Fisheries and Oceans Canada | Pêches et Océans Canada
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Canadian Science Advisory Secretariat
Central and Arctic Region **Science Response 2020/029**

INFORMATION FOR IDENTIFICATION OF CANDIDATE CRITICAL HABITAT OF ATHABASCA RAINBOW TROUT *(ONCORHYNCHUS MYKISS)*

Context

Athabasca Rainbow Trout (*Oncorhynchus mykiss*) is a genetically distinct population of Rainbow Trout, found in tributary streams and the mainstem of the Athabasca River of Western Alberta. Considered a "remnant population" from the last ice age, it is thought that Athabasca Rainbow Trout has managed to survive in its unique coldwater habitat by maintaining a small body size into adulthood (Sawatzky 2018). However, Athabasca Rainbow Trout populations have declined by > 50% of their range (DFO 2018). The major threats to Athabasca Rainbow Trout are human-caused sedimentation of streams, stream fragmentation, non-native species (including genetic introgression and competition), and overfishing (Athabasca Rainbow Trout Cumulative Effects model, in prep). Climate change, cumulative effects of habitat loss/degradation, road development, and resource extraction also represent threats for Athabasca Rainbow Trout.

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) has assessed Athabasca Rainbow Trout as *Endangered*. Fisheries and Oceans Canada (DFO) Species at Risk program has followed this decision and listed Athabasca Rainbow Trout as *Endangered* under the *Species at Risk Act* (SARA) in June 2019. Subsequently, a recovery strategy will be developed that must identify the species' Critical Habitat defined as "*the habitat that is necessary for the survival or recovery of a listed species*". Under the SARA S.41.1(c) a species' Critical Habitat must be identified to the greatest extent possible, based on the best available information.

DFO Species at Risk program has requested Science Advice in support of the identification of candidate Critical Habitat and residence for the Athabasca Rainbow Trout. This Science Response Report results from the Science Response Process of December 18, 2019 on the Information for Identification of Candidate Critical Habitat for Athabasca Rainbow Trout (*Oncorhynchus mykiss*).

Background

Athabasca Rainbow Trout occur in the Athabasca River watershed in the Western Arctic National Freshwater Biogeographical Zone and are geographically separated from other native Rainbow Trout in North America. They are considered a unique eco-type adapted to cold, clear water with fast currents. They are generally found in waters at elevations of 900–1,500 m and are absent in streams with elevations < 850 m (COSEWIC 2014). Adult Athabasca Rainbow Trout live in riffles, runs, glides, and pools of tributaries and headwaters, and tend to occupy deeper and faster moving water than juveniles. They spawn in the spring in streams with fine gravel and moderate flows and overwinter in large, deep pools of streams associated with groundwater upwelling, making connectivity between their seasonal habitats an important survival factor for this species. Redds created by the females for spawning and the initial development of eggs and alevins meet the SARA definition of residence. Athabasca Rainbow

Trout have slower growth rates and mature at smaller sizes than other introduced trout species. Their diet consists of aquatic and terrestrial insects, fish, and fish eggs.

Athabasca Rainbow Trout are unique in that they exhibit locally adaptive traits important for their persistence in the Athabasca River. This is substantiated by the general lack of genetic introgression at many localities despite repeated stocking events (e.g., Edson River and Trout Creek HUC 8 watersheds), known pure populations connected to known hybrid populations in the absence of physical barriers (e.g., tributaries to the Athabasca River mainstem), and a small size at maturity constituting an adaptation to the low growth potential of Athabasca Rainbow Trout in many of the streams in the distribution area.

Analysis and Response

When an aquatic species is listed on Schedule 1 of the *Species at Risk Act* (SARA) as *Threatened*, *Endangered* or *Extirpated*, DFO is required to identify and protect habitat required for the survival and recovery of the species, which is linked to the population and distribution objectives established in a Species Recovery Strategy. The identification is based on the best available information.

