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# Millicoma Dace: Current Status, Future Research, and Management Considerations

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## ABSTRACT

- The Millicoma Dace is a form of Longnose Dace that is endemic to the Coos River drainage in southwestern Oregon.
- The historical distribution of Millicoma Dace has been inferred based on museum collection records, and concerns regarding the status of Millicoma Dace prompted efforts in 2014 and 2015 to evaluate the current distribution of Millicoma Dace.
- In general, the known historical and known current distributions of Millicoma Dace are similar. However, these distributions are not based on a comprehensive survey of all available habitat within the Coos River drainage and therefore represent an unknown portion of the true distribution of Millicoma Dace.
- Available data are insufficient to provide a robust estimate of trend in abundance of Millicoma Dace.
- Although field-based observations point toward selection by Millicoma Dace for fast-water habitat units with coarse substrates, this pattern has not been formally evaluated. Available habitat data suggest that Millicoma Dace may use a variety of habitat types at the stream-reach level.
- Further research on habitat selection by Millicoma Dace is warranted prior to implementation of habitat enhancement for the conservation of this form of Longnose Dace.
- Additional research on life-history, behavior, physiological limits and optima, ecology, and taxonomy may aid in understanding the status of Millicoma Dace.

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## BACKGROUND

The Longnose Dace *Rhinichthys cataractae* is a cyprinid fish that is distributed throughout much of North America; ranging from the Pacific Coast to the Atlantic Coast, south to northern Mexico, and north throughout much of Canada (Scott and Crossman 1973; McPhail and Taylor 2009). The Millicoma Dace is a form of Longnose Dace that is endemic to the Coos River drainage in southwestern Oregon. Comparative morphological variation between Millicoma Dace and other forms of Longnose Dace in the Pacific Northwest was first described by Bisson and Reimers (1977). Among Pacific Coast forms of Longnose Dace (i.e., Chehalis River, Umpqua River, Coos River), the Millicoma Dace has shorter median and paired fins, a smaller head, more slender body proportions, additional caudal peduncle scales, and a less deeply forked caudal fin; additionally, Pacific Coast forms of Longnose Dace differ from other Pacific Northwest forms (Bisson and Reimers 1977). McPhail and Taylor (2009) showed that mitochondrial DNA sequences (cytochrome *b* and control region) differed between Columbia Basin Longnose Dace and coastal forms of Longnose Dace, and that the coastal forms of Longnose Dace were well-separated into two groups: Millicoma Dace and Umpqua Dace *R. eversmanni*.

The Umpqua River is believed to have once been a tributary to the Willamette River, but a stream capture event geographically isolated these two drainages (Diller 1915 *in* Markle et al. 1991); the stream capture event likely occurred during the late Cenozoic Era (Baldwin 1981 *in* Markle et al. 1991). This vicariance event is suspected to have isolated five species of Columbia River cyprinids in the Umpqua River, including the Umpqua River form of Longnose Dace (Bisson and Reimers 1977; Markle et al. 1991). Consequently, Bisson and Reimers (1977) hypothesized that Millicoma Dace may have originated in one of two ways: 1) Longnose Dace may have directly colonized the Coos River from the Willamette River by means of distinct stream capture events (independent origin hypothesis); 2) Longnose Dace may have colonized the Coos River from the Umpqua River either along the coast or through stream capture events (dependent origin hypothesis). McPhail and Taylor (2009) suggest that Longnose Dace more likely colonized the Coos River from the Umpqua River (dependent origin hypothesis) based on their genetic analyses, and that Umpqua Dace and Millicoma Dace are sister taxa. Although Millicoma Dace are currently considered a form of Longnose Dace, McPhail and Taylor (2009) argue that Millicoma Dace warrant specific status based on genetic divergence, and based on at least one unique morphological trait (i.e., dorsal fin-ray numbers; Bisson and Reimers 1977).

Concerns regarding the status and a potential decline in the distribution of Millicoma Dace prompted efforts in 2014 and 2015 to evaluate the distribution and abundance of Millicoma Dace (Scheerer et al. 2014, 2015, 2017). The present document summarizes available distribution and abundance data, summarizes habitat data collected within the putative distribution of Millicoma Dace, provides additional interpretation of these data, recommends potential future research, and comments on management considerations based on current knowledge.

## DATA AVAILABILITY AND ANALYSIS

Historical distribution data for Millicoma Dace were obtained from Table 1 *in* Scheerer et al. (2014). This table provides a summary of locations where Millicoma Dace specimens were collected from 1961 through 1997; these specimens are currently archived in the Oregon State University Ichthyology Collection. There is no evidence to suggest that these data were collected as part of a methodical effort to identify the distribution of Millicoma Dace; presumably they were collected opportunistically. Consequently, these data represent an unknown portion of the historical distribution (pre-1998) of Millicoma Dace (hereafter referred to as 'minimum historical distribution of Millicoma Dace').

Current distribution data for Millicoma Dace were obtained from primary data presented in Scheerer et al. (2014, 2015, 2017). These data were collected during surveys specifically aimed at evaluating site-level occupancy and abundance of Millicoma Dace, rather than a comprehensive evaluation of the distribution of the species. Consequently, these data are likely insufficient for estimating the current distribution of Millicoma Dace for at least two reason. First, the sampling frame used to collect these data did not consider substantial areas of potential habitat. Second, the data collected do not describe the distribution limits of Millicoma Dace in most circumstances (i.e., the transition between areas occupied and not occupied by Millicoma Dace). Therefore, these data cannot be used to infer the full distribution; they represent a minimum current distribution of Millicoma Dace (circa 2014-2015). Additionally, sites sampled in 2014 were selected to generally overlap with historical sample sites (Scheerer et al. 2014).

