**Factsheet: Calculating water quality trends**

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**LAWA displays trends for the last 5, 10 and 15 years for the river and lake water quality data. Data are evaluated to determine whether water quality indicators are showing improving or degrading trends.  An indeterminate result occurs when the available data do not show a significant trend. Sites that are 'not assessed' are monitored, but the data do not meet the criteria to be eligible for a trend analysis.**

**What do water quality trends show us?**

LAWA calculates trends to show how the quality of water in rivers and lakes has changed at each site over time. Changes in water quality often take years to be seen, and it may be decades for any restoration actions to show effect in water quality trend results.

Trends calculated over different periods tell us different information.  Natural systems are variable, and shorter-term trends can be influenced by climate and weather patterns, as well as being affected by land use and land management changes at sites (e.g. changes in point-source discharges such as sewage treatment plant upgrades).  Longer-term trends are generally more reliable, and can account for short-term influences of seasonal and climatic weather patterns.

**What water quality indicators does LAWA show trends for?**

LAWA shows 5, 10 and 15-year trends for eight river water quality indicators: water [clarity](https://www.lawa.org.nz/learn/glossary/c/clarity/) ([black disc](https://www.lawa.org.nz/learn/glossary/b/black-disc/)), [turbidity](https://www.lawa.org.nz/learn/glossary/t/turbidity/), [*E. coli*](https://www.lawa.org.nz/learn/glossary/e/e-coli-escherichia-coli/), [total nitrogen (TN)](https://www.lawa.org.nz/learn/glossary/t/total-nitrogen-tn/), [total oxidised nitrogen (TON)](https://www.lawa.org.nz/learn/glossary/t/total-oxidised-nitrogen-ton/), [ammoniacal nitrogen](https://www.lawa.org.nz/learn/glossary/a/ammoniacal-nitrogen/), [dissolved reactive phosphorus (DRP)](https://www.lawa.org.nz/learn/glossary/d/dissolved-reactive-phosphorus-drp/) and [total phosphorus (TP)](https://www.lawa.org.nz/learn/glossary/t/total-phosphorus-tp/).  LAWA also shows 10 and 15-year trends for the [Macroinvertebrate Community Index](https://www.lawa.org.nz/learn/glossary/m/macroinvertebrate-community-index-mci/) (MCI), which is an indicator of the biological health of a river.

LAWA shows trends for six lake water quality indicators: total phosphorus (TP), total nitrogen (TN), ammoniacal nitrogen, [chlorophyll](https://www.lawa.org.nz/learn/glossary/c/chlorophyll-a/)*a*, [Secchi disc depth](https://www.lawa.org.nz/learn/glossary/s/secchi-disc/)(clarity) and *E. coli.*

**LAWA trend categories for rivers and lakes**

LAWA categorises trends into five classes.  These are: very likely degrading, likely degrading, indeterminate, likely improving, and very likely improving.

**Improving Trends**

|  |  |
| --- | --- |
| Very likely improving trend | Likely improving trend |
| Very likely improving trend | Likely improving trend |

 The increasing trend symbols are used for sites that show an improving trend in water quality and are either classified as 'very likely improving' or 'likely improving'.  An improvement is a decrease in most water quality indicators, such as phosphorus and nitrogen concentrations.  However, for visual clarity indicators (black disc and Secchi disc depth) and the Macroinvertebrate Community Index (MCI), an improvement is an increase in value.

A 'very likely improving' trend is given when there is 90 - 100% likelihood of an improving trend.  A 'likely improving' trend is given when there is 67 - 90% likelihood of an improving trend.  The lower certainty reflects the fact that while there is an indication of an improving trend, there is less statistical support for it.  These likelihood definitions follow a framework laid out by the Intergovernmental Panel on Climate Change (IPCC).

With enough data, the trend evaluation method can detect even a very subtle trend.  In these cases the trend can be classified as improving, even if there is only a small change in water quality over time.

**Indeterminate Trend**

|  |
| --- |
| Indeterminate trend_Sept2018 |
| Indeterminate trend |
|  |
|  |
|  |

This classification is given to sites where there is insufficient evidence to confidently determine if water quality is showing an improving or degrading trend.  An indeterminate trend means that the data do not show an upward or downward trend direction with sufficient statistical certainty.

**Degrading Trends**

|  |  |
| --- | --- |
| Very likely degrading trend | Likely degrading trend |
| Very likely degrading trend | Likely degrading trend |

The degrading trend symbols are used for sites that show a degrading trend in water quality and are either classified as 'very likely degrading' or 'likely degrading'.