Critical Habitat is defined under SARA as "*the habitat that is necessary for the survival or recovery of a listed wildlife species*". Further, habitat in respect of aquatic species is defined as "*spawning grounds and nursery, rearing, food supply, migration, and any other areas on which aquatic species depend directly or indirectly to carry out their life processes, or areas on which aquatic species formerly occurred and have the potential to be reintroduced*". Information to support identification of habitat necessary for the survival or recovery of Athabasca Rainbow Trout should include the geographic location (e.g., coordinates); biophysical function, features, and attributes; and a summary of habitat identification relative to population and distribution objectives (DFO 2015).

This Science Response provides a review of available information that supports the identification of habitat necessary for the survival and recovery of Athabasca Rainbow Trout within the Athabasca River watershed. Critical Habitat identification includes a biophysical and a geographic description. Consequently, the two objectives listed below were identified to support this review, and are responded to in further detail within this document:

Objective 1: Review information available on the habitat necessary for survival and recovery of Athabasca Rainbow Trout within Athabasca River watershed and identify the function, features, and attributes of this habitat.

Objective 2: Present potential candidate Critical Habitat locations using the Bounding Box approach.

The intent of the information in the Science Response is to provide information in support of the identification of candidate Critical Habitat. The information was derived from the COSEWIC Status Report (COSEWIC 2014), the Recovery Potential Assessment (RPA) for the species (DFO 2018), and the Alberta Athabasca Rainbow Trout Recovery Plan 2014–2019 (Alberta Athabasca Rainbow Trout Recovery Team 2014). The approach used to delineate the Critical Habitat is the Bounding Box Approach (BBA), which defines an area within which Critical Habitat is found (DFO 2015).

The BBA is a useful approach when habitat features and their attributes can be described but their exact location varies yearly or knowledge of their specific location is not available. In order for a particular site to be considered Critical Habitat, it must be within the bounding box (i.e.,

stream segment) and represent the described function, features, and attributes within the bounding box.

The Hydrologic Unit Code (HUC), developed by the United States Geological Survey, was used to display the Bounding Box for Critical Habitat on a HUC 10 sub-watershed level. Athabasca Rainbow Trout distribution was identified at a HUC 8 mapping scale (Appendix 1) using the Athabasca Rainbow Trout distribution layer developed for the Provincial Recovery Plan (Alberta Athabasca Rainbow Trout Recovery Team 2014). This species distribution layer was derived from the 'Fish Species Presence' Layer in the provincial Fisheries and Wildlife Management Information System (FWMIS), which represents a listing of fish species that have been captured in a particular body of water as a result of fisheries inventories. Any species listed indicates it was captured anywhere along that waterbody, and not a specific location. This spatial product does not constitute species absence, but rather fish species positively identified from fish survey information contained in FWMIS. Once Athabasca Rainbow Trout distribution was identified, Ecologically Significant Habitat (Alberta Athabasca Rainbow Trout Recovery Team 2014) and genetic data, based on the microsatellite approach (Taylor and Yau 2013, 2015) were used to further refine and identify candidate Critical Habitat. This approach can also be used in HUC 10 watersheds within Jasper National Park, however, little information was available for the watersheds within Jasper National Park's limits and the identification of candidate Critical Habitat within National Parks is led by Parks Canada.

Critical Habitat for aquatic species may include riparian areas on both stream banks for the entire length of the stream segments identified as Critical Habitat (Figure 1; DFO 2019). Riparian areas and instream structures contribute to stream complexity, creation of refugia, stabilization of stream banks, maintenance of colder stream temperatures by reducing insolation, and are a source of terrestrial invertebrates.

