

A Field Guide to the Taxonomy of Ciscoes in Great Slave Lake, Northwest Territories, Canada



Miscellaneous Publication 2011-02

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A Field Guide to the Taxonomy of Ciscoes in Great Slave Lake, Northwest Territories, Canada

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A school of adfluvial cisco (*Coregonus artedii*) seeking shelter and rest in a nearshore pool on their fall upstream migration through Tartan Rapids, Yellowknife River, Northwest Territories.

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If you are not more confused after working on coregonines, then you are not doing your job right.

-C.C. Lindsey

Introduction

This field guide is dedicated to C.C. Lindsey and was prepared at the request of the Interdepartmental Recovery Fund (IRF) and the Fisheries and Oceans Canada Species-at-Risk Act (SARA) working group. The shortjaw cisco (*Coregonus zenithicus*) is listed as threatened under SARA. A requisite to conserving the shortjaw cisco is the ability to identify and differentiate it from other ciscoes occurring in Great Slave Lake—the purpose of this guide is to provide assistance in that process.

Identifying the Coregonine Ciscoes of Great Slave Lake

To date, the taxonomy of Great Slave Lake ciscoes remains unresolved, and their diversity has not been adequately described. This situation creates a problem for fisheries management, particularly with respect to the shortjaw cisco (*Coregonus zenithicus*), a species at risk in Canada. This guide was developed to be a tool for distinguishing among ciscoes in Great Slave Lake, Northwest Territories, Canada. Technical terms are defined in the glossary at the end of the guide. The cisco species are notoriously difficult to identify due to their similarity, the existence of morphs within species (e.g., small adfluvial versus large lacustrine *C. artedi*), ontogenetic shifts in body morphology, a high degree of variation in body shape within species, and the potential for hybridization among species. While seemingly perplexing at first, basic anatomical characteristics can be used to differentiate the ciscoes.

The ciscoes of Great Slave Lake differ from their counterparts distributed farther southward (e.g., those in the Laurentian Great Lakes as well as inland lakes; Todd and Smith 1992). First, Great Slave Lake has not been influenced by invasive species and by other human-induced changes to the extent that the southern lakes have; it contains an intact assemblage of native coregonines. In this sense, Great Slave Lake is a model system for studying diversity within the cisco complex, and such studies may provide a better understanding of the patterns and processes driving the evolution of cisco diversity. The second major difference is that the key characteristics used to differentiate among ciscoes in the Laurentian Great Lakes are not as important as are other traits for differentiating among ciscoes in Great Slave and other northern lakes. For example, gillraker number is a primary feature for discriminating among ciscoes, but use of this characteristic is somewhat problematic in the north due to apparent changes in gillraker number with age (and/or body size), and in part because of the high degree of overlap in this characteristic among species and morphs. These differences necessitate a more thorough analysis of cisco diversity in Great Slave Lake that uses a broad suite of characteristics and ecological data. Herein, five Great Slave Lake ciscoes are differentiated and described, and their taxonomic affiliations are assessed.