Shapefiles were downloaded for Hydrologic Unit Code (HUC) boundaries from The National Map Viewer (USGS 2019). The shapefiles were 12-digit HUC boundaries that encompassed the distribution of sample sites for the combined minimum historical and minimum current distributions of Millicoma Dace, and for the entire area upstream from the confluence of the Millicoma River and the South Fork Coos River. The individual 12-digit HUC boundaries were merged using ArcGIS 10.5.1 (ESRI, Redlands, California) to delineate the drainage basin that encompassed the minimum historical and minimum current distributions of Millicoma Dace.

The Oregon Coast Processing Unit stream shapefile was downloaded from the NorWeST regional database website (U.S. Forest Service 2019). NorWeST shapefiles are based on NHDPlus stream polylines (Horizon Systems Corporation 2019), and the NorWeST stream shapefile is divided into stream segments that are about 1-km in length. The stream shapefile was clipped to the merged 12-digit HUC boundaries using ArcGIS 10.5.1. Together the merged 12-digit HUC boundaries and the clipped stream shapefile represent the Coos River drainage for this assessment (i.e., the drainage basin and streams encompassing the minimum historical and minimum current distributions of Millicoma Dace; Figure 1). NorWeST stream segments within the Coos River drainage varied in length from 0.04-1.99 km (mean = 1.18 km).

The Coos River drainage was overlaid with point data representing the historical sample locations (i.e., locations for Millicoma Dace specimens collected prior to 1998) and the current sample locations (i.e., sites sampled in 2014 and 2015). These sample locations