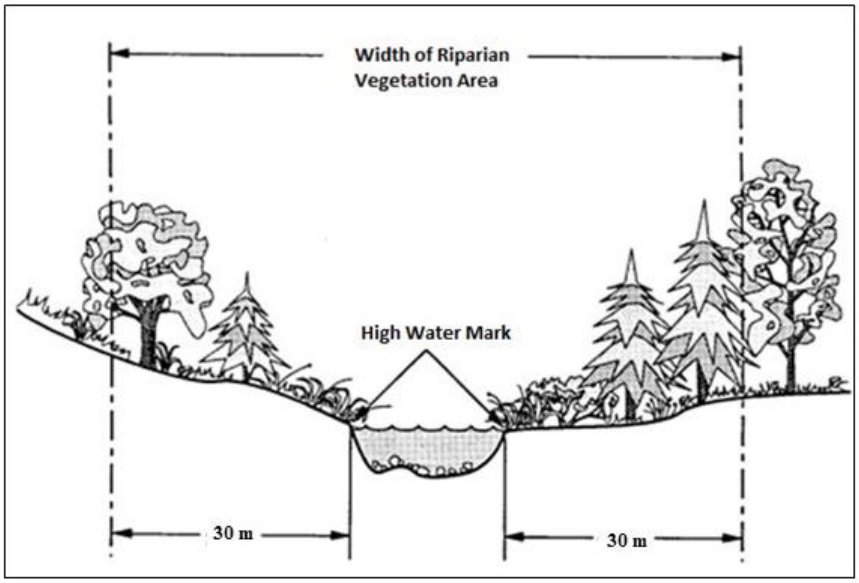

Figure 1. Proposed width of the riparian area that falls in the Critical Habitat of Athabasca Rainbow Trout. Riparian vegetation areas are continuous and extend horizontally from the high water mark to a width of 30 m (from DFO 2019).

The width of the riparian area that is required to protect the attributes of Critical Habitat must be sufficient in size to maintain clean and cold water, sediment and silt free substrates, and provide

terrestrial food inputs and woody debris into the aquatic environment. As a reasonable and precautionary approach, a width of 30 m from the high water mark on both stream banks is recommended. Areas of groundwater recharge outside of the 30 m buffer and within 100 m of the high water mark should also be included in the Critical Habitat (Westslope Cutthroat Trout Habitat Technical Subcommittee 2017). Riparian vegetation areas provide large woody debris supply for fish habitat and maintenance of channel morphology, localized bank stability, channel movement, shade, and insect and debris fall, help prevent erosion, and reduce sedimentation.

A detailed review of the habitat functions, features, and attributes for each life stage of Athabasca Rainbow Trout was conducted in the frame of the Recovery Potential Assessment of Rainbow Trout and is summarized in Table 1 (Sawatzky 2018, DFO 2018).

Table 1. Summary of the functions, features, and attributes for each life stage of Athabasca Rainbow Trout. Modified from DFO (2018). See Sawatzky (2018) for the full list of citations.

Life Stage	Function	Feature(s)	Attributes
Egg / Embryo – spawning through emergence); for resident (non-migratory) and fluvial (migratory) populations	Spawning Incubation and early rearing (mid-May to mid-Aug)	• Clean, small to medium gravel; gravel beds generally found upstream of riffle crests in small to medium perennial streams (often Strahler Order 2–4) • Redds are often constructed in areas with sub-gravel flow	• Gravel beds with rounded or angular gravel with mean particle sizes ranging from 4–15 mm • Water depth over gravel beds ranging from 5–40 cm, where flow is non-turbulent with velocities ranging from 12–70 $cm \cdot s^{-1}$ • Fine sediment and silt (< 2.0 mm) in spawning gravels does not exceed 15–20% • Optimum dissolved oxygen (DO) saturation > 90% and minimum optimum DO concentration > 8 $mg \cdot l^{-1}$ • Fluvial populations migrate on the descending limb of the snowmelt hydrograph at temperatures ranging from 4–6 °C • Mean water temperatures during the spawning period range from 6–10 °C • Optimum water temperature during incubation ranges from 8–12 °C; temperatures < 3 °C or > 18.5 °C cause increased embryo mortality • Unimpeded access to spawning areas for fluvial Athabasca Rainbow Trout
Fry (young-of-year to age 1) for resident and fluvial populations	Nursery	• A variety of habitats with reduced water velocity in small to medium perennial streams (often Strahler Order 2–4) including riffles, riffle crests, stream margins, boulders, riparian vegetation, and large woody debris	• Optimum growth temperature ranges from 10–15 °C • Temperatures ≥ 22–24 °C and ≤ 0 °C are considered life threatening • Shallow stream margins with a variety of abundant cover (aquatic vegetation or woody debris), non-embedded (free of fine sands, silts and clays < 2 mm diameter) large gravel
Juvenile Adult	Feeding Cover	• Small to medium perennial streams (often Strahler Order 2–4) with riffles, runs, glides, and pools and cover (large woody debris or aquatic vegetation). Adults tend to occupy	• Preferred water temperatures range from 7–18 °C • The upper lethal temperature for adults is approximately 27 °C but temperatures from 22–24 °C and as low as 0 °C are considered life threatening • Recommended oxygen concentration for Rainbow Trout in general: 7 $mg \cdot l^{-1}$ if < 15 °C; > 9 $mg \cdot l^{-1}$ if > 15 °C • Lower lethal oxygen concentration: 3 $mg \cdot l^{-1}$ • Preferred water velocity for Rainbow Trout in general ranges from 0.20–0.30 $m \cdot s^{-1}$ • Adults have been recorded at sites with substrates dominated by medium sized (64–255 mm) cobble