Cisco Taxonomy

Previous Systematic Studies of Great Slave Lake Ciscoes

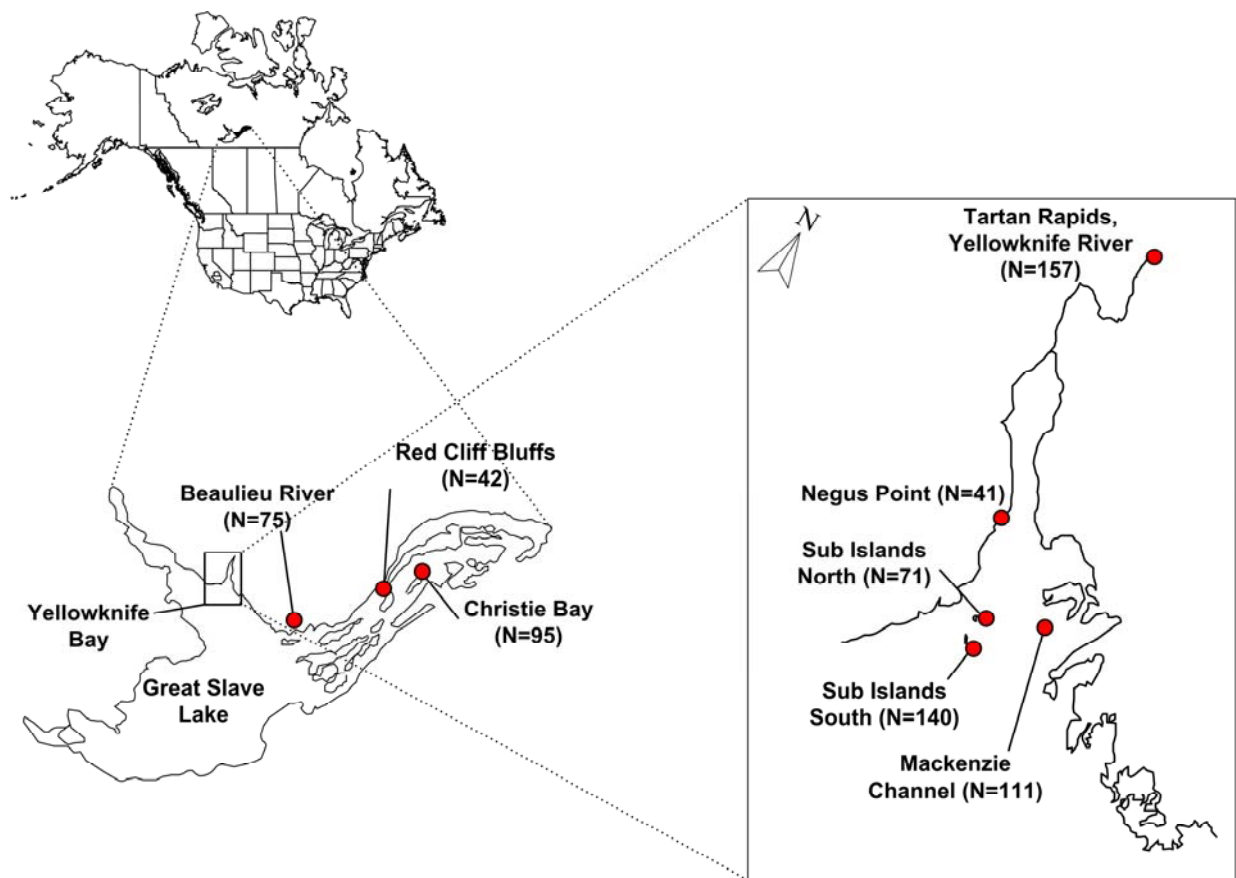
The ciscoes of Great Slave Lake have been described previously in five studies with various results, and the specimens from one study were reexamined by others twice. First, Harper and Nichols (1919) described a new species of cisco, *Leucichthys macrognathus*, on the basis of a single specimen collected from Great Slave Lake. This species is now considered synonymous with the shortjaw cisco. Rawson (1951) reported that at least three cisco species existed in Great Slave Lake—these collections were confirmed by J.R. Dymond to be the cisco (formerly lake herring) (*C. artedi*), a morph that resembled the blackfin cisco (*C. nigripinnis*), and a large morph that could not be identified to species. These specimens were deposited in the Royal Ontario Museum (ROM) and subsequently assessed by T.N. Todd (USGS Great Lakes Science Center, personal communication, 2008), R.L. Eshenroder (Great Lakes Fishery Commission), and N.E. Mandrak (Fisheries and Oceans Canada) who collectively suggested that the collection contained *C. artedi*, *C. nigripinnis*, *C. zenithicus*, and possibly least cisco (*C. sardinella*). Clarke (1973) identified two cisco species in Great Slave Lake—*C. artedi* and one that resembled *C. zenithicus*. Roberge et al. (1985) distinguished *C. artedi* from *C. sardinella* taken in multi-mesh gillnets from Great Slave Lake and mentioned a third morph that they did not describe, referring to it as unidentified. Using a suite of more than 30 morphometric and meristic characteristics, Murray and Reist (2003) were unable to confirm the presence of *C. zenithicus* in Great Slave Lake.

