Oregon E-Cycles Collections Determination for 2024

May 1, 2023

Introduction & Summary

For each calendar year, Oregon's electronics recycling law[1] requires the Oregon Department of Environmental Quality (DEQ) to determine the total weight of electronic devices to be collected under the state's "E-Cycles" program. This number has conventionally been known as the "collections determination."

The law also requires DEQ to report the proportions of that total which represent two classes of devices: (i) televisions, and (ii) other devices – specifically, computers, monitors, peripherals, and printers, hereafter collectively called "computing devices."

For 2024, **DEQ sets a collection determination of 13.8 million pounds. DEQ projects that 58% of pounds collected will be TVs, and 42% computing devices.** The document below describes issues that were considered in developing this determination and includes an account of DEQ's calculations.

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DEQ is a leader in restoring, maintaining and enhancing the quality of Oregon's air, land and water.

oregon E-CYCLES

[1] ORS 459A.300 and related sections

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Background

Setting a reasonable collections determination (hereafter, CD) for Oregon's E-Cycles program is not a simple task. The CD is both a goal and an expectation for participants in E-Cycles, but it must be set ahead of time, and foresight is imperfect. Numerous factors make predicting future collections difficult, including:

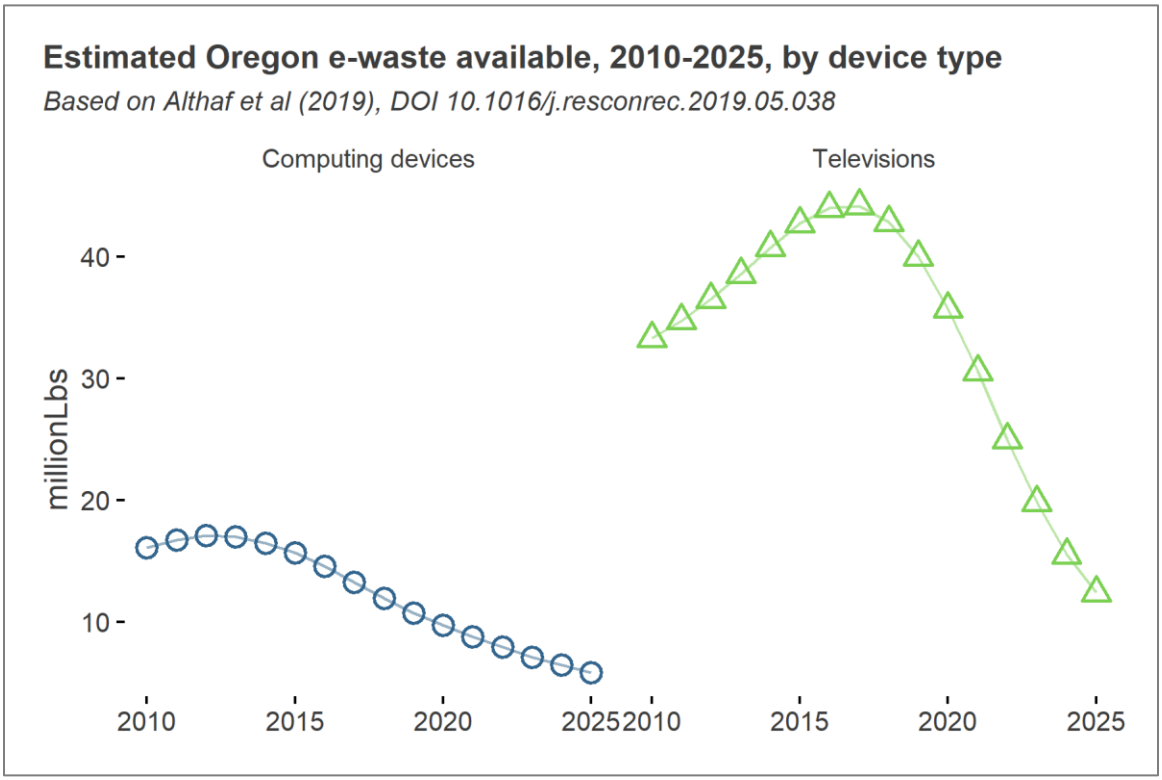
- The fast-changing nature of electronics production, consumption, and use.
- The diverse reasons for differences between the volume of electronics conceivably available for recycling, and the volume that is actually collected.
- The potential lingering effects of the COVID pandemic, both direct (e.g. changes in collections) and indirect (e.g. shifts toward remote work).