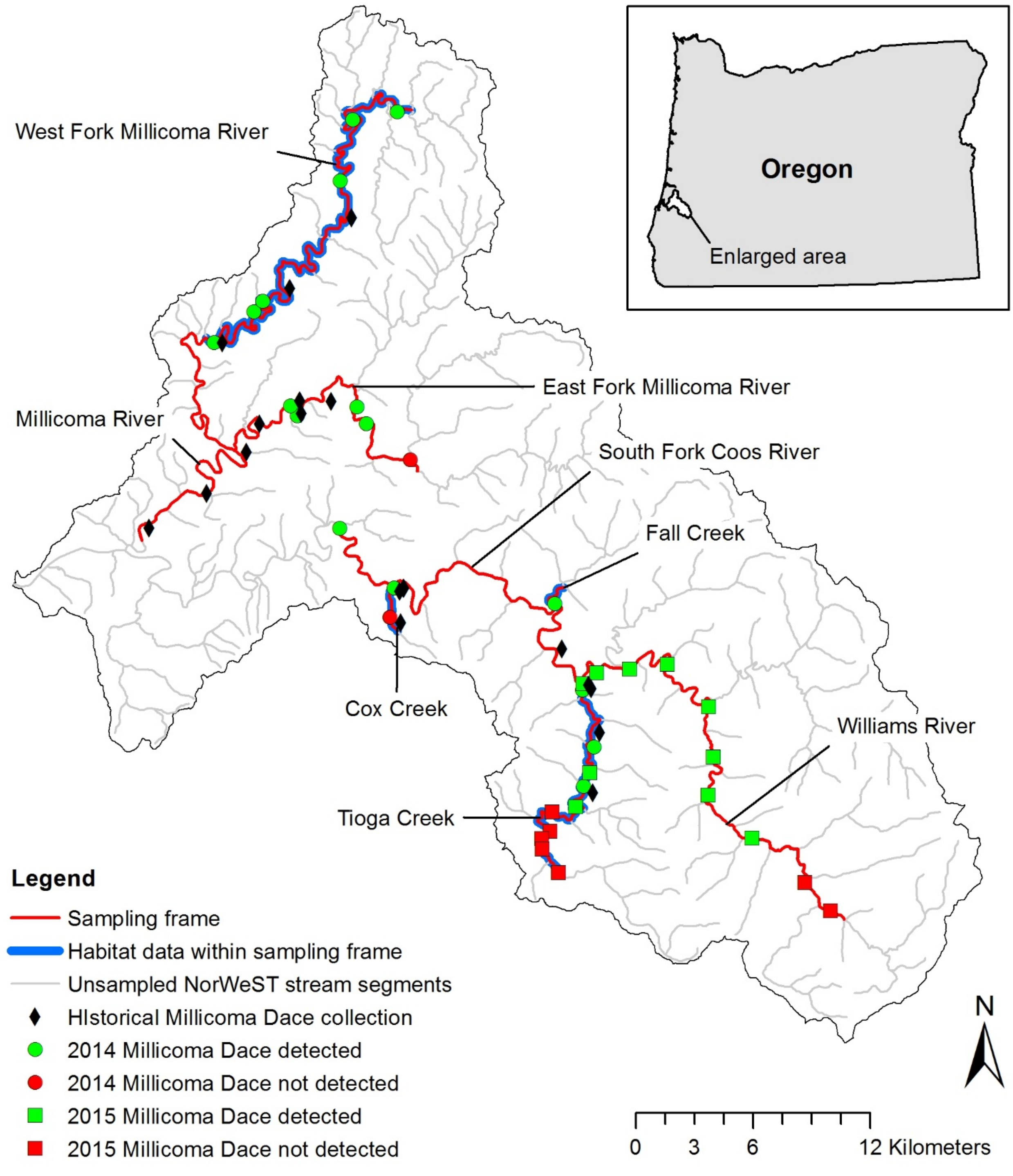


Figure 1.—Sampling frame within the Coos River drainage, available reach-level habitat data within the sampling frame, unsampled NorWeST stream segments, historical sample sites (Millicoma Dace collection locations prior to 1998), and sites sampled in 2014 and 2015 where Millicoma Dace were detected and not detected. Historical sample sites are offset along the x-axis (east) to reveal 2014 sample site locations that overlapped with historical sample site locations.

generally did not directly overlay on the stream shapefile, which is likely due to one or a combination of the following: 1) geographic coordinates were inferred for an unknown number of the historical collection locations (see Scheerer et al. 2014); 2) errors associated with data collection or transcription for the current sample locations; 3) imprecise stream polylines. Consequently, the sample locations were either snapped to the nearest stream polyline, or were placed on the stream polyline considered to be most consistent with previous reports (Figure 1 *in* Scheerer et al. 2015; Figure 1, 2 *in* Scheerer et al. 2017). In most cases the Euclidian distance between the geographic locations reported in Scheerer et al. (2014, 2015, 2017 [primary data]) were within about 1-km from the stream polyline. However, EFMILL-05 was about 3 km from its putative location, COXCRK-01 was about 5 km from its putative location, WFMILL-01 was about 8 km from its putative location, and TIOGA-05 was about 76 km from its putative location (Appendix A). Additionally, a stream shapefile was created that included just the NorWeST stream segments encompassed by the sites that have been sampled for Millicoma Dace in the Millicoma River and its tributaries and the Coos River and its tributaries (hereafter referred to as 'sampling frame'; Figure 1).

Reach-level habitat data were obtained from Oregon Department of Fish and Wildlife (2014; ODFW 2014). The reach-level habitat data shapefile for HUC 17100304 (summer surveys) was downloaded and clipped to the Coos River drainage. Additionally, the reach-level habitat were clipped to the sampling frame (Figure 1). In general, reach-level habitat data are only available for relatively small proportions of the Coos River drainage and for small proportions of the sampling frame. Specifically, available reach-level habitat data overlap with about 44% of the sampling frame, were primarily available for the upper portions of the West Fork Millicoma River, Cox Creek, Fall Creek, and Tioga Creek, and were not available for the East Fork Millicoma River, South Fork Coos River, or the Williams River (Figure 1).

Reach-level habitat data were extracted for sites sampled in 2014 and 2015 using the NorWeST database (U.S. Forest Service 2019) and ODFW (2014). Because only a fraction of the sampling frame was covered by reach-level habitat data from ODFW (2014), some reach-level habitat data were only extracted from a subset of sample sites (Appendix B). All calculations from geographic information system (GIS) data are based on the 1:100,000 NHDPlus stream polyline.

## CURRENT STATUS OF MILLICOMA DACE

### *Distribution*

In general, the minimum historical and minimum current distributions of Millicoma Dace are similar. Sites sampled in 2014 were selected to largely overlap with historical museum collection locations, and Millicoma Dace were detected at 16 out of 18 of these sites (Figure 1; Scheerer et al. 2014; 2017). The two historical sites where Millicoma Dace were not detected in 2014 may not represent a true change in distribution. The first site is located in the East Fork Millicoma River > 5 km upstream from the closest historical sample site; it is unknown whether this area was occupied prior to 1998. The second site, in Cox Creek, was coincident with a historical sample site. However, detection probabilities for the most recent surveys were relatively low (Scheerer et al. 2017); therefore, it is plausible that Millicoma Dace were present and not detected at this site.

Some portion of the sampling frame was not sampled in 2014-2015. Millicoma Dace were historically documented in the Millicoma River downstream from the confluence of the East Fork Millicoma River and the West Fork Millicoma River (Figure 1). Surveys during 2014 and 2015 were not conducted in this area because either 1) they were tidally influenced or 2) they did not contain riffle habitat (Scheerer et al. 2014). It would be worth revisiting these areas in future surveys if documenting the current distribution or changes in the distribution of Millicoma Dace is of interest to resource managers.

Sampling efforts in 2015 extended the minimum distribution of Millicoma Dace in Tioga Creek slightly upstream relative to historical records, and far upstream into the Williams River, a tributary with no historical records (Figure 1; Scheerer et al. 2015; 2017). This sampling provided estimates of the upstream limit on the distribution of Millicoma Dace in Tioga Creek and the Williams River. Given the relatively low detection probabilities for Millicoma Dace during these surveys (i.e., 9-28%; Scheerer et al. 2017), these are likely to be coarse estimates. Regardless, Millicoma Dace were not detected in the upstream-most five sites in Tioga Creek nor in the upstream-most two sites in the Williams River.

Surveys conducted in 2014 extended the minimum distribution of Millicoma Dace downstream from historical collection sites in the South Fork Coos River (Figure 1; Scheerer et al. 2014; 2017). However, a relatively large portion of the South Fork Coos River upstream from the confluence with the Millicoma River does not appear to have historical records of Millicoma Dace and has not been sampled for Millicoma Dace recently. Future surveys of this area for Millicoma Dace would provide additional information on their downstream extent.

