White Paper

Integrated Report Improvements

Delisting Methodology

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Summary

DEQ's 2012 *Methodology for Oregon's Water Quality Report and List of Water Quality Limited Waters* did not provide definitive delisting procedures. The lack of specific detail for delisting protocols based on data collected after a water is initially placed on the 303(d) list reduces transparency and consistency for stakeholders, promotes inconsistent decision making and discourages robust monitoring programs that would otherwise provide more data to support accurate listing determinations.

Without a definitive method to remove a waterbody from the 303 (d) list when new information indicates it is no longer impaired and the impetus to do so, Oregon's 303(d) list may continue to include waters that have achieved water quality standards. Additionally, without clear guidelines for delisting based on improved water quality, waterbodies that were impaired but are now meeting water quality objectives because of restoration work or reduction in pollution also remain listed. DEQ is then limited in accounting for improvements in water quality reflected by removing water bodies from the 303(d) list.

DEQ's current methodology lists six administrative situations where a water will change status from listed on the 303(d) list as Category 5 (impaired, TMDL required) to Category 2 (attaining) or Category 4 (water quality limited, but with a TMDL to address impairment). These administrative situations are generally implementable as written. However, there is no clear method for changing the status of a waterbody, based on new data or a subsequent improvement in water quality, that indicate the waterbody currently attains the standard.

DEQ is proposing to clarify the guidelines for re-assessment of impaired waters when there is new or additional data indicating water quality standards are now attained. Delisting with new data shall account for data from the most recent assessment cycle and establish a minimum sample size. The preferred method is to use the binomial test as a statistical approach that mirrors the proposed listing methodology, with appropriate confidence intervals and hypotheses. As an alternate approach, a set minimum sample size should be defined.

Background

Section 303(d) of the CWA requires states to prepare lists of "surface waters that do not meet applicable water quality standards", referred to as the impaired waters list, and to establish Total Maximum Daily Loads (TMDLs) for pollutants causing the impairment of these waters on a prioritized schedule. The 303(d) listing requirement provides DEQ with the opportunity to utilize scientifically and statistically valid information to assess Oregon waterbodies and prioritize the waterbodies and pollutants for TMDL development.

DEQ's Assessment Methodology contains documentation required by federal regulations to support listing and delisting determinations and is submitted to EPA along with DEQ's final updates to Oregon's 303(d) list. While not a rule itself, the Assessment Methodology describes

how DEQ applies Oregon's water quality standards (contained in OAR 340-041) to assess state waters and identify water quality impairments.

Here, we refer to "delisting" as removal of a waterbody that has previously been placed on the 303(d) list either because the water is now attaining standards or because other conditions have changed. For instance, if a waterbody is still impaired, but a TMDL is not needed because the impairment is not due to a pollutant, it can be changed to a Category 4C and removed from the 303(d) list.

This paper focuses on the conditions under which DEQ would find an impaired Category 5 or Category 4 water to be attaining in a subsequent assessment cycle, resulting in a reclassification as Category 2.

Category	Description
Category 1	All designated uses are supported. (Oregon does not use this category.)
Category 2	Available data and information indicate that some designated uses are supported and the water quality standard is attained.
Category 3	Insufficient data to determine whether a designated use is supported.
	Oregon further sub-classifies waters if warranted as: **3B:** Potential concern when data are insufficient to determine use support but some data indicate non-attainment of a criterion.[5]
Category 4	Data indicate that at least one designated use is not support but a TMDL is not needed. This includes:
	4A: TMDLs that will result in attainment of water quality standards have been approved.
	4B: Other pollution control requirements are expected to address pollutants and will result in attainment of water quality standards.
	4C: Impairment is not caused by a pollutant (e.g., flow or lack of flow are not considered pollutants).
Category 5	Data indicate a designated use is not supported or a water quality standard is not attained and a TMDL is needed. This category constitutes the Section 303(d) list that EPA will approve or disapprove under the Clean Water Act.

Figure 1. DEQ's assessment categories.[1]

Current Practice

DEQ's 2012 assessment methodology identified seven different justifications for removing a Category 5 impaired waterbody from the 303(d) list and reassigning to Category 2 (attaining) or Category 4 (impaired, but not requiring a TMDL):

1) Current information shows water quality standards are attained
2) Current information shows an error in the Category 5: 303(d) listing – which indicates the 303(d) Category 5 status was assigned in error.
3) Water quality standards have changed or no longer apply in certain waterbodies.
4) Water quality standard pollutant changed - with recent water quality standard changes, several toxic substance criteria for a family or group of chemicals were replaced by criteria for individual chemicals.