The evolving electronics ecosystem

Electronics are playing larger and larger roles in our work and personal lives. Nonetheless, the total weight of electronic waste generated in the United States has been dropping since the mid-2010s, because in general devices have been getting lighter.

Althaf and co-authors[2] have estimated the amount of e-waste available for collection (not necessarily the weight actually collected) in the USA through 2025. Their projections, scaled for Oregon, are charted below.

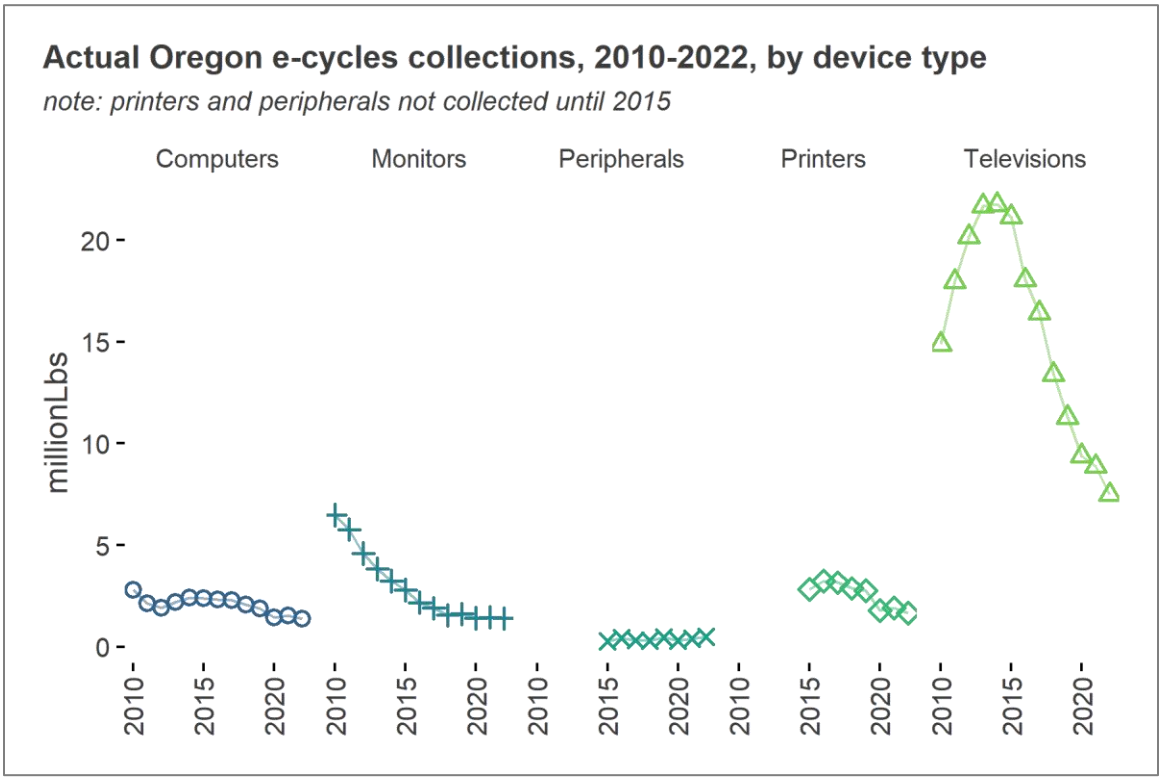
Figure 1



[2] Shahana Althaf, Callie W. Babbitt, and Roger Chen, "Forecasting Electronic Waste Flows for Effective Circular Economy Planning," *Resources, Conservation and Recycling* 151 (December 1, 2019): 104362, https://doi.org/10.1016/j.resconrec.2019.05.038.

Actual collections of e-waste in the Pacific Northwest have shown declines that echo the trends in Althaf et al.'s projections of availability. In Washington state,[3] e-waste collections were 13% lower in 2022 than 2021. In Oregon, where DEQ has detailed data, actual collections peaked about 2015 and have come down since, as illustrated below.

Figure 2



Together, Althaf's analysis and Oregon's experience suggest that e-waste streams have been dominated by displays (TVs and monitors). While the weight of both types of displays seems to be declining, especially with the disappearance of cathode ray tube devices, displays are still the biggest elements in collected e-waste, by weight.