A significant caveat related to the distribution of Millicoma Dace is that historical information (i.e., pre-1998) comes from museum specimens that were collected over a period of 36 years, and that were not collected as part of a formal study of distribution. These records do not include information on sites where Millicoma Dace were determined to be absent, and provide no information on abundance. Likewise, current distribution data (2014 and 2015) were collected to provide an assessment of Millicoma Dace distribution relative to sites sampled prior to 1998, rather than to provide an absolute estimate of distribution. A variety of standard methods used for modeling species distributions require presence and absence data; e.g., logistic regression. Maximum-entropy techniques have been shown to be valuable for modeling species distributions based on presence only data (Phillis et al. 2004), but these techniques are typically employed at large spatial scales (e.g., continental scales; Phillips et al. 2006). The utility of these techniques may be limited at fine scales, such as the spatial extent occupied by Millicoma Dace (but see Gormley et al. 2011). Finally, a substantial number of tributaries containing potential habitat have not been surveyed for Millicoma Dace and the current and historical status of Millicoma Dace in these areas is not known.

*Habitat requirements*

In general, Longnose Dace occupy a variety of habitat types. For example, Longnose Dace may occupy habitats varying from swift-flowing streams to still-water habitat such as lakes (Scott and Crossman 1973). However, limited data are available related to habitat requirements for, and habitat selection by, Millicoma Dace.

Scheerer et al. (2017) used an information theoretic approach to evaluate the relationship between site-level habitat covariates and Millicoma Dace detection probability and abundance; the site-level habitat covariates evaluated included sample site length, sample site area, dominant substrate type, stream temperature at the time of sampling, percent cover, and average depth. Millicoma Dace detection probability was negatively associated with bedrock as the dominant substrate type within sites, and abundance was positively associated with sample site size (length and area).

Scheerer et al. (2017) suggest that Millicoma Dace require specific habitat that is composed of riffle and rapid habitat with large substrates (Scheerer et al. 2014). However, this conclusion was based on informal observations made during sampling (Scheerer et al. 2014). Because sites sampled by Scheerer et al. (2014; 2015; 2017) encompassed both slow-water and fast-water habitat units, data were not recorded at the habitat unit scale, and the proportions of different habitat units and substrate types within samples sites were not recorded, it is not possible to statistically test the reported pattern. Future studies could treat habitat units (e.g., pools, riffles) as the primary observational unit to provide a more straightforward framework for evaluating whether Millicoma Dace are more likely to use fast-water habitats compared to slow-water habitats. Future studies could also quantify percent composition of various substrate types as opposed to only documenting the dominant substrate type, which may facilitate analyses related to substrate selection.

Although previous studies and sampling efforts have not specifically identified Millicoma Dace habitat relationships, simple evaluations of available reach-level habitat data (e.g., ODFW 2014; U.S. Forest Service 2019) and Millicoma Dace presence and absence data may help generate predictions related to Millicoma Dace habitat use. For example, of the 35 sites sampled in 2014 and 2015, the 26 sites where Millicoma Dace were detected were in stream reaches that were generally lower in elevation and gradient and had slightly higher, but variable temperatures compared to the 9 sites where Millicoma Dace were not detected (Figure 2; Appendix B). Based on available reach-level habitat data within the sampling frame (ODFW 2014), reaches where Millicoma Dace were detected in 2014 and 2015 were highly variable in percent pools, percent bedrock substrate, volume of large woody debris, habitat units per 100 m (a measure of stream complexity), and number of large boulders (Figure 2; Appendix B). These patterns may not be entirely consistent with the conclusions of Scheerer et al. (2017) that suggest Millicoma Dace are more common in riffle and rapid habitats, which are often associated with higher gradient stream reaches. Inconsistencies may simply be a result of the scale at which available