Life Stage	Function	Feature(s)	Attributes
		deeper and faster-moving water than juveniles	• Cover: large woody debris (also important for channel structure) or riparian vegetation (Rainbow Trout in general)
Fry Juvenile Adult	Overwintering	• Primary pools (complex pools that span the entire channel width), beaver ponds, and areas of hyporheic flow in perennial streams	• Primary pools with a mean pre-freeze-up minimum depth of 0.65 m and volume of 7.2 m^3 (Tri-Creeks) • Large cobble, free of fine sands, silts, and clays in regions of hyporheic flow • Unimpeded access to/from additional overwintering areas • Water temperatures between 4–15 °C, lower temperatures may be tolerated but frazil ice forms near 0.2 °C • Lower lethal oxygen concentration: 3 $mg \cdot l^{-1}$ • Water velocities ranging from: 0.01–1.0 $m \cdot s^{-1}$ • Stream residents overwinter in second- to fourth-order streams; river migrants overwinter in fifth-order or larger rivers where overwintering habitat is not considered limiting • Landscape function is important to maintain groundwater flow

For the Athabasca Rainbow Trout, candidate Critical Habitat was identified to the extent possible using the best available information and using the Ecological Significant Habitat (ESH) established by the Alberta Athabasca Rainbow Trout Recovery Team (2014). ESH is defined as the "*habitat components necessary for the survival and recovery of Athabasca Rainbow Trout*", which is equivalent to the SARA definition of Critical Habitat and consequently a logical starting point for designation of candidate Critical Habitat.

ESH considered three life-history components of Athabasca Rainbow Trout: (1) spawning and incubation habitat for stream-resident and river-migrant populations; (2) nursery cover for fry and parr of stream-resident and river-migrant populations; and (3) overwintering habitat for stream-resident populations. The attributes for nursery cover were similar to the attributes for spawning and incubation habitat for both life-history forms, and overwintering habitat for stream resident populations. Therefore, these habitat components were considered ecologically significant for spawning and incubation habitat for stream resident and river-migrant populations and overwintering habitat for stream-migrant populations.

Athabasca Rainbow Trout ESH is typically confined within second to fourth order streams above 900 meters above sea level in Athabasca Rainbow Trout native range. However, some exceptions do occur, for example, large first order channels that flow directly into large mainstem rivers; and small fifth order streams that retain appropriate sized spawning gravels while supporting overwintering habitat for stream-resident and river-migrant populations. Therefore, for Athabasca Rainbow Trout, candidate Critical Habitat was designated using ESH identified in the Provincial Recovery Plan (Alberta Athabasca Rainbow Trout Recovery Team 2014) as well as in areas upstream that provide direct and indirect habitat to ESH and areas downstream that have habitat features for spawning and overwintering for both life history forms.