Though a decrease in waste sounds like good news for the environment, Althaf and colleagues[4] note that the new, lighter products present environmental and conservation issues of their own, due to the concentration of rare and hazardous materials in those products. They suggest that weight-based goals for electronics recycling – such as the ones that Oregon's E-Cycles program uses – may no longer have the same environmental value they once did, and that recycling programs need to find new ways to measure performance of those programs.

[3] Jared Paben, "Pacific NW State Reports 13% Drop in E-Scrap Recycling," *E-Scrap News* (blog), January 25, 2023, https://resource-recycling.com/e-scrap/2023/01/25/pacific-nw-state-reports-13-drop-in-e-scrap-recycling/.
[4] Shahana Althaf, Callie W. Babbitt, and Roger Chen, "The Evolution of Consumer Electronic Waste in the United States," *Journal of Industrial Ecology* 25, no. 3 (2021): 693–706, https://doi.org/10.1111/jiec.13074.

Available e-waste vs. collections

When actual collections under Oregon E-Cycles are compared to Althaf et al.'s projections of available waste, as in the figures below, some things are immediately noticeable.

Figure 3

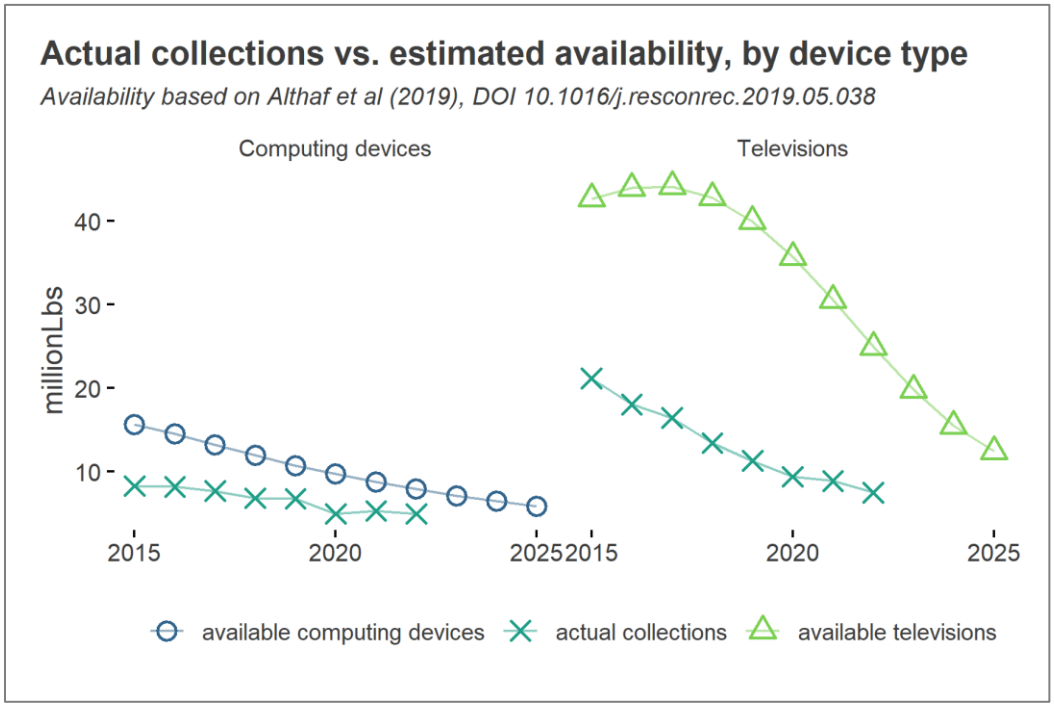
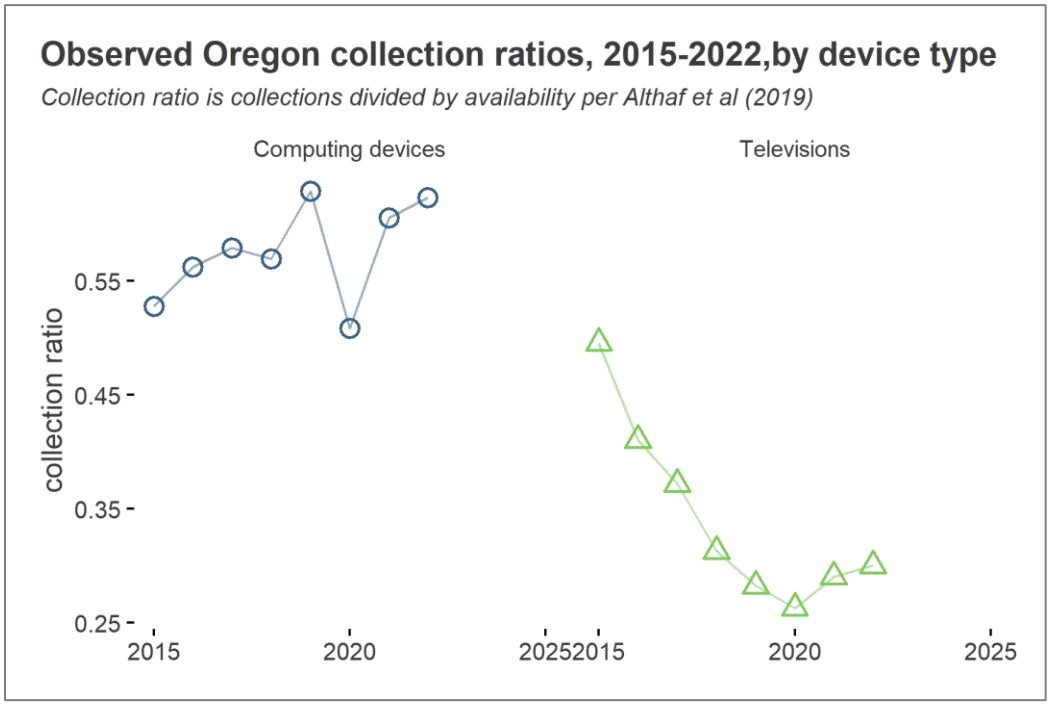