[1] DEQ, 2014. Methodology for Oregon's 2012 Water Quality Report and List of Water Quality Limited Waters. Oct., 2014. http://www.deq.state.or.us/wq/Assessment/docs/AssessmentMethodologyRep.pdf

5) TMDLs approved for waterbody and pollutant - if a TMDL is developed for a pollutant on a watershed scale, all waterbody waterbodies listed for that pollutant criteria within the watershed are delisted and placed in Category 4A.
6) Other pollution control requirements in place – when pollution control measures are implemented and are expected to result in attainment of water quality standards, the water bodies will be delisted from Category 5: 303(d) and placed in Category 4B.
7) Impairment is not caused by a pollutant - when data or information indicate that waterbody impairment is being caused by pollution (i.e. habitat or flow modification), not pollutants (e.g. toxic substances), the waterbody is moved to Category 4C.

These justifications closely reflect EPA's guidance for delisting policy (Figure 2). Most of the justifications for delisting relate to administrative reasons. Justifications 2-4 would remove waters from the 303(d) list to address errors in the initial conclusion of the cause of impairment or changes in the applicable water quality standards or designated uses. Justifications 5-7 change the designation from Category 5 to Category 4 to address implementation of corrective actions such as a completed TMDL or implementation of pollution controls. While removed from the 303(d) list, Category 4 waters are still considered impaired as part of the 305(b) report.

Justifications 2-7 are based on either errors of process or changes in the relevant standards and appear to be specific enough to implement in their current state. This delisting document will focus on methods for removing a waterbody from the 303(d) list based on new data or information.

2006 IR Guidance

Table 3-4. Segment/Pollutant Combinations Removed from State's Year 2004 Section 303(d) List

Segment/ Pollutant Combination on Year 2004 Section 303(d) List	Segment (Waterbody) ID	Summary[a] Rationale for Delisting of Segment/Pollutant Combinations (*identify number of reason*)
		1. State determines water quality standard is being met 2. Flaws in original listing 3. Other point source or nonpoint source controls are expected to meet water quality standards 4. Impairment due to non-pollutant 5. EPA approval of TMDL 6. Waterbody not in state's jurisdiction 7. Other

Note:
[a] Detailed justifications for removing waters from previous section 303(d) list should be provided in the record of decision for the listing cycle in which the state proposes the water for removal.

Figure 2. EPA guidance for delisting [2]

[2] EPA 2005. Memorandum: Guidance for 2006 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d), 305(b) and 314 of the Clean Water Act. July 29, 2005. http://www.epa.gov/owow/tmdl/2006IRG

Sufficient Data for Delisting

Reclassifying a waterbody as Category 2 requires new or additional data that shows the standard is currently being attained and the Category 5 or 4 determination is no longer applicable. DEQ's 2012 Assessment Methodology described only vague data requirements for delisting based on new or additional water quality data:

> *"sufficient information from the current assessment to evaluate the pollutant or parameter and the information demonstrated that currently applicable water quality standards were being met… Generally, similar data were required to delist a waterbody as initially used to place the waterbody on the 303(d) list. For example, if the listing was based on two successive years of a standard not being met, DEQ looked for at least two successive years of data indicating that the standard is being met."*[3]

What constitutes "similar data" under the current policy is not well defined. While this methodology is intended to provide a margin of certainty that waters are in fact attaining, and to avoid repeatedly adding and removing the same waterbody from the 303(d) list, it is unclear how much new data showing attainment is required for a waterbody to be reclassified from impaired as a Category 5 or Category 4 listing to an attaining status.

If the requirement for "similar data" is interpreted as needing a similar number of samples showing attainment as were used to show impairment, it could create an arbitrary burden that disincentivizes the collection of large amounts of data and unreasonably delays delisting in the event no new exceedances occur. If "similar data" is interpreted as requiring the waterbody to be attaining the standard for as many years as it was on the list, it creates an arbitrary timeframe under which an attaining waterbody would erroneously be considered impaired.

In general, DEQ expects that more data will be available for the "delisting" assessment than were available for the "listing" assessment. New data is often collected as a result of ongoing routine monitoring, third party data submittal, and new data collected for TMDL development.