The fish collections, data processing, and analyses required to produce this guide were ongoing from 2007 to 2010. More than 1,000 specimens were collected, and approximately 800 were analyzed using geometric body shapes, 23 size-corrected linear morphometric measures, nine meristic counts, 30 osteological features, and buoyancies. Fatty acid profiles and stable carbon and nitrogen isotopes were analyzed from a subset of the individuals. In addition, nine habitat characteristics were measured at each collection site. Where possible, specimens were compared to historical collections from Great Slave Lake archived at the ROM. Users of this guide should be aware that the morphological and habitat descriptions provided are a function of the fish and habitats sampled; therefore, the variation that occurs within Great Slave Lake likely exceeds the variation described herein. This guide is a result of the first detailed morphometric and taxonomic analysis of cisco forms in Great Slave Lake. Similar to other taxonomies, it will evolve as new samples and new analytical methods improve our understanding of cisco diversity in this lake.

To aid in distinguishing among cisco morphs of Great Slave Lake, we took the liberty of adding descriptive terms to their common names. For example, *C. artedi* that have a riverine component to their life history are referred to as the “adfluvial cisco” to distinguish them from their conspecifics that do not enter rivers, the “lacustrine cisco.” Although unconventional, the common nomenclature we have elected to use reduces ambiguity when referring to the morphs.

Locations Sampled in Great Slave Lake

Specimens used to create this cisco field guide were gillnetted and dipnetted from nine sites within the East Arm and Yellowknife Bay, Great Slave Lake, Northwest Territories. All gillnets were 200-m long x 1.8-m deep and were composed of eight 25-m panels of 12.7-, 25.4-, 38.1-, 50.8-, 63.5-, 76.2-, 88.9-, and 101.6-mm stretch mesh. Nets were deployed on bottom in depths of 10-237 m for <24 hours.