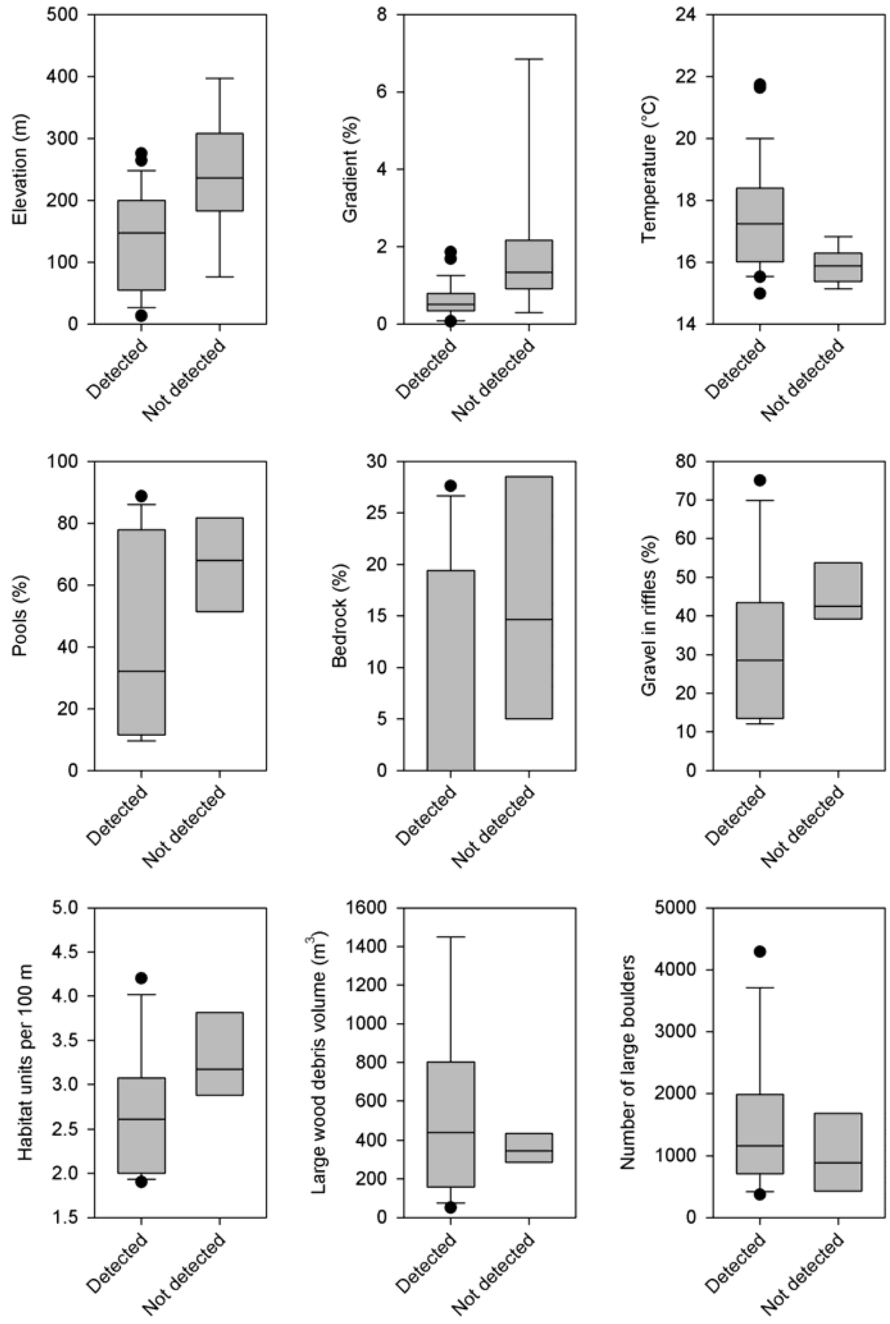


Figure 2.—Box plots for reach-level habitat data within the sampling frame associated sites sampled in the Coos River drainage during 2014 and 2015. Upper and lower boundaries of boxes represent the 25th and 75th percentiles, whiskers represent the 10th and 90th percentiles, and dots represent outlying observations of the distribution of sample sites where Millicoma Dace were detected and not detected. Reach-level elevation, gradient, and temperature were derived from the NorWeST database (U.S. Forest Service 2019). Stream temperature is the estimated mean August stream temperature in 2011. Reach-level % pools, % bedrock, % gravel in riffles, number of habitat units per 100 m, large woody debris volume, and number of large boulders were derived from ODFW (2014).

habitat data are summarized or the fact that reach-level habitat data are only available for a limited proportion of the sampling frame. Potential alternative hypotheses to explain these varied results may be that Millicoma Dace occupy a relatively narrow range of gradients, or that these fish select riffles and rapids in close proximity to slow water habitat units. A formal evaluation of habitat use and habitat availability for Millicoma Dace could be undertaken to resolve among these and other alternatives.

In general, Millicoma Dace are widespread throughout the sampling frame in the Coos River drainage. Available data suggest that the spatial extent of Millicoma Dace is similar to or greater than previously inferred from collection locations associated with museum specimens. However, the available data are not sufficient to generate statistically robust estimates of trends in distribution or abundance. Although observations suggest Millicoma Dace have narrow habitat requirements, consisting of fast-water habitats with large substrates, these conclusions are preliminary and require further study. The available habitat data for the reaches in which Millicoma Dace were detected indicate that habitat characteristics are relatively variable among sample locations. Millicoma Dace appear to be limited by elevation in at least some tributaries, perhaps mediated by increasing stream gradients or decreasing stream temperatures towards head-water regions.

## CONCLUSIONS, RESEARCH OPPORTUNITIES, AND MANAGEMENT CONSIDERATIONS

Currently, data on the distribution of Millicoma Dace are sufficient to conclude that the species is still present at the majority of sites where they were collected prior to 1998. However, historical collection efforts were never systematically conducted across the potential range, and recent survey efforts have primarily focused on historical collection sites, limiting inference to an unknown portion of the distribution of Millicoma Dace. Likewise, the available estimates of population abundance reflect a single time point, and are not sufficient to detect trend in abundance. If robust trend data are deemed necessary for management of Millicoma Dace then additional survey efforts are warranted.

Millicoma Dace have primarily been collected in the fast-water portions of sample sites and in association with cobble and boulder substrates within the Coos River drainage. This led to the conclusion that they require these habitats, and the recommendation that such habitats should be restored or enhanced to support Millicoma Dace populations (Scheerer et al. 2017). This conclusion may have been made prematurely, as modeling results did not explicitly support this pattern, and a comparison of available reach-level habitat variables suggest that Millicoma Dace presence may be associated with lower elevation and lower gradient stream reaches. Additional research on the habitat requirements of Millicoma Dace could be conducted in the laboratory or in conjunction with further investigations of the distribution limits of this form of Longnose Dace. Additionally, more extensive habitat surveys within the Coos River drainage could provide information on areas where habitat restoration may benefit Millicoma Dace.