As with the listing methodologies, sufficient data includes an expectation that new samples are representative of the waterbody. Additional data should either represent the conditions in the waterbody as a whole, through a regular monitoring schedule, or capture key critical periods.

Alternative Policy Options

DEQ is considering the following options to evaluate whether available information shows waterbodies previously listed as Category 5 or 4 are now attaining water quality standards.

[3] DEQ, 2014. Methodology for Oregon's 2012 Water Quality Report and List of Water Quality Limited Waters. Oct., 2014. http://www.deq.state.or.us/wq/Assessment/docs/AssessmentMethodologyRep.pdf

Table 1. Alternative Delisting Policy Options for Oregon	
(1)	Status-quo: Retain requirement that similar data are required; refine and clarify the existing definition of 'similar data'.
(2)	Weight attainment determination on waterbody status of most recent 3-year period.
(3)	Set a fixed minimum number of samples needed to determine attainment.
(4)	Employ a statistical approach to de-list.

Analysis

Option 1. Status quo - define and clarify the existing definition of 'similar data'.

Using the status quo current approach, DEQ would consider delisting a waterbody that was assigned Category 5 or 4 when a set of new data that is at least as large as the number of samples collected for the initial listing have been collected. To an extent, this option assumes that the listing methodology will continue to rely on the >1-in-3-year critical exceedance frequency.

Using the approach of requiring a "similar" dataset to delist is generally adequate to characterize current water quality conditions and form a reasonable basis for delisting when sample sizes are small, data is collected on a regular schedule, and the date window for evaluation is close to the ideal 2-year assessment window. However, there are some notable exceptions for both large and small datasets.

Example 1:
One interpretation of the "similar data" requirement is that a similarly sized dataset would be needed to delist. The Upper and Lower Tualatin River was placed on the 2012 303(d) list for copper. More than 600 valid data points in the lower Tualatin River and almost 250 valid data points in the upper Tualatin River were used in the listing.

If DEQ were to require the same sample size of data to delist, it would constitute an unjustifiable burden to provide the same number of valid samples, regardless of the quality or attainment status of the samples, before a delisting would be considered. For example, removing the Tualatin River from its Category 5 copper listing would require a minimum of 600 new samples to be collected. This requirement further serves to disincentivize collection of large and long-term data sets by stakeholders.

Example 2:
The second interpretation of the "similar data" requirement is the waterbody needs to be attaining for a similar duration of time as the data used to place the water on the list. In the case of a 2012 listing for Fanno Creek, past data showed exceedances of the standard starting in 2006 based on a >1-in-3-year critical exceedance rate (Figure 3). Fanno Creek has not had a sample excursion of the default hardness-based criterion (generally more conservative) since 2014. (Note that DEQ has not evaluated this data set against the currently effective biotic ligand model criteria, which replaced the hardness-based criteria in 2016; however, based on DEQ's overall analyses associated with the criteria development, DEQ expects the copper criteria in Fanno Creek to be slightly less stringent than the hardness-based criteria that were effective when Fanno Creek was listed.

Based on the current dataset and a ten-year period of record, exceedances of the default hardness criteria occurred from 2007 through 2013. If DEQ employed an approach that required a similar duration of documented attainment, a delisting could only occur following a 10-year data period starting from 2014, preventing Fanno Creek from being delisted until 2024; forcing an 8-12 year interval as Category 5.

Advantages:

1) Provides approximately the same level of confidence as the initial listing for the waterbody.

Risks:

1) No set confidence level, and confidence varies with the initial sample size.
2) Assumes an arbitrary number of grab samples accurately represents the true condition of the waterbody.
3) Amount of data required to delist is arbitrarily related to the amount of data available at time of initial listing.
4) Does not guarantee meeting a desired level of confidence for the delisting decision.
5) Does not address Type-II error probability of delisting a waterbody that is actually impaired.
6) Provides a disincentive to the collection of large and long-term data sets by stakeholders.

Option 2: Weight attainment determination on status of most recent 3-year period

Option 2 applies to situations where the data assessed for the initial listing is longer than an ideal assessment window of every 2 years. This approach is to assess the waterbody based on the most recent range of data where the minimum number of samples are available. If a site has the minimum number of samples and is attaining in the most recent 3 years, the site would be eligible for delisting.