Figure 4



Actual collections are consistently smaller than projected e-waste availability. The "collections ratio," calculated as actual collections divided by estimated available pounds of waste, is always less than 1. Not

including the COVID-influenced year 2020, the collections ratio ranged from 0.53 to 0.63 for computing devices, and 0.28 to 0.50 for televisions.

Some difference between availability and collections is to be expected. A recent report from the United Nations[5] listed a number of reasons why old or unused electronics might not end up in official collections. Electronics might be inappropriately disposed, being mixed together with metal scrap or (illegally) discarded to landfill or incineration. Alternatively, people and businesses may choose to hold on to devices, reasoning that they might use or sell items in the future, or admitting they don't know how to recycle them.

Some of these reasons – for example, awareness of recycling opportunities – might reflect the performance or effectiveness of electronics recycling programs. Other reasons are more organic, reflecting changes in the electronics ecosystem and people's perceptions of the value of their devices. DEQ does not have sufficient data to quantify the relative effects of these two types of phenomena on Oregon's recycling collections. This contributes to uncertainty about the appropriate magnitude of the CD.

Another clear finding from the Oregon results is that the collection ratio is consistently lower for televisions than computing devices. This echoes results in the UN report, which found that households were more likely to hold on to certain types of devices; televisions and other screens were more likely to be kept at home and out of the recycling stream than some other types of equipment. Together these data suggest that collections ratio, by device type, should be explicitly considered when predicting future collections.

Public awareness

Another variable that makes it difficult to set a precise CD is DEQ's work to promote the E-Cycles program to the public.

A 2019 DEQ survey found that 79% of those surveyed knew that Oregon has an electronics recycling program, and that 67% of Oregon residents have at least one device eligible for recycling through the Oregon E-Cycles program.[6] DEQ intends to replicate its survey in 2023 to determine whether public awareness about the program or the percentage of people with devices eligible for recycling has changed over time. An increase in either one of these factors may result in increased recycling.

Also, DEQ created a subsequent 2021 public awareness campaign designed to move to action the 67% of residents who have items at home that could be recycled. The campaign is currently on pause, but has the potential to increase recycling if and when it is launched.

Another driver of public awareness is the ongoing outreach local governments conduct throughout the year to encourage residents in their localities to take advance of drop-off events. DEQ cannot predict how much or how little outreach will be conducted at the local levels.

[5] C P Baldé et al., "Update of WEEE Collection Rates, Targets, Flows, and Hoarding – 2021," 2022, https://weee-forum.org/wp-content/uploads/2022/12/Update-of-WEEE-Collection_web_final_nov_29.pdf.
[6] rockitscience, Larkspur, and Benenson Strategy Group, "Oregon E-Cycles Branding and Messaging Implementation Guide" (Oregon Dept. of Environmental Quality, May 2021), https://www.oregon.gov/deq/FilterDocs/EcyclesImplementation.pdf.