A degrading trend is an increase in most water quality indicators, such as phosphorus and nitrogen concentrations.  However, for visual clarity indicators (black disc and Secchi disc depth) and the Macroinvertebrate Community Index (MCI), a degradation is a decrease in value.

A 'very likely degrading' trend is given when there is 90 - 100% likelihood of a degrading trend.  A 'likely degrading' trend is given when there is 67 - 90% likelihood of a degrading trend.  The lower certainty reflects the fact that while these is an indication of a degrading trend, there is less statistical support for it.

With enough data, the trend evaluation method can detect even a very subtle trend.  In these cases, the trend can be classified as degrading, even if there is only a small change in water quality over time.

**Trend Not Assessed**

|  |
| --- |
| Not assessed for a trend |
| Not Assessed |

Sites are not assessed for trends when they do not meet the criteria to be included in the trend analysis (e.g. there were not enough data/samples over the period, not enough variability in the data to assess a trend, too many below-detection-limit measures in the data, or long runs of the same value).

**How do we calculate water quality trends?**

**Data requirements**

Trends are calculated for the last 5, 10 and 15 years. Data are evaluated to determine whether water quality is showing improving, degrading, or indeterminate trends.

The data used to calculate water quality trends for rivers is collected monthly or quarterly. Sites that are sampled monthly will have more data than sites that are sampled quarterly.  Macroinvertebrate data are generally collected annually, but sometimes twice per year.  You can find out whether a trend has been calculated based on monthly, quarterly or annual data on the 'Can I trust this data?' pop-ups for each site.  Generally, the more data points we have available for a site, the more statistical power we have for detecting a trend.  LAWA calculates and displays 10- and 15-year trends for river and lake water quality sites using monthly data preferably, and quarterly data if not trends can not be calculated with monthly data.  LAWA calculates and displays 5-year trends using monthly data only, it does not use quarterly data.

For 10- and 15-year trends, river and lake water quality sites were excluded from the analysis if they had less than 90% of the data expected, and data from less than nine (or thirteen) out of the last ten (or fifteen) years.  For Macroinvertebrate Community Index (MCI) trends, sites with less than eight years of data points over the last ten years were excluded from the analysis.  For fifteen-year MCI  trends to be calculated, thirteen out of the fifteen had to be represented in the data.

For five-year trends, the river and lake water quality sites were excluded from the analysis if they had less than 90% of measures over five years.  LAWA does not calculate five-year trends for macroinvertebrates.

**The trend methodology**

To determine whether water quality at a river or lake site is showing improving, degrading or indeterminate trends, LAWA follows the methodology of McBride (2018), as implemented in R functions (R Core Team) provided by LandWaterPeople.

Trends are calculated on data for one site/measurement combination at a time.

The data for each combination were tested for seasonal effects, and then analysed with either a seasonal or non-seasonal version of the non-parametric Mann-Kendall Slope Test.  This test evaluates all pairwise combinations of the data, evaluating whether the later observations is higher or lower than the earlier observation, for each pair. The magnitude of the difference has no importance, only the sign.  The seasonal version of this test compares the water quality data of each season separately (January with Januaries, February with Februaries, etc) which means any changes present are not hidden by seasonal patterns.

Probability values from this test are interpreted in a Bayesian context as the probability of a mis-classification.  The confidence is then derived as one minus half the probability of mis-calculation.  The Mann-Kendall-derived value classifies each trend into one of five categories: very likely improving, likely improving, indeterminate, likely degrading, and very likely degrading.  This is where the probability range associated with each category (as described above) comes from.

Censored values (data that are less than or greater than laboratory detection limits) are included in the trend analysis, as very low or very high values.  However, if too many of the data are censored, the trend evaluation can become unreliable, and we opt not to calculate it.  We choose not to calculate trends where there are fewer than five total and three unique, non-censored observations.  Sites which do not meet these requirements for trend analysis are reported as 'not assessed'.  This label is also used when sites did not have enough measurements available, such as only six years of measurements available for ten-year trends.

Ideally, data should be flow adjusted before trend analysis to remove any effects of variation in water quality measurements caused by variable stream flow.  However, many councils do not measure river flow at their water quality sampling sites so data used for trend analysis on LAWA are not flow-adjusted.

**Where do I find more information?**

[Environment Aotearoa 2019](https://www.mfe.govt.nz/publications/environmental-reporting/environment-aotearoa-2019). A joint report by the Ministry for the Environment and Stats NZ.

LandWaterPeople (LWP).  <https://landwaterpeople.co.nz>/

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