This approach can also be considered as an additional refinement of the definition of "similar data" to mean the most recent time period for which the minimal sample size is available. Here, the sample excursions that resulted in a Category 5 listing fell outside of the current data assessment window, and there is sufficient data to evaluate attainment of the standard within the current assessment window.

The amount of time a waterbody would have to remain on the 303(d) list before there was sufficient new data to allow a new assessment within the most recent cycle is determined by the rate new monitoring data is collected. For DEQ's ambient water quality monitoring network, where sites are visited every other month. Sites in the ambient network are sampled for conventional water quality parameters such as alkalinity, dissolved oxygen, pH, nitrate and phosphate, temperature and turbidity. DEQ also conducts monitoring for toxic pollutants three times per year on a rotating basin basis. Sites in the toxics monitoring network are sampled for pollutants, including pesticides, metals, and industrial chemicals. Some human health criteria also apply to pollutants monitored as part of this program.

Waterbodies on the 303(d) list would be listed for a minimum of two years to collect the minimum ten samples of conventional pollutants required to evaluate attainment in the most recent assessment cycle. For toxic pollutants and some human health criteria, it would take two basin rotations, or about three years, to collect the minimum of 5 additional samples required to evaluate attainment.

Advantages:

1) Provides a consistent set of data requirements for delisting eligibility that is independent of the initial sample size.
2) Uses the current conditions of the waterbody to categorize impairment or attainment.
3) Waterbodies would always be eligible for delisting within 2-3 years if routine monitoring is conducted.

Risks:

1) A minimal sample size of five to ten has low confidence when making an attainment decisions.
2) Does not address Type-II error probability of delisting a waterbody that is actually impaired.
3) May result in waterbodies that are on the margin or have high natural variability being de-listed and re-listed from cycle to cycle.
4) Provides a disincentive to the collection of large and long-term data sets by 3rd parties.
5) There is no current mechanism in place for additional monitoring of stations that are not on the ambient or toxics monitoring network.

Option 3: Set a fixed minimum number of samples needed to determine attainment.

In the case of a Category 5 listing resulting from a small dataset, utilizing the current assessment methodology for toxics, at least five valid samples are required to list a waterbody as attaining (Category 2). Using this approach, a waterbody with at least five new samples could be considered for delisting. If there were no exceedances, it could also be removed from the impaired waters list in the next assessment cycle.

The degree of uncertainty about a listing is dependent on the number of exceedances and sample size; the smaller the sample size, the greater the uncertainty about listing status. Using five samples to represent the variability in a waterbody will not result in high confidence about the delisting determination. This could result in waterbodies oscillating on and off the impaired waters list over an extended time period.

There is no way to quantify the confidence interval using >1-sample-in-3-years as a critical exceedance rate. Sample sizes of 16-25 are required to achieve a minimum confidence level of 80%–90% confidence in the attainment of standards based on at least two exceedances for the raw score and most commonly used statistical-based assessment methods[4]. Using small sample sizes to make decisions on both listing and delisting carries higher risk in mischaracterization of the status of the waterbody. On the other hand, setting minimum sample sizes too large can cause delay in taking timely action on assessments.

Advantages:

1) Provides a consistent set of data requirements for delisting eligibility independent of initial sample size.
2) Increased sample size increases the confidence level of delisting determinations.
3) Reduced Type-II error rates.

Risks:

[4] EPA, 2002. Consolidated Assessment and Listing Methodology (CALM). Toward a Compendium of Best Practices, First Edition. United States Environmental Protection Agency. July 2002.

1) If utilized with the >1sample-in-3-year critical exceedance rate, type-I errors are not controlled.
2) Extends the time frame before listed waterbodies can be considered for delisting based on new information.

Option 4: Employ a statistical method to delist.

The third option utilizes a statistical approach that accounts for the number of samples available in a dataset and the level of certainty desired to determine whether a waterbody is attaining or exceeding the water quality standards.
The statistical approach should match the statistical approach used for listing determinations. In this case, the preferred statistical method is the binomial test (see discussion of proposed Binomial approach in Listing Methodology whitepaper). This would apply to conventional pollutants and toxic substances, but not to human health criteria, which apply over a much longer duration of exposure.

The preferred statistical assessment method is the binomial test. The binomial method tests a hypothesis that the samples evaluated represent the waterbody as a whole. The recommended null hypothesis for delisting decisions is that the waterbody is not attaining the standard. This requires a higher burden of evidence to show the waterbody is in fact attaining, since it was previously shown to be exceeding the standard. The greater risk is in making a type-II error, or a false-negative, incorrectly rejecting the null hypotheses that the waterbody is exceeding the standard, and delisting water when it should be continued to be considered impaired.