COVID-19 pandemic disruptions to e-waste flows and demand for electronics

The COVID-19 pandemic brought on several phenomena with the potential to change e-waste collections. As documented and discussed[7] in DEQ's *E-Cycles Collection Determination for 2023*, the first year of the pandemic (2020) showed disruptions in e-waste collection, creating an expectation of rebound in later years. Then in 2021 and 2022, market data showed increasing demand for some types of electronics. For example, industry sources reported that 2021 PC shipments were 15% higher than 2020 shipments,[8] clearly suggesting a possible spike in e-waste in future years, as older devices were replaced. These phenomena influenced Oregon's CD for 2023, raising the level of anticipated collections above CDs for 2021 and 2022.

However, more recent market data has not shown such clear and directional trends. A literature search found no projections of 2023 and 2024 e-waste quantities highly relevant to Oregon and suggested that 2023 would not show large changes in shipments of TVs and PCs.

Analysis

Approach

For all the reasons explored above, DEQ cannot expect to precisely predict recycled electronics collections under E-Cycles a year or more ahead of time. Instead, DEQ's analysis attempts to set a ***credible range*** for the quantity of electronics that might reasonably be collected under E-Cycles in 2024. DEQ will then apply multiple considerations, including comments from stakeholders, in choosing an exact collections determination value within that range.
DEQ's method for creating a range for 2024 was slightly different than the one it used for 2023. For the 2023 CD, DEQ set a low boundary by extrapolating from historical trends in actual collections; it set a high boundary by "correcting" those extrapolations with additional, market-based evidence about COVID-related changes to e-waste and electronics purchasing.

For the 2024 CD, the market-based evidence was less abundant and less clearly directional. Accordingly, DEQ created a range of candidate CD values by creating predictions, for each of two device types (computing devices and televisions), based on high, medium, and low values of two variables:

- Historical trends in collections, extrapolated to 2024; and
- Observed collections ratios.

Method

To create a range of candidate CD values:

- First, DEQ extrapolated historical trends in collections out to 2024, using a LOESS curve fitting model on collections data expressed as pounds per capita per year. (Justification for the LOESS model and comments about autocorrelation can be found in the 2023 CD document.) The curve fitting yielded a projected (moderate) value for collections, as well as upper and lower confidence bounds. These values were adjusted for Oregon's anticipated population in 2024.
- Next, DEQ created variants of the high, moderate and low values from curve fitting by scaling those values based on the historical range of collections ratios. The moderate collections ratio was the same one anticipated by comparing the moderate curve fitting estimate with Althaf et al.'s projection for Oregon in 2024 and resulted in a scaling factor of 1 (no correction). Scaling factors for high and low collections ratios were drawn from the relationship in magnitude of the

[7] Oregon Department of Environmental Quality, "Oregon E-Cycles Collections Determination for 2023," April 29, 2022, https://www.oregon.gov/deq/FilterDocs/e-cycles-coldet.pdf.
[8] "Canalys Newsroom - Global PC Shipments Pass 340 Million in 2021 and 2022 Is Set to Be Even Stronger," accessed March 5, 2022, https://www.canalys.com/newsroom/global-pc-market-Q4-2021.

maximum and minimum collections ratios, observed 2015-2022 but omitting the year 2020, to the moderate collections ratio.

Overall, DEQ created 18 device-type specific predictions of pounds collected in 2024:

	computing devices			televisions		
	Low boundary of historical trend	Fitted (moderate) value of historical trend	High boundary of historical trend	Low boundary of historical trend	Fitted (moderate) value of historical trend	High boundary of historical trend
Minimum historical collections ratio	✓	✓	✓	✓	✓	✓
Moderate historical collections ratio	✓	✓	✓	✓	✓	✓
Maximum historical collections ratio	✓	✓	✓	✓	✓	✓