The relationship between Millicoma Dace and habitat may be influenced by interspecific interactions within the stream community. For example, the congeneric Speckled Dace *R. osculus* was commonly observed in slow-water habitats during sampling in 2014 and 2015 (M. Gray, Oregon Department of Fish and Wildlife, *personal communication*). Consequently, a better understanding of ecological interactions between Millicoma Dace, Speckled Dace, and other species in the Coos River drainage may provide insight into the trade-offs between various habitat restoration or modification actions. Additional areas where further research could improve our ability to effectively manage Millicoma Dace include general life-history and behavior, physiological limits and optima, ecological interactions with other species, and taxonomic status (McPhail and Taylor 2009).

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Appendix A.—Sample site ID, sub-basin, sample year, geographic coordinates, and adjusted geographic coordinates for sample sites where Millicoma Dace were detected (Y) or not detected (N). Sites sampled from 1961 through 1997 represent museum collections; consequently, Millicoma Dace are always detected for these sites. Sites sampled in 2014 and 2015 were surveyed in part to determine Millicoma Dace occupancy; therefore, Millicoma Dace were not always detected at these sites. Geographic coordinates (UTM zone 10 North American Datum 83 [NAD83]) are presented from Scheerer et al. (2014, 2015, 2017 [primary data]) and as adjusted values. Adjusted values represent coordinates for sample sites that were snapped to the nearest portion of the stream polyline for this assessment. When the nearest portion of the stream polyline was not apparent, we placed the sample site on the NHD plus stream layer in an attempt to mimic previous reports and publications (Figure 1 *in* Scheerer et al. 2015; Figure 1, 2 *in* Scheerer et al. 2017). In most cases the Euclidian distance between the values reported in Scheerer et al. (2014, 2015, 2017 [primary data]) were within about 1-km from the NHD Plus stream polyline. However, EFMILL-05 was about 3 km from it putative location, COXCRK-01 was about 5 km from its putative location, WFMILL-01 was about 8 km from its putative location, and TIOGA-05 was about 76 km from its putative location. (Data for samples collected from 1961 through 1997 adapted from Scheerer et al. 2014; data for samples collected during 2014 and 2015 adapted from Scheerer et al. 2014, 2015, 2017 [primary data]).

| | | | Millicoma Dace | UTM zone 10 | | UTM zone 10 (adjusted) | |
|---|---|---|---|---|---|---|---|
| Site ID | Sub-basin | Sample year | detected (Y/N) | Easting | Northing | Easting | Northing |
| HIST-01 | West Fork Millicoma River | 1997 | Y | 422086 | 4820357 | 422078 | 4820355 |
| HIST-02 | West Fork Millicoma River | 1997 | Y | 422086 | 4820357 | 422086 | 4820357 |
| HIST-03 | West Fork Millicoma River | 1961 | Y | 418909 | 4816746 | 418926 | 4816753 |
| HIST-04 | West Fork Millicoma River | 1969 | Y | 415471 | 4813974 | 415471 | 4813964 |
| HIST-05 | West Fork Millicoma River | 1969 | Y | 411704 | 4804491 | 411705 | 4804491 |
| HIST-06 | Coos River | 1967 | Y | 414651 | 4806235 | 414651 | 4806235 |
| HIST-07 | East Fork Millicoma River | 1971 | Y | 416699 | 4808377 | 416691 | 4808366 |
| HIST-08 | East Fork Millicoma River | 1972 | Y | 417360 | 4809803 | 417361 | 4809801 |
| HIST-09 | East Fork Millicoma River | 1992 | Y | 419486 | 4810364 | 419517 | 4810351 |
| HIST-10 | East Fork Millicoma River | 1971 | Y | 419412 | 4810968 | 419432 | 4810980 |
| HIST-11 | East Fork Millicoma River | 1971 | Y | 419407 | 4810979 | 419425 | 4810993 |
| HIST-12 | East Fork Millicoma River | 1967 | Y | 419410 | 4810976 | 419428 | 4810990 |
| HIST-13 | East Fork Millicoma River | 1967 | Y | 421057 | 4810999 | 421047 | 4810970 |
| HIST-14 | South Fork Coos River | 1980 | Y | 424755 | 4801403 | 424750 | 4801408 |
| HIST-15 | South Fork Coos River | 1980 | Y | 424755 | 4801403 | 424753 | 4801411 |
| HIST-16 | South Fork Coos River | 1980 | Y | 424565 | 4801228 | 424539 | 4801241 |
| HIST-17 | South Fork Coos River | 1980 | Y | 424585 | 4799623 | 424596 | 4799627 |
| HIST-18 | South Fork Coos River | 1969 | Y | 432839 | 4798314 | 432842 | 4798290 |
| HIST-19 | South Fork Coos River | 1979 | Y | 434334 | 4796250 | 434348 | 4796254 |
| HIST-20 | South Fork Coos River | 1969 | Y | 434234 | 4796455 | 434234 | 4796434 |
| HIST-21 | South Fork Coos River | 1979 | Y | 434754 | 4794020 | 434779 | 4794017 |
| HIST-22 | South Fork Coos River | 1979 | Y | 434382 | 4790915 | 434425 | 4790915 |
| EFMILL-01 | Millicoma River | 2014 | Y | 419858 | 4809930 | 419431 | 4810729 |
| EFMILL-02 | Millicoma River | 2014 | Y | 419890 | 4810031 | 419789 | 4810220 |
| EFMILL-03 | Millicoma River | 2014 | Y | 422838 | 4810711 | 422845 | 4810657 |
| EFMILL-04 | Millicoma River | 2014 | N | 425505 | 4807925 | 425561 | 4807956 |
| EFMILL-05 | Millicoma River | 2014 | Y | 426264 | 4809930 | 423308 | 4809819 |
| WFMILL-01 | Millicoma River | 2014 | Y | 422806 | 4810680 | 415515 | 4813966 |
| WFMILL-02 | Millicoma River | 2014 | Y | 417673 | 4815428 | 417564 | 4815548 |
| WFMILL-03 | Millicoma River | 2014 | Y | 418015 | 4815987 | 418025 | 4816089 |
| WFMILL-04 | Millicoma River | 2014 | Y | 422080 | 4822220 | 421972 | 4822246 |
| WFMILL-05 | Millicoma River | 2014 | Y | 422623 | 4825318 | 422622 | 4825386 |