How to Use this Field Guide

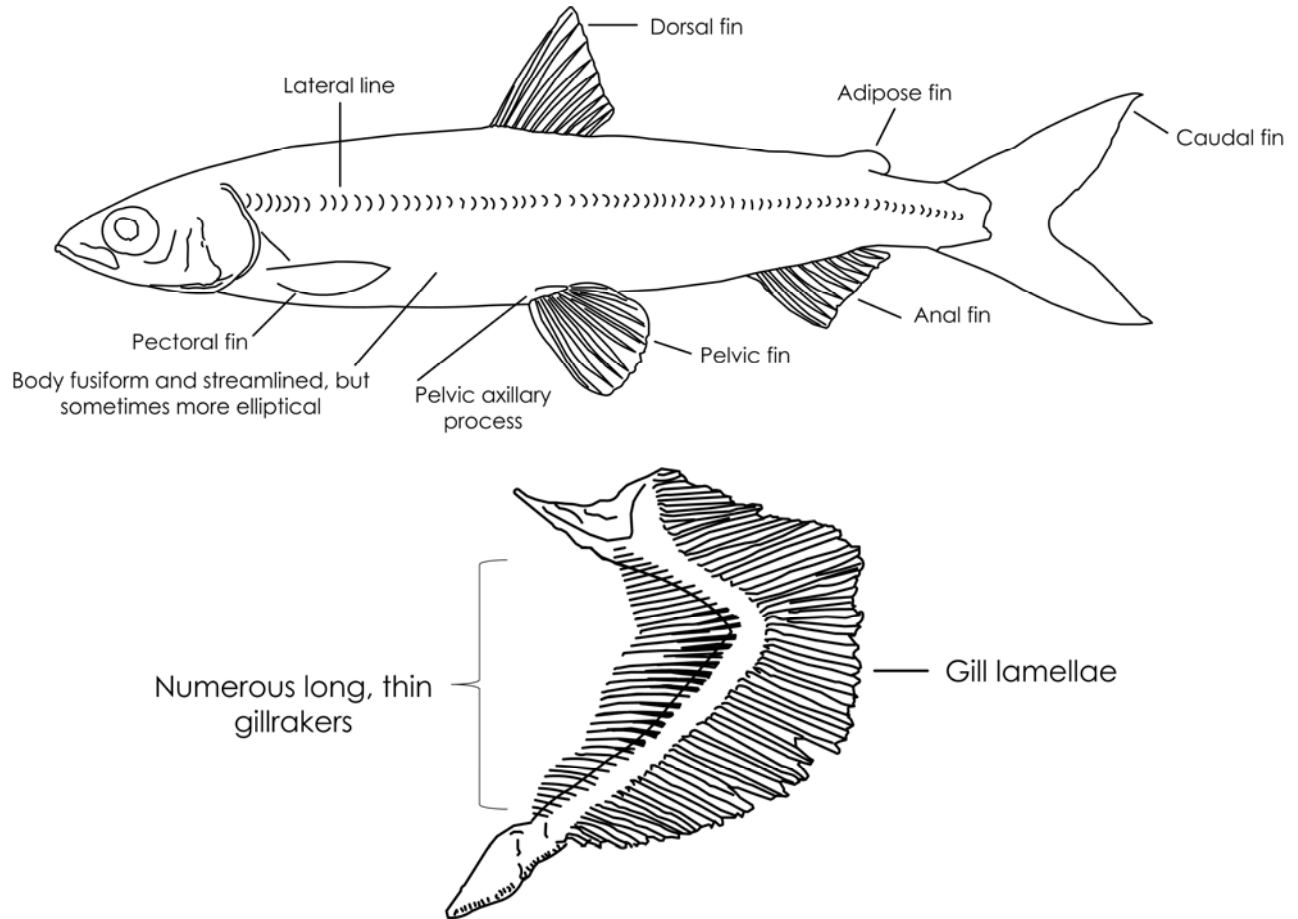
The first step in using this guide is to become familiar with the general anatomy of ciscoes and the potential variations in body form among them. With a fresh specimen in hand, the second step is to consult the key to narrow the identification down to one (or more) potential species or morphs. The key provides a weighting system for six characteristics: premaxillary angle (i.e., angle between the horizontal axis of the head and the premaxillae), lower jaw position, pelvic fin position, gillraker number, paired fin length, and eye diameter (orbital length). The degree to which each species or morph exhibits a particular characteristic is represented by circle size—large circles indicate a main character trait, medium circles indicate a moderate or occasional character trait, and small circles indicate a rare character trait (*sensu*, T. Todd (retired), unpublished data). For example, a lacustrine cisco is characterized by numerous gillrakers (46+), short paired fins, and a small eye; therefore, large circles appear under the columns for these traits. In contrast, the least cisco does not exhibit any of these character states; therefore, either nothing (i.e., character state has not been encountered) or small circles (i.e., rare character state) appear in the respective columns for that species. Note that a great deal of overlap in characteristics occurs; therefore, after the identification is narrowed down to one or more candidate species or morphs, consult the respective detailed sections and review information on habitat, biology, morphometrics, and meristics to complete the identification. Note that dorsal body coloration can be helpful in differentiating among cisco, but caution must be exercised when using this characteristic because coloration changes rapidly postmortem. The color illustrations in this guide are based on live or freshly captured specimens viewed in direct sunlight and may not be typical of specimens that are examined well after mortality.

An Example Identification

Consider a cisco collected from a 40-m depth in Yellowknife Bay. The specimen is 180-mm fork length; the dorsum is peanut brown in color; and it has an included jaw, a broad dorsal fin, narrow pectoral fins that are short, and a small- to medium-sized eye. On the basis of its external anatomy, the specimen narrows down to either adfluvial cisco or shortjaw cisco. Next, consult the illustrated section for these two candidate species. After viewing the color illustrations, the line drawings of detailed morphological features, and the descriptions, this hypothetical specimen should have been identified as a shortjaw cisco. The rationale behind this identification is that, while most characteristics are common to both the adfluvial cisco and the shortjaw cisco, an included jaw and peanut-brown dorsal coloration are inconsistent with the characteristics of an adfluvial cisco. If doubts remain after consulting this guide, we suggest retaining a voucher specimen or a scaled digital image, and consulting with an expert.