The number of allowable sample excursions scales with sample size, and is likely to allow either a greater or lesser number of sample excursions than a fixed critical exceedance rate. Critical exceedance rates of 5%-15% and confidence intervals of 80% - 95% are commonly used by other states. These parameters are selected based on the expected quality of the data, and the tolerable risk of making an error in delisting decisions. A minimal sample size must be available before it is possible to achieve a desired level of confidence. For 90% confidence to determine that <10% of samples in the waterbody will exceed a threshold, there must be at least 22 samples with no sample excursions (Table 2).

The delisting procedure is not required to be a mirror image of the listing procedure. For example, DEQ may want to use a critical exceedance rate of <10% of samples with a 90% confidence to list, but use a 95% confidence interval to delist. A larger sample size required for delisting than for listing at a comparable level of confidence may be desirable. The same sample size could be used for listing and delisting at the expense of a lower confidence level in the case of delisting.

Table 2: Maximum number of excursions, x, for n sample size, for a critical exceedance rate of <10% with minimum confidence levels of ~80% (grey), ~90% (orange), or ~95% confidence (blue).[5]								
n	*x*	% Conf	n	*x*	% Conf	n	*x*	% Conf
10	0	65.13	43	1	93.77	76	4	88.79
11	0	68.62	44	1	94.29	77	4	89.44
12	0	71.76	45	1	94.76	78	4	90.06
13	0	74.58	46	2	85.16	79	4	90.65
14	0	77.12	47	2	86.17	80	4	91.1
15	0	79.41	48	2	87.11	81	4	91.73
16	0	81.47	49	2	88	82	4	92.23
17	0	83.32	50	2	88.83	83	4	92.7
18	0	84.99	51	2	89.61	84	4	93.15
19	0	86.49	52	2	90.44	85	4	93.57
20	0	87.84	53	2	91.02	86	4	93.97
21	0	89.06	54	2	91.66	87	4	94.34
22	0	90.15	55	2	92.26	88	4	94.7
23	0	91.14	56	2	92.81	89	5	89.08
24	0	92.02	57	2	93.34	90	5	89.68
25	0	92.82	58	2	93.82	91	5	90.24
26	0	93.54	59	2	94.27	92	5	90.78
27	0	94.19	60	2	94.7	93	5	91.3
28	0	94.77	61	3	87.1	94	5	91.79
29	1	80.11	62	3	87.9	95	5	92.25
30	1	81.63	63	3	88.66	96	5	92.69
31	1	83.06	64	3	89.47	97	5	93.11
32	1	84.36	65	3	90.04	98	5	93.51
33	1	85.58	66	3	90.68	99	5	93.88
34	1	86.71	67	3	91.28	100	5	94.24
35	1	87.76	68	3	91.84			
36	1	88.74	69	3	92.38			
37	1	89.64	70	3	92.88			
38	1	90.47	71	3	93.35			
39	1	91.24	72	3	93.79			
40	1	91.95	73	3	94.2			
41	1	92.61	74	3	94.59			
42	1	93.22	75	3	94.96			

California and Florida use the binomial approach to list water bodies as well as to delist water bodies. However, a stronger body of evidence is required to remove a waterbody from Category 5 than what is required to initially place it in Category 5. Both states require a minimum of 28 water

[5] Adapted from Lin et al, 2000. A Nonparametric Procedure for Listing and Delisting Impaired Waters Based on Criterion Exceedances. Florida Department of Environmental Protection Technical Report.

samples to delist a waterbody with a critical exceedance rate of ≤10% and approximately 95% confidence.

DEQ could also require that a waterbody would not be eligible to delist until after the next reporting cycle– in order to ensure newly collected samples are temporally representative. This would prevent water bodies with marginal pollutant levels from oscillating between Category 2 and Category 5 due to inter-annual variation of pollutant parameters.

Advantages:

1) More complicated to calculate, but thresholds for the desired critical exceedance and confidence interval can be pre-calculated and presented as a lookup table; as in the example, above.
2) Provides a consistent confidence level for decision making.
3) The number of allowable excursions scales with sample size, reflecting greater certainty in larger samples.
4) The user directly controls the type-I error probability of delisting a waterbody when it is actually exceeding the standard by selecting the desired statistical confidence level.
5) Reduce type-II error probability over both raw score and >1-sample-in-3-year critical exceedance rates.
6) Provides strong incentive for longer-term monitoring and additional data collection to characterize listed waterbodies by affected stakeholders.