A designation framework for candidate Critical Habitat was established using ESH as described above and was also guided by similar rule sets used for the identification of Critical Habitat for Westslope Cutthroat Trout (DFO 2019). Genetic analysis and recovery feasibility were considered in the identification of Critical Habitat for Athabasca Rainbow Trout. All streams where Athabasca Rainbow Trout were determined to have an average admixture coefficient or proportion indigenous (Qi) scores of ≥ 0.99 were considered pure populations. Current genetic data collection and analysis is not representative of Athabasca Rainbow Trout distribution. Consequently maintaining only current reaches of genetically pure Athabasca Rainbow Trout will be insufficient to ensure viable populations in the long-term (i.e., limited protection for

survival and inadequate recovery potential). Additionally, areas with near-pure populations (mean Qi score ≥ 0.95 and < 0.99), that had a mean Qi score ≥ 0.98 (n ≥ 15) or had a high proportion of pure individuals in a sample (≥ 90% of individuals with Qi ≥ 0.99) were included as candidate Critical Habitat as areas where the pure native species formerly occurred and have a high potential for recovery (Appendix 1). Areas of known hybridization (mean Qi < 0.95); or with mean Qi scores < 0.98 and lower proportions of pure individuals (< 90% pure individual) were not included. Also not included in the candidate Critical Habitat designation at this time, were areas that did not provide indirect habitat to ESH and areas where fisheries inventories were either not completed or data indicated no presence of either Rainbow Trout or other fish species.

To determine whether the amount of Critical Habitat delineated by this method would be sufficient to support a recovering population, the probability of extinction (P_{ext}) after 100 years based on the minimum viable population (MVP) was calculated. The P_{ext} was calculated with a probability of catastrophe per generation of 15%, an extinction threshold of 50 adults with 100% stream residents, the most conservative scenario from the recovery potential modelling performed (Caskenette and Koops 2018). Based on the 23 adults/0.1 ha benchmark (Caskenette and Koops 2018), 11 out of 13 HUCs could achieve a P_{ext} < 2% based on available protected habitat. The remaining 2 HUCs could achieve P_{ext} of 2–5%.

Table 2. Estimates of the potential adult abundance (using the benchmark of 100 age 1+ individuals/0.1 ha with 23% adults) for each HUC 8 were calculated using the suggested Critical Habitat stream length multiplied by the average stream width (by stream order) with the potential abundance reduced to 20% for the less ideal streams of order 5. In addition, the potential probability of extinction (P_{ext}) of Athabasca Rainbow Trout was calculated for the Critical Habitat protected in each HUC based on the potential adult abundance, for a probability of catastrophe of 15% and an extinction threshold of 50 adults assuming the populations are stable (λ = 1) for populations with 100% stream residents.

HUC Name	HUC 8	Critical Habitat (order 2-4) Area (ha)	Critical Habitat (order 5) Area (ha)	Potential Adult Abundance (23 adults/0.1 ha)	Potential P_{ext} (α= 1)
Berland	17010301	325.11	107.24	79,710	0.012
Wildhay	17010302	208.96	144.38	54,703	0.014
Athabasca-Oldman	17010401	258.15	0.00	59,374	0.013
Athabasca-US Whitecourt	17010501	300.10	76.41	72,538	0.013
Athabasca-US Freeman	17010602	3.11	0.00	715	0.050
Upper McLeod	17020101	343.43	0.00	78,989	0.012
Embarras	17020102	210.65	23.28	49,521	0.014
Lower McLeod	17020201	36.91	0.00	8,490	0.024
Edson River	17020203	100.19	111.22	28,159	0.017
Trout Creek	17020204	85.45	0.00	19,654	0.019
Wolf Creek	17020202	109.65	0.00	25,218	0.017
Sakwatamau	17010601	171.27	77.05	42,937	0.015
Freeman	17010603	128.35	0.00	29,520	0.016

Conclusions

Native Athabasca Rainbow Trout are considered a unique eco-type of Rainbow Trout that is especially adapted to cold, unproductive headwater streams and upper reaches of mainstem

rivers in the Athabasca River watershed that has been assessed as *Endangered* by COSEWIC and listed as such by DFO under the SARA. The potential areas for candidate Critical Habitat that are of importance to Athabasca Rainbow Trout were identified. In addition, recommendation for the protection of the riparian zones are provided and functions, features, and attributes of Critical Habitat have been outlined. Using this approach, candidate Critical Habitat for the Athabasca Rainbow Trout is only partially identified at this point in time. Therefore, ongoing work is required to identify potential recovery areas, to further develop methodologies and expertise, and to obtain stakeholder support to expand the current distribution of Athabasca Rainbow Trout. An example of undesignated potential Critical Habitat includes, data limited, near-pure Athabasca Rainbow Trout streams currently not identified in this approach and considered as high recovery potential based on habitat features and attributes. The ongoing goal will be to continue to provide science advice for the identification of additional candidate Critical Habitat in support of the Species at Risk program.