Cisco Anatomy

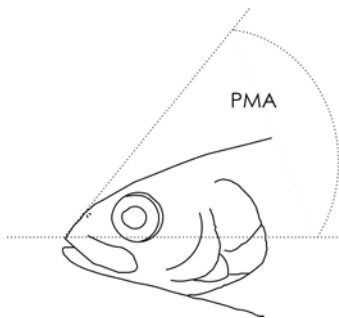
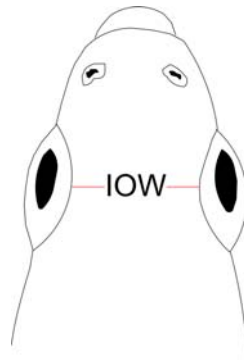
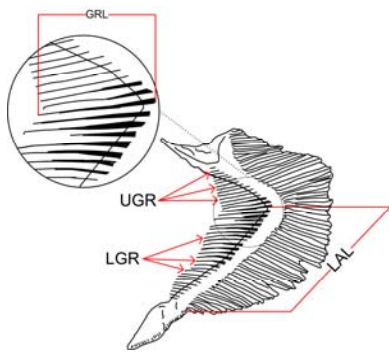
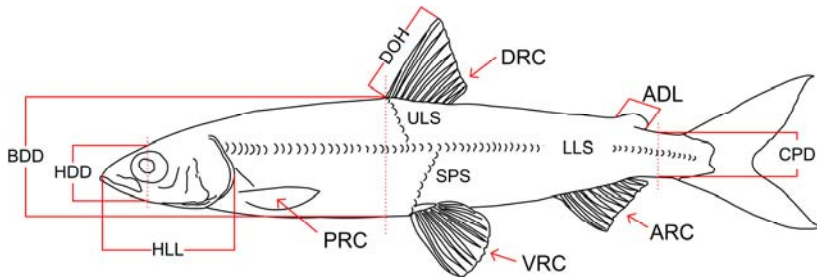
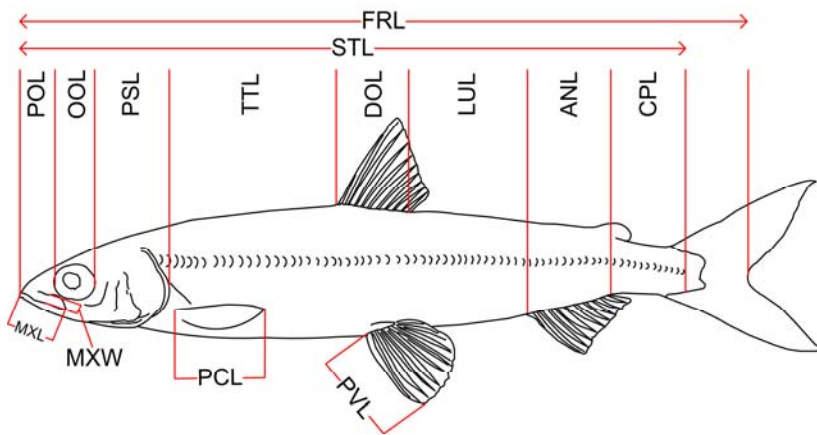
Ciscoes are specialized zooplanktivores. Some of their morphological adaptations are thought to reflect the sizes, types, and behaviors of their various prey. In general, ciscoes are distinguished by a single dorsal fin that is shorter than the head; dorsal rays fewer than 16; a small body size that is fusiform and streamlined, but sometimes elliptical in shape; a small mouth that does not extend beyond the eye; teeth that are weak or absent; numerous (>32), long, thin gillrakers; a complete lateral line; pelvic fins and pelvic axillary process; an adipose fin; and a forked caudal fin (Scott and Crossman 1973).