Risks:

1) Attaining confidence of at least 80% requires a minimal sample size of 16.
2) The type-I error probability is higher than for the >1-in-3-years critical exceedance rate.

Conclusion

Recommendation

The delisting methodology should use the same statistical approach used for listing determinations. In conjunction with recommended changes to the listing methodology, and based on the analysis above, DEQ recommends a combination of Option 4 and Option 2.

For conventional pollutants and c toxic substances, DEQ should use a binomial test to remove water bodies from Category 5 provided there is sufficient data that shows they are attaining the requirement for Category 2 in the most recent assessment cycle.

For human health criteria, the geometric mean of all available samples for the duration of exposure specified in the water quality criteria for each pollutant (lifetime, 30-day, etc.) within the assessment window should be less than the criterion magnitude. This is consistent with the proposed listing methodology, and constitutes a clarification to the assessment method for human health criteria, which are based on a lifetime duration of exposure.

All administrative reasons for changing the status of a waterbody that was placed on the 303(d) list that do not require new or additional data also remain valid conditions to delist a waterbody (items 2-7, page 2).

Proposed Delisting Methodology

Toxic Substances Criteria and Conventional Pollutants:

- Null hypothesis (H0): the waterbody exceeds the criteria (impaired, no change)
- Alternative hypothesis (HA): the waterbody is attaining (delist)
- Confidence is 90%
- Consult an independent technical review panel to confirm or adjust the proposed confidence intervals and null hypotheses.

Human Health Criteria

- The geometric mean of all applicable samples within the assessment window is less than the criterion magnitude.

Table 3. Proposed Delisting Guidelines					
	Chronic			Acute	
	No change	Delist	Min. confidence interval	No change	Delist
Aquatic Life Toxics	Binomial H_O: >5% of samples exceed the 4-day chronic criterion	Binomial H_A: ≤5% of samples exceed the 4-day chronic criterion value	90%	Binomial H_O: >5% of samples exceed the 1-hour chronic criterion	Binomial H_A: ≤5% of samples exceed the 1-hour chronic criterion value
Conventional Pollutants	Binomial H_O: Actual exceedance proportion >10%	Binomial H_A: Actual exceedance proportion ≤10%	90%	NA	NA
Human Health Criteria	Geometric mean sample concentration > criterion	Geometric mean sample concentration ≤ criterion	NA	NA	NA

Alternate recommendation

In the event a binomial is not feasible, DEQ should adopt Option 2, and delist waterbodies if they are attaining the water quality criterion if there is sufficient data indicating attainment in the current assessment cycle.

To delist to Category 2, DEQ may also consider adjusting the minimal sample size using the binomial distribution at a set level of confidence with zero sample excursions. A minimal sample size for a 10% critical exceedance rate is 16 at an 80% confidence level with no excursions, and 22 samples at a 90% confidence level with no excursions.

Potential Impact

The number of sites that would be eligible for re-assessment is currently unknown. However, a specific case-study of the proposed delisting procedure is available from the public comments received for the 2012 303(d) list.

Example 1: Fanno Creek

The current list has a Category 5 listing for copper on Fanno Creek (Figure 3). Ninety samples from USGS Station 14206950 were assessed for the time period 2000 to 2010. Ten out of the ninety samples were excursions above the hardness dependent criteria, and it was placed in Category 5. Seventy-one copper samples were collected at USGS Station 14206950 between 2014 and 2017 with no excursions of the hardness dependent criteria in the most recent 3 year period.

If the Option 1 method requiring similar data to delist were applied, then, this waterbody would not be eligible for delisting consideration and would remain on the 303(d) list since only 71 samples were collected since 2010, rather than 90.

If the binomial test using the recommended combination of Option 2 and Option 4 were applied, the waterbody could be removed from Category 5 with >90% confidence that it is not impaired for copper.

Example 2: Willamette River at Portland

The current 303(d) list has a Category 5 listing for copper on the Willamette River, also from 2010. The listing was based on sixty-two samples collected at four different sampling locations. If the locations were assessed for the next assessment using a 10-year dataset, 53 of the 62 samples have been collected within the last 10 years. Of the 53 samples, only 3 samples exceed the current biotic ligand model criteria or the previous hardness-based criteria.

