts of the country.