Appendix A.—Continued on next page.

Appendix A.—Continued from previous page.

| Site ID | Sub-basin | Sample year | Millicoma Dace detected (Y/N) | UTM zone 10 Easting | UTM zone 10 Northing | UTM zone 10 (adjusted) Easting | UTM zone 10 (adjusted) Northing |
|---|---|---|---|---|---|---|---|
| WFMILL-06 | Millicoma River | 2014 | Y | 424883 | 4825699 | 424900 | 4825769 |
| COXCRK-01 | South Fork Coos River | 2014 | N | 421937 | 4804452 | 424512 | 4799905 |
| FALLCRK-01 | South Fork Coos River | 2014 | Y | 433070 | 4800290 | 432962 | 4800586 |
| SFCOOS-01 | South Fork Coos River | 2014 | Y | 421954 | 4804470 | 421952 | 4804464 |
| SFCOOS-02 | South Fork Coos River | 2014 | Y | 424748 | 4801226 | 424737 | 4801393 |
| TIOGA-01 | South Fork Coos River | 2014 | Y | 434440 | 4796215 | 434385 | 4796177 |
| TIOGA-02 | South Fork Coos River | 2014 | Y | 435015 | 4793213 | 434964 | 4793266 |
| TIOGA-03 | South Fork Coos River | 2014 | Y | 434424 | 4791267 | 434436 | 4791231 |
| TIOGA-04 | South Fork Coos River | 2015 | Y | 434849 | 4791853 | 434763 | 4791944 |
| TIOGA-05 | South Fork Coos River | 2015 | Y | 500782 | 4753102 | 434039 | 4790191 |
| TIOGA-06 | South Fork Coos River | 2015 | N | 432743 | 4789889 | 432839 | 4789937 |
| TIOGA-07 | South Fork Coos River | 2015 | N | 432653 | 4788934 | 432712 | 4788937 |
| TIOGA-08 | South Fork Coos River | 2015 | N | 432402 | 4788548 | 432286 | 4788569 |
| TIOGA-09 | South Fork Coos River | 2015 | N | 432348 | 4788058 | 432314 | 4788038 |
| TIOGA-10 | South Fork Coos River | 2015 | N | 433181 | 4786803 | 433138 | 4786823 |
| WILLIAMS-01 | South Fork Coos River | 2015 | Y | 434520 | 4796513 | 434406 | 4796507 |
| WILLIAMS-02 | South Fork Coos River | 2015 | Y | 435141 | 4796896 | 435114 | 4797045 |
| WILLIAMS-03 | South Fork Coos River | 2015 | Y | 436778 | 4797023 | 436780 | 4797234 |
| WILLIAMS-04 | South Fork Coos River | 2015 | Y | 438778 | 4797402 | 438736 | 4797481 |
| WILLIAMS-05 | South Fork Coos River | 2015 | Y | 440830 | 4795337 | 440827 | 4795320 |
| WILLIAMS-06 | South Fork Coos River | 2015 | Y | 441139 | 4792681 | 441088 | 4792757 |
| WILLIAMS-07 | South Fork Coos River | 2015 | Y | 440937 | 4790817 | 440810 | 4790793 |
| WILLIAMS-08 | South Fork Coos River | 2015 | Y | 443043 | 4788471 | 443075 | 4788584 |
| WILLIAMS-09 | South Fork Coos River | 2015 | N | 445997 | 4786332 | 445777 | 4786319 |
| WILLIAMS-10 | South Fork Coos River | 2015 | N | 446925 | 4784756 | 447068 | 4784876 |

Appendix B.—Sample site ID and reach-level elevation, gradient, temperature, % pools, % bedrock, % gravel in riffles, number of habitat units per 100 m, large woody debris (LWD) volume, and number of large boulders for sample sites where Millicoma Dace were detected (Y) or not detected (N). Reach-level elevation, gradient and temperature were derived from the NorWeST database (U.S. Forest Service 2019). Stream temperature is the estimated mean August stream temperature in 2011. Reach-level % pools, % bedrock, % gravel in riffles, number of habitat units per 100 m, LWD volume, and number of large boulders were derived from ODFW (2014). Reach-level habitat data were not available for all sample sites.