Contributors

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(February 10, 2020)

Sources of information

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Appendix 1. Athabasca Rainbow Trout distribution maps

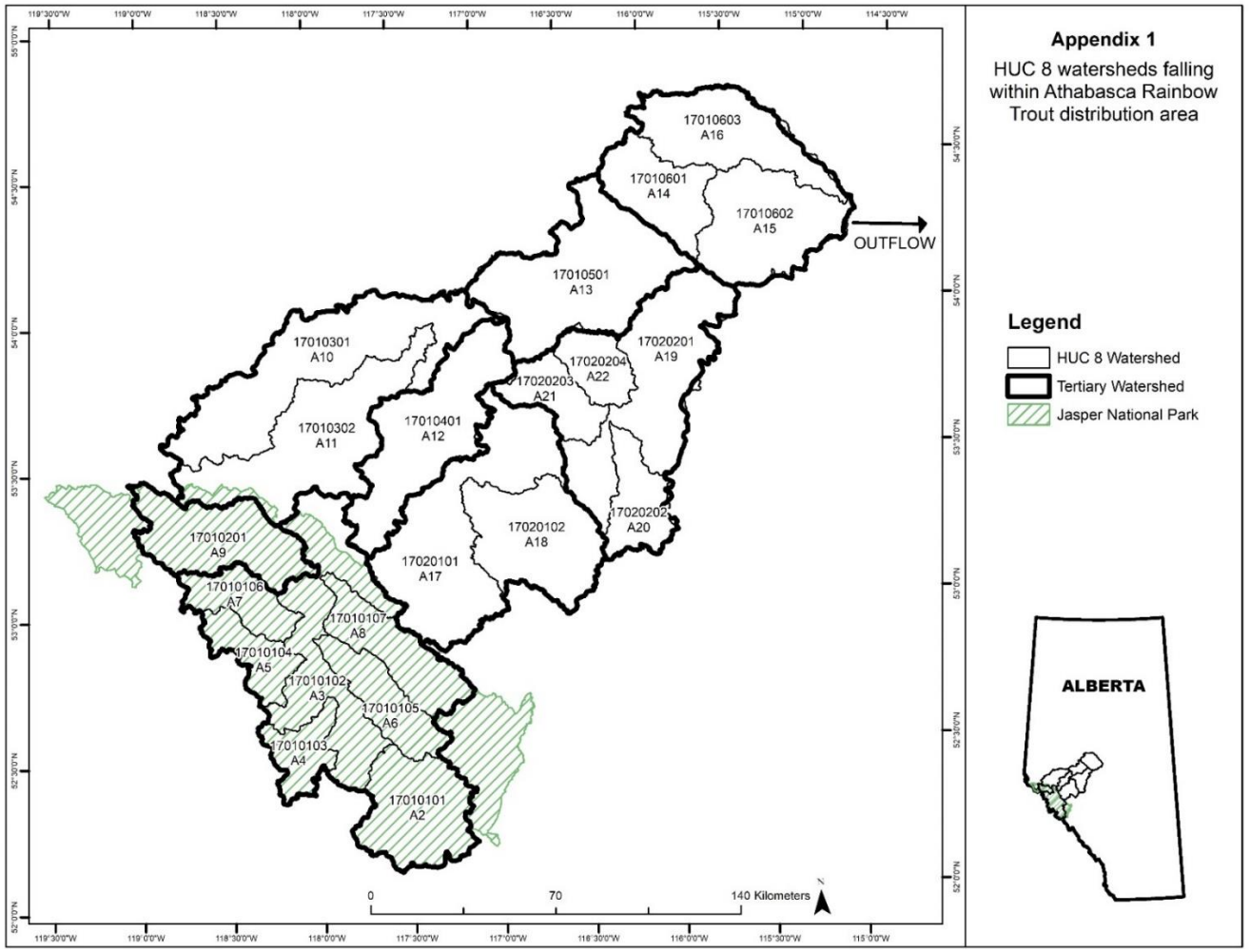

Figure A1.1. HUC 8 watersheds falling within Athabasca Rainbow Trout distribution area.