Notes:

- Collectively, the pectoral and pelvic fins are referred to as paired fins.
- The gillrakers act as a sieve to filter small food particles from the water column. As the fish opens its mouth, water is drawn in via negative pressure and passes over the gillrakers and out the opercles (gill covers). As the water passes out of the mouth, zooplankton and other food items in the water are retained within the mouth and can be swallowed.

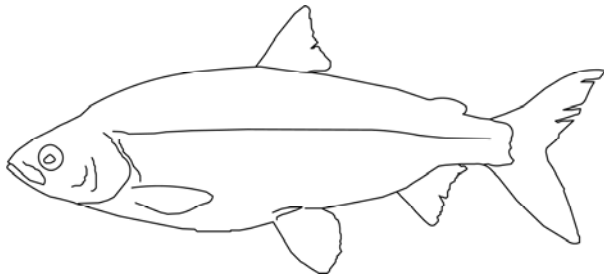
Morphometrics and Meristics



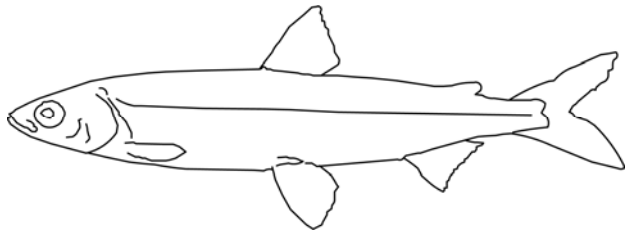
- ADL—Adipose length
- ANL—Anal fin length
- ARC—Anal rays
- BDD—Body depth
- CPD—Caudal peduncle depth
- CPL—Caudal peduncle length
- DOH—Dorsal fin height
- DOL—Dorsal fin length
- DRC—Dorsal rays
- FRL—Fork length
- GRL—Middle gillraker length
- HDD—Head depth
- HLL—Head length
- IOW—Interorbital width
- LAL—Lower arch length
- LGR—Lower gillrakers
- LLS—Lateral line scales
- LUL—Lumbar length
- MXL—Maxillary length
- MXW—Maxillary width
- OOL—Orbital length
- PCL—Pectoral fin length
- PMA—Premaxillary angle
- POL—Preorbital length
- PRC—Pectoral rays
- PSL—Post orbital length
- PVL—Pelvic fin length
- SPS—Suprapelvic scales
- STL—Standard length
- TTL—Trunk length
- UGR—Upper gillrakers
- ULS—Scales above the lateral line
- VRC—Pelvic rays

Variation within versus between Species

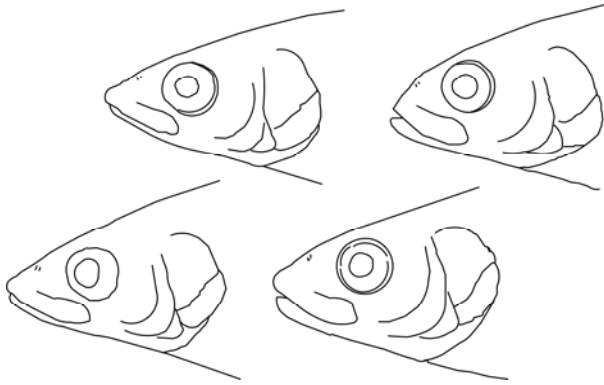
Two levels of variation complicate cisco taxonomy. The first level is intraspecific variation—variation in body form within a species. For example, ciscoes can take on a very robust body form when inhabiting large lakes or a very small, streamlined form when inhabiting low-productivity lakes or rivers (top row). In a further complication, ontogenetic changes in morphology occur over the life of an individual (e.g., gillraker number appears to increase with age). The second level of variation is interspecific—variation between species. The bottom row depicts both of these kinds of variation. Note the subtle differences in eye size, snout length, and jaw position within the shortjaw cisco and the least cisco groups and the striking differences in mouth orientation and eye size between these two species. In the shortjaw cisco, the mouth is oriented slightly down (inferior), whereas the mouth is oriented up (superior) in the least cisco. One must be cognizant of both types of variation as interspecific variation helps separate two putative species, whereas intraspecific variation may blur the distinction between them.