| Site ID | Millicoma Dace detected (Y/N) | Elevation (m) | Gradient (%) | Temperature (°C) | Pools (%) | Bedrock (%) | Gravel in riffles (%) | Habitat units per 100 m | LWD volume ($m^3$) | Number of large boulders |
|---|---|---|---|---|---|---|---|---|---|---|
| COXCRK | N | 157 | 6.84 | 15.1 | 34.8 | 0 | 37 | 5.4 | 398 | 431 |
| EFMILL01 | Y | 13 | 0.10 | 15.8 | . | . | . | . | . | . |
| EFMILL02 | Y | 13 | 0.06 | 15.5 | . | . | . | . | . | . |
| EFMILL03 | Y | 44 | 0.51 | 15.5 | . | . | . | . | . | . |
| EFMILL04 | N | 76 | 1.44 | 15.6 | . | . | . | . | . | . |
| EFMILL05 | Y | 46 | 0.51 | 15.8 | . | . | . | . | . | . |
| FALLCRK | Y | 127 | 1.69 | 16.2 | 35.4 | 0 | 39 | 2.8 | 441 | 4287 |
| SFCOOS01 | Y | 33 | 0.38 | 21.7 | . | . | . | . | . | . |
| SFCOOS02 | Y | 58 | 0.42 | 21.6 | . | . | . | . | . | . |
| TIOGA01 | Y | 141 | 0.51 | 17.8 | 73.9 | 21.2 | 15 | 4.2 | 51.2 | 618 |
| TIOGA02 | Y | 167 | 1.06 | 17.8 | 74.1 | 14 | 38.2 | 2.67 | 868.4 | 2354 |
| TIOGA03 | Y | 192 | 0.47 | 17.3 | 79.2 | 27.6 | 58.1 | 2.94 | 129.9 | 969 |
| TIOGA04 | Y | 184 | 0.64 | 17.6 | 79.9 | 10.6 | 45 | 2.56 | 154.4 | 530 |
| TIOGA05 | Y | 198 | 0.82 | 17.4 | 88.7 | 24.4 | 75 | 3.12 | 164 | 371 |
| TIOGA06 | N | 208 | 0.3 | 16.8 | 89.9 | 22.6 | 45 | 2.35 | 264.1 | 413 |
| TIOGA07 | N | 251 | 0.91 | 16.4 | 78.9 | 28.5 | 53.8 | 3.05 | 434.3 | 884 |
| TIOGA08 | N | 236 | 0.91 | 16.2 | 78.9 | 28.5 | 53.8 | 3.05 | 434.3 | 884 |
| TIOGA09 | N | 236 | 0.91 | 16.2 | 56.9 | 6.7 | 40 | 3.29 | 292.1 | 1683 |
| TIOGA10 | N | 252 | 1.34 | 15.9 | 56.9 | 6.7 | 40 | 3.29 | 292.1 | 1683 |
| WFMILL01 | Y | 33 | 0.4 | 16.4 | 28.9 | 0 | 13 | 1.9 | 313 | 1020 |
| WFMILL02 | Y | 61 | 0.67 | 16.5 | 12.7 | 0 | 12 | 2 | 1450 | 1194 |
| WFMILL03 | Y | 103 | 1.06 | 16.8 | 12.7 | 0 | 12 | 2 | 1450 | 1194 |
| WFMILL04 | Y | 205 | 0.47 | 16.1 | 9.6 | 0 | 24 | 2 | 604 | 1978 |
| WFMILL05 | Y | 241 | 0.4 | 15.8 | 9.6 | 0 | 24 | 2 | 604 | 1978 |

Appendix B.—Continued on next page.

Appendix B.—Continued from previous page.

| Site ID | Millicoma Dace detected (Y/N) | Elevation (m) | Gradient (%) | Temperature (°C) | Pools (%) | Bedrock (%) | Gravel in riffles (%) | Habitat units per 100 m | LWD volume ($m^3$) | Number of large boulders |
|---|---|---|---|---|---|---|---|---|---|---|
| WFMILL06 | Y | 264 | 0.08 | 15.0 | 11 | 0 | 33 | 3.6 | 437 | 1121 |
| WILLIAMS01 | Y | 145.29 | 0.24 | 19.3 | . | . | . | . | . | . |
| WILLIAMS02 | Y | 142.64 | 0.24 | 19.3 | . | . | . | . | . | . |
| WILLIAMS03 | Y | 148.63 | 0.77 | 19.2 | . | . | . | . | . | . |
| WILLIAMS04 | Y | 176.33 | 0.07 | 18.9 | . | . | . | . | . | . |
| WILLIAMS05 | Y | 195.99 | 1.03 | 18.2 | . | . | . | . | . | . |
| WILLIAMS06 | Y | 206.3 | 0.73 | 17.8 | . | . | . | . | . | . |
| WILLIAMS07 | Y | 231.29 | 0.68 | 17.2 | . | . | . | . | . | . |
| WILLIAMS08 | Y | 275.62 | 1.86 | 16.6 | . | . | . | . | . | . |
| WILLIAMS09 | N | 362.82 | 1.86 | 15.8 | . | . | . | . | . | . |
| WILLIAMS10 | N | 396.86 | 2.47 | 15.1 | . | . | . | . | . | . |