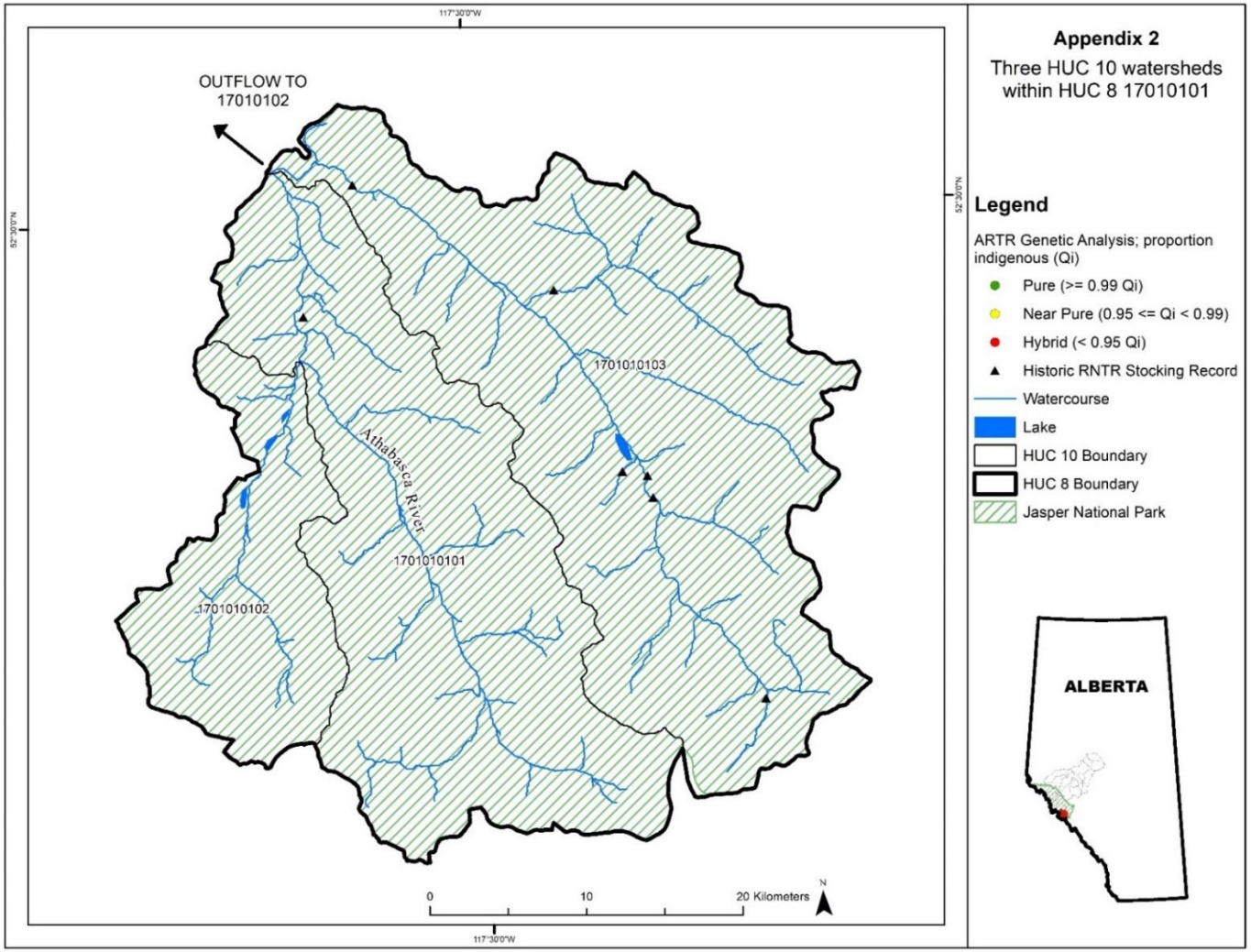

Figure A1.2. Athabasca Rainbow Trout distribution range in Jasper National Park including historic Rainbow Trout stocking information in three HUC 10 watersheds within HUC 8 17010101.