If the Option 1 method were applied, the 3 sample exceedances remained in the data assessment window (i.e. occurred after 2006 for a 10-year data assessment) and the site would retain its Category 5 listing for copper.

Out of twenty samples collected since the previous assessment at USGS Site 14211720, no exceedances of the previous hardness dependent criteria occurred. Using the statistical approach to delisting, DEQ could remove the Category 5 listing for copper with 94% confidence that the actual criterion exceedance frequency is less than 5%.

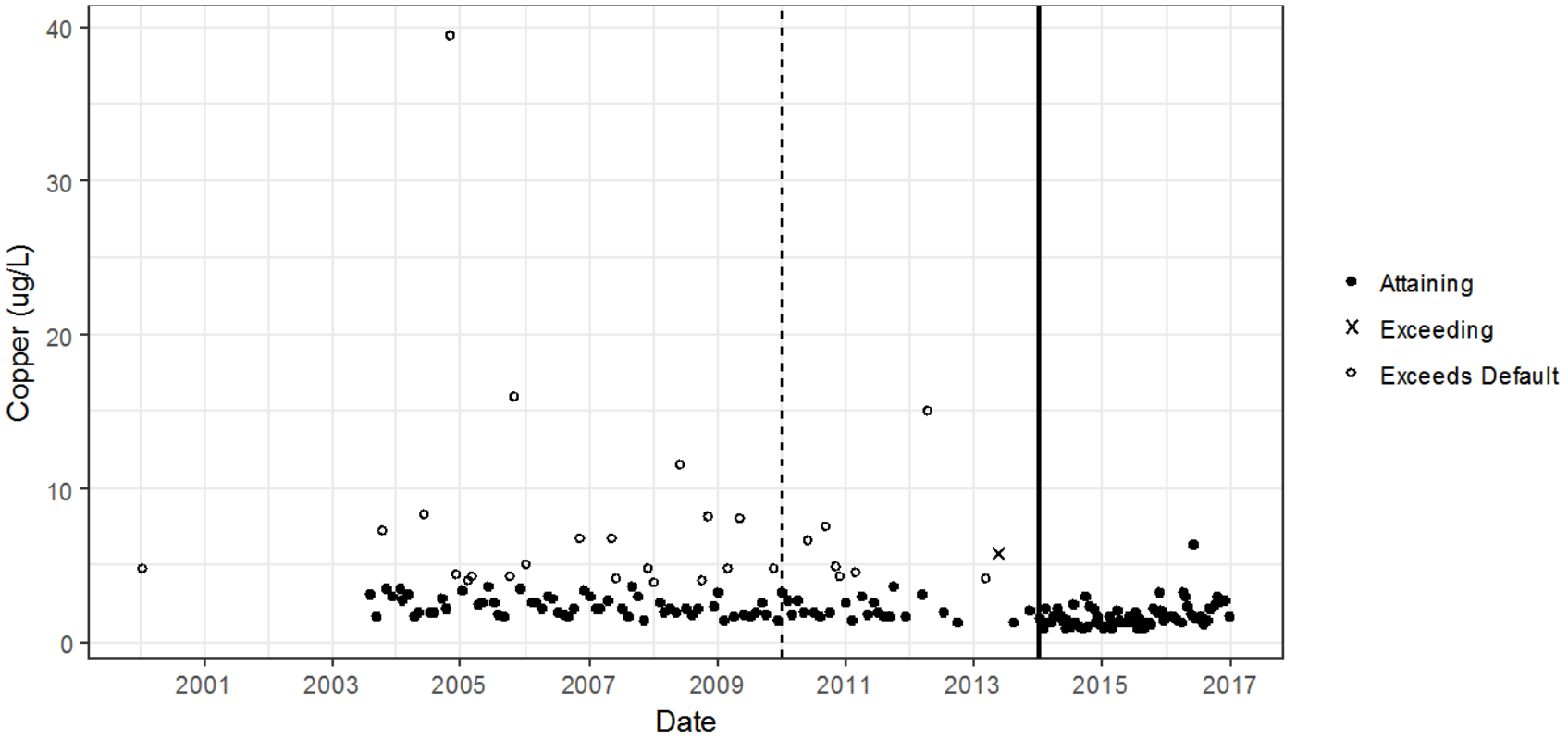

Figure 3. Copper data for Fanno Creek 2000-2017. Data supporting the 2010 Category 5 listing for copper is to the left of the dashed vertical line. Data for the most recent 3-year period, 2014-2017, is to the right of the solid line. There are no exceeding samples in the most current 3-year window.