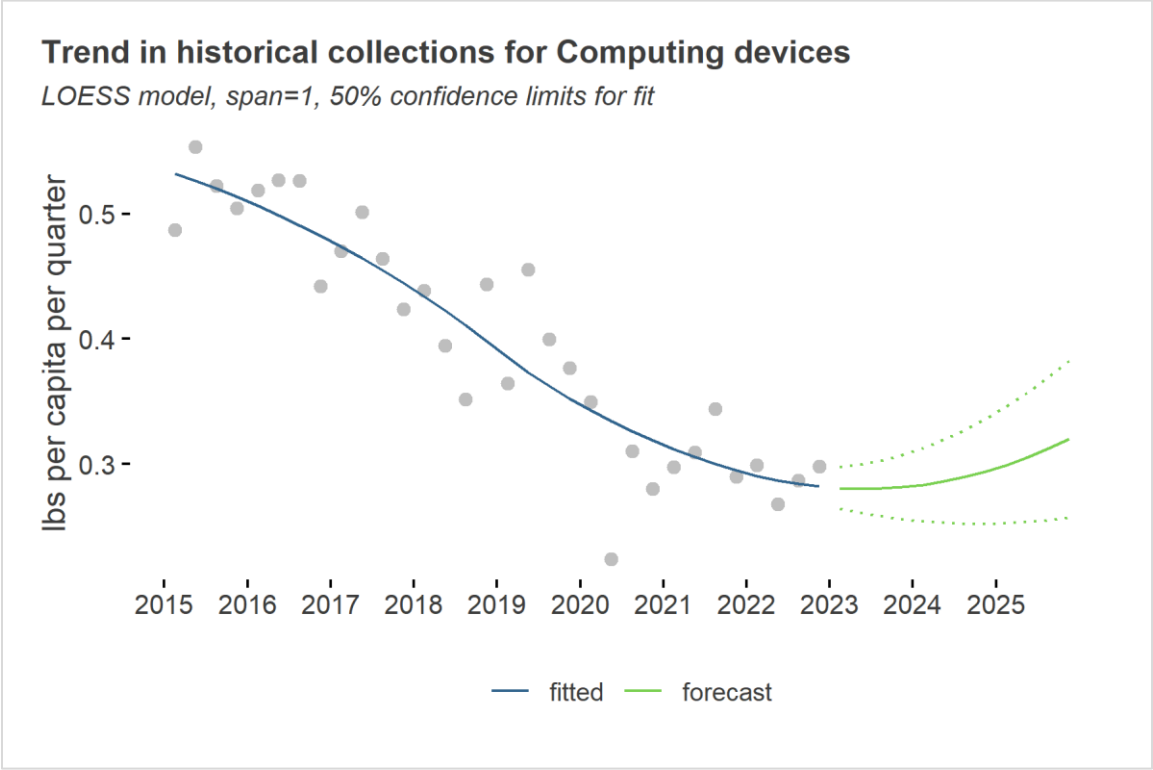
Summing the two device types yielded 9 different candidate values for the 2024 CD.

It is important to acknowledge the two main components of this calculation (the historical trend, and the collections ratio) are not independent. Both components are influenced by "organic" factors related to the production, consumption, design and use of electronics, such as lightweighting. And both components are influenced by "programmatic" factors such as the effectiveness or design of recycling program operations. Some degree of correlation should be expected between the two components. However, the sources behind those two components (including observed collections, Oregon population estimates, and Althaf et al.'s projection of e-waste availability) should be diverse enough that the 9 different candidate values will represent a realistic range of possibilities for Oregon collections in 2024.

Historical trends and projections for 2024

Oregon collections of computing devices show the expected decline from 2015 through 2022, with an especially low but anomalous point early in 2020, as the COVID pandemic began:

Figure 5



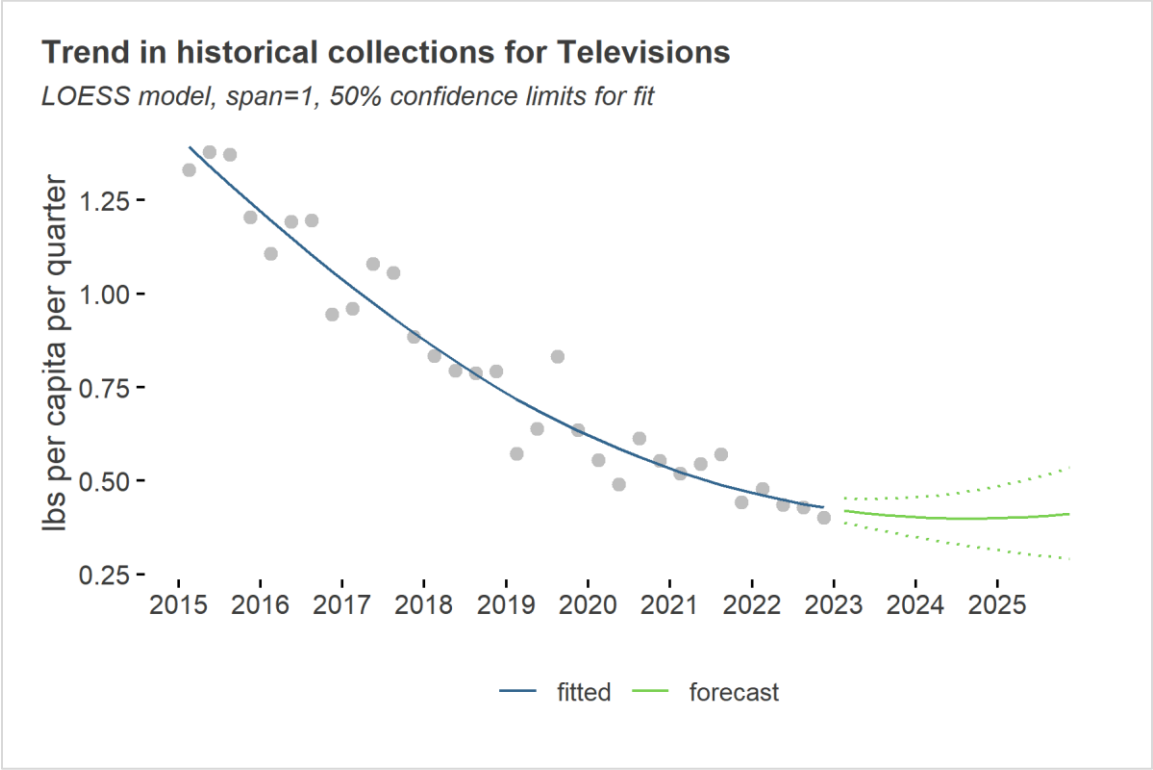
The curve fitting model suggests that in 2022 and 2023, the declining trend in collections was flattening out, and might even increase again in 2025. The moderate value forecast for 2024, when adjusted for Oregon's population, is 5.0 million pounds, with lower and upper bounds of 4.4 and 5.6 million pounds.

Several things might be noted about this chart. First, there are certainly variations from quarter to quarter and perhaps season to season, but it is not immediately obvious that these influence the overall trend over years, expressed by the "fitted" and "forecast" lines. Second, the forecast line – at least on the noisy quarterly data set – is not very precise. In each chart, the dotted lines represent 50% confidence intervals for the predicted curve (that is, of all the possible forecast lines that could be drawn by the regression, 50% of them are within those boundaries).

This demonstrates that forecasting complex curves from historical data inherently involves uncertainty. The solid forecast line is not a guarantee – rather, it is the most reasonable prediction that can be made, given the data and technique available.

The chart illustrating collections of televisions is similar:

Figure 6



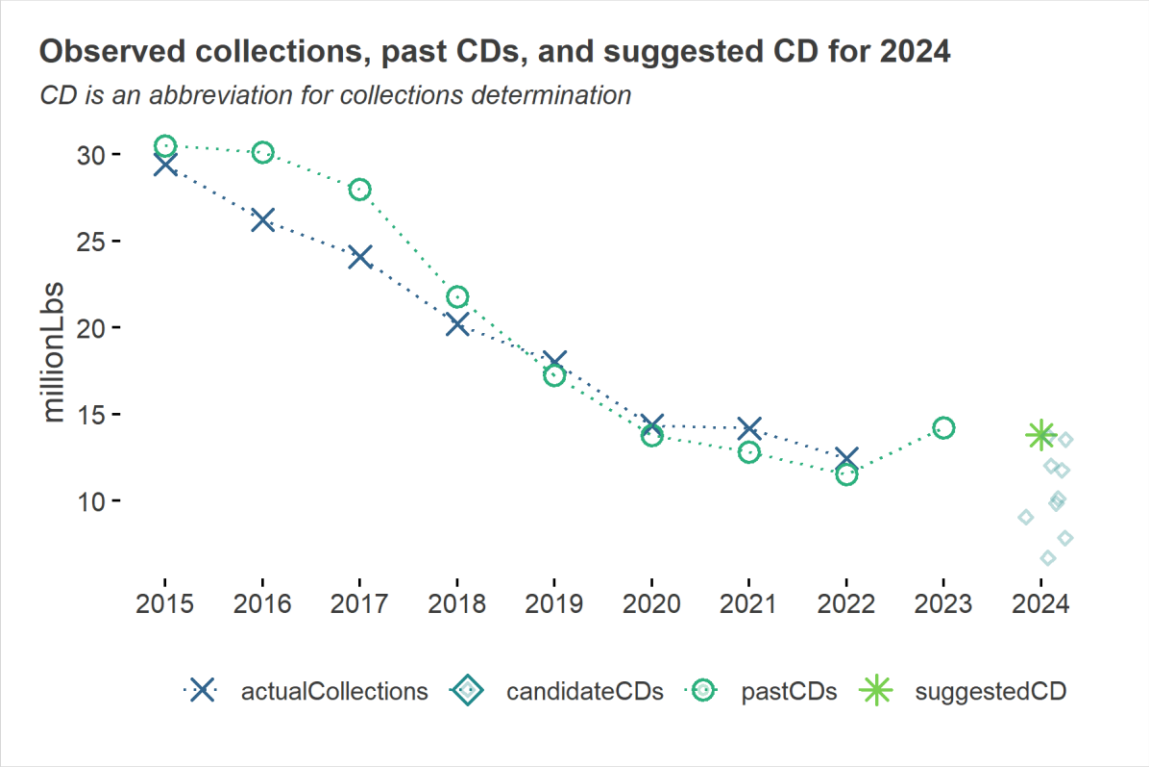
Again, there is a fairly clear decline from 2015 through 2022, with a suggestion that the decline may be flattening out. For televisions, the curve fitting model forecast for 2024, given Oregon's 2024 population, is 6.9 million pounds, with lower and upper bounds of 5.8 and 8.2 million pounds.