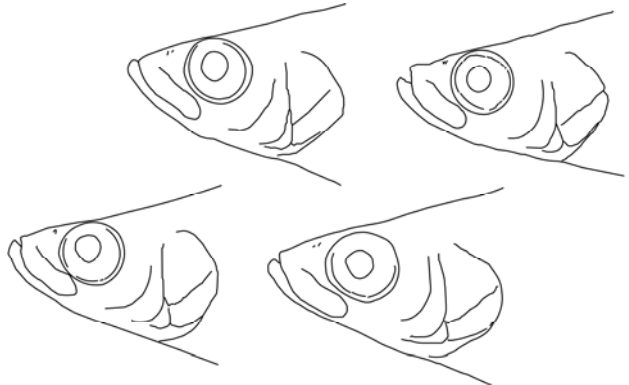
Lateral profile of the large lacustrine cisco, *C. artedi*.



Lateral profile of the small adfluvial cisco, *C. artedi*.

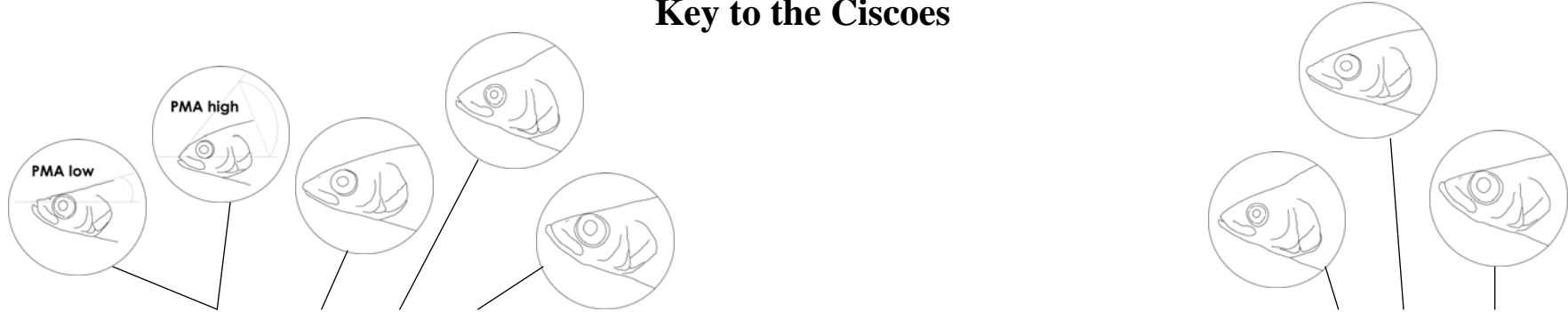


Intraspecific (i.e., within species) variation in head profile of the shortjaw cisco (*C. zenithicus*).



Intraspecific variation in the head profile of the least cisco (*C. sardinella*).

Key to the Ciscoes



| Morph/Species | PMA* | Lower jaw position | | | Pelvic fin position ¹ | | | Gillraker number | | | | Paired fin length ² | | | Eye diameter (OOL) ³ | | |
|------------------|-----------|--------------------|----------|----------|----------------------------------|--------|-----------|------------------|-------|-------|-----|--------------------------------|--------|------|---------------------------------|--------|-------|
| | | Included | Terminal | Extended | Anterior | Middle | Posterior | 35-40 | 41-45 | 46-50 | 51+ | Short | Medium | Long | Small | Medium | Large |
| Lacustrine cisco | 43 ± 0.64 | | ● | ● | | ● | ● | | | ● | ● | ● | | | ● | | |
| Adfluvial cisco | 46 ± 0.52 | ● | ● | | | ● | | | ● | | | ● | | | ● | ● | |
| Big-eye cisco | 34 ± 1.43 | | ● | ● | | ● | ● | ● | ● | | | | ● | | | | ● |
| Least cisco | 24 ± 1.12 | | | ● | ● | | | | ● | | | | | ● | | | ● |
| Shortjaw cisco | 51 ± 0.92 | ● | ● | | | ● | ● | ● | ● | | | ● | | | ● | ● | |