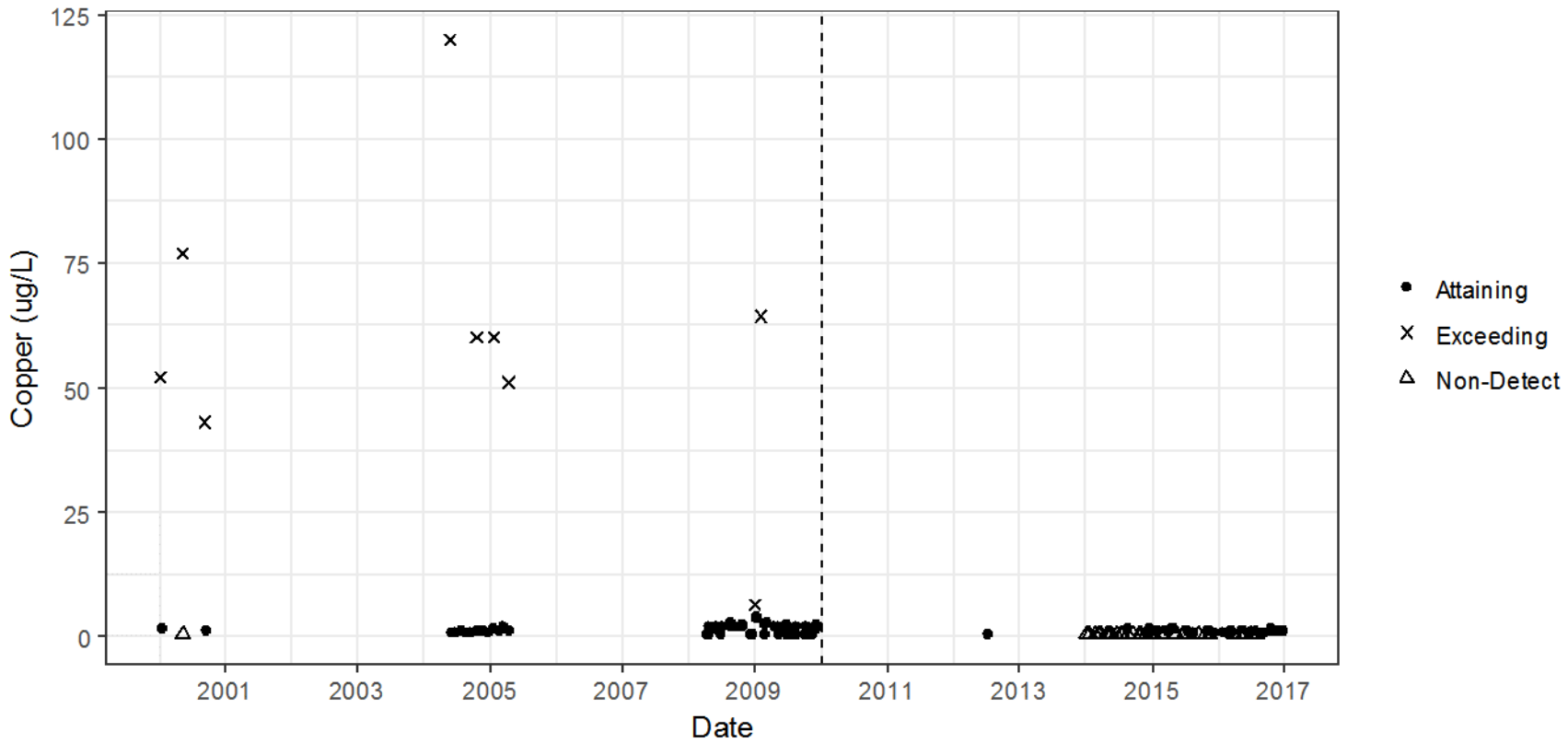

Figure 4. Copper data for Lower Willamette River listing 2000-2017. Data supporting the 2010 Category 5 listing for copper is to the left of the vertical dashed line. There are no sample excursions since the 2010 assessment cycle.

References

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