Adding the two device categories together, the curve fitting model prediction for collections in 2024 is 11.9 million pounds, with a lower bound of 10.2 million and an upper bound of 13.8 million. The relative contributions of computing devices and televisions to the total, using the central fit projections, is 42% to 58%.

Scaling with collections ratios

The figure below shows how the range of candidate values for the 2024 collections determination expands when the results of the curve fitting analysis are varied to express a range of historical collections ratios for each device type. Nine candidate values for 2024 are shown as small diamonds, with previous collections determinations and actual collections data for reference:

Figure 7



The range of candidate values for the 2024 CD now ranges from 6.6 to 13.8 million pounds. The central prediction, based on the moderate curve fitting prediction and no alteration of the likely collection ratio, stays at 11.9 million pounds. The lower bound of the range of values has expanded. This is largely due to the fact that past collection ratios were often smaller than the ones implied for 2024 by the curve fitting analysis, assuming the availability predictions of Althaf et al. are reliable. That is, given the range of plausible collections ratios, there is more room to go down than up.

Analysis summary

DEQ's modeling estimates that a reasonable CD for 2024 could range from 6.6 to 13.8 million pounds, and that the relative contributions of computing devices to televisions in the total will be 42% to 58%.

Additional considerations

To select the collections determination from the analytical model's estimated range of numbers, DEQ considered several other factors.

Stability in the collection network

If DEQ sets the collection determination too low, program operators may easily exceed their minimum collection obligation and seek to reduce the number of collection sites in their network the following year. This has potential to cause disruption and reduce convenience for the public. Therefore, DEQ did not consider selecting any number between 6.6 to 11.9 million pounds.

Credits available

If DEQ sets the collection determination too high, program operators have the option to draw from credits banked in previous years to meet their obligations. This would also maintain stability in the collection network and sustain current convenience levels for the public. Because of this, DEQ is comfortable selecting a number above 11.9 million pounds.

Increased awareness

As of the publishing date of this report, House Bill 3220A, which would modernize the Oregon E-Cycles program, is moving through the Oregon Legislature. The legislative and public conversations about the program have undoubtedly increased statewide awareness about Oregon E-cycles, potentially leading to greater collection. This supports DEQ's comfort with a number above 11.9 million pounds.

House Bill 3220A

If House Bill 3220A passes, the collection determination established for 2024 would also be used for 2025. If, however, analysis of factors related to collection suggests significantly more returns for 2025 are likely, DEQ may evaluate options to update this 2024 determination for the 2025 calendar year to provide stability to the system.

Public input

DEQ posted the *2024 Draft Oregon E-Cycles Collections Determination* report online for public input on April 5, 2023, and hosted a virtual public information meeting on April 13, 2023, to explain the document and answer questions. Public comments were accepted during the meeting and until April 19, 2023. Attendees who gave comment at the meeting supported the goal proposed by DEQ. Only one written comment was submitted, which also supported the goal as proposed.

Conclusion

Based on analytical results, the additional considerations and comments submitted, the collection determination for 2024 is 13.8 million pounds.

Translation or other formats

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