Main character state
 Moderate or occasional character state
 Rare character state

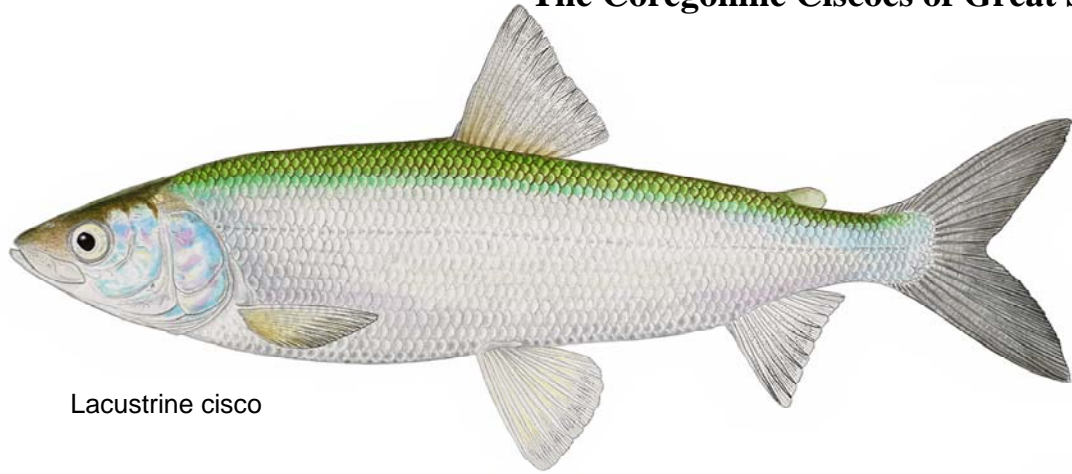
* Mean ± SE premaxillary angle

² Relative to standard body length

¹ Pelvic fin position relative to 50% standard body length

³ Relative to head length

The Coregonine Ciscos of Great Slave Lake



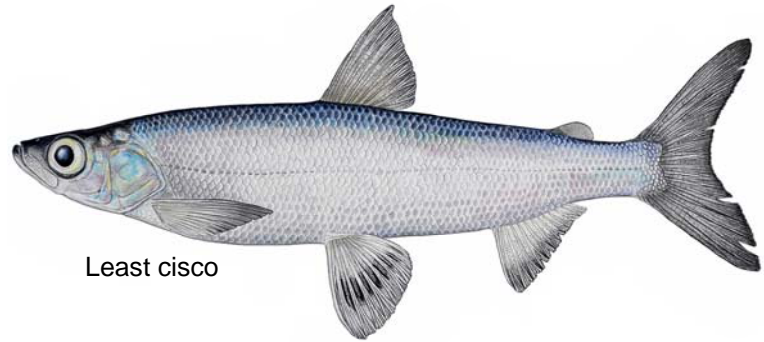
Lacustrine cisco



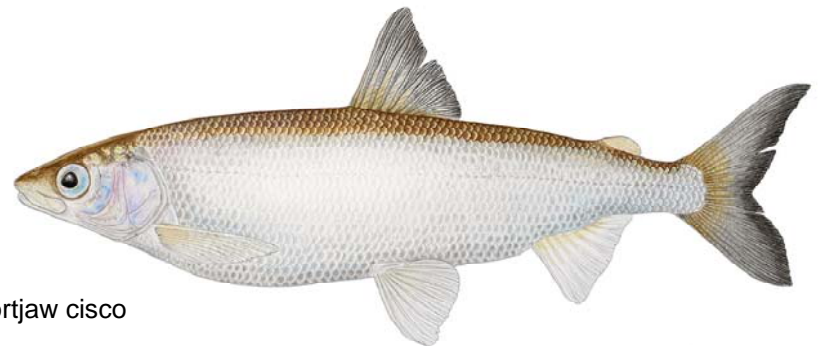
Adfluvial cisco



Big-eye cisco



Least cisco



Shortjaw cisco