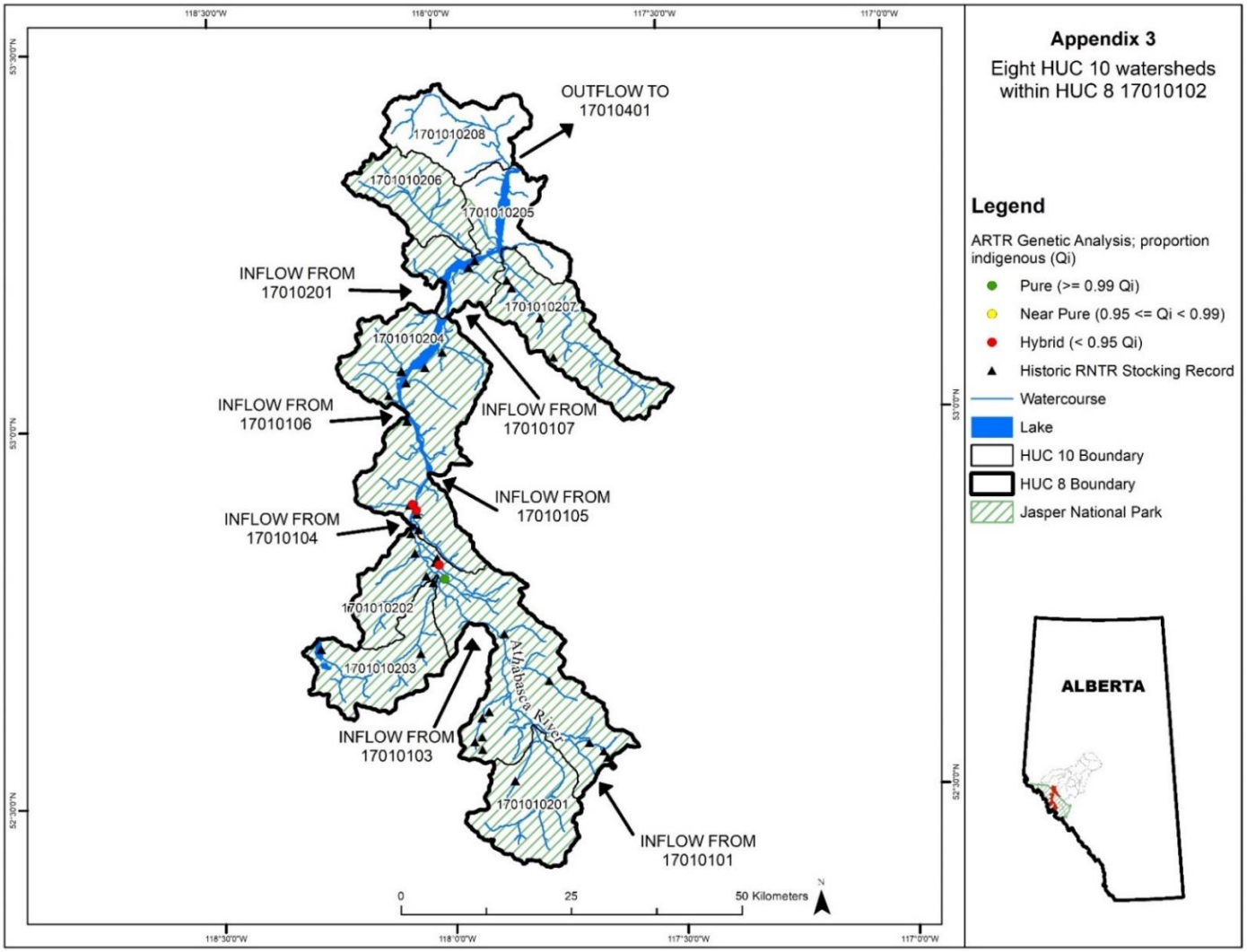

Figure A1.3. Athabasca Rainbow Trout distribution range in Jasper National Park including genetic and historic Rainbow Trout stocking information in eight HUC 10 watersheds within HUC 8 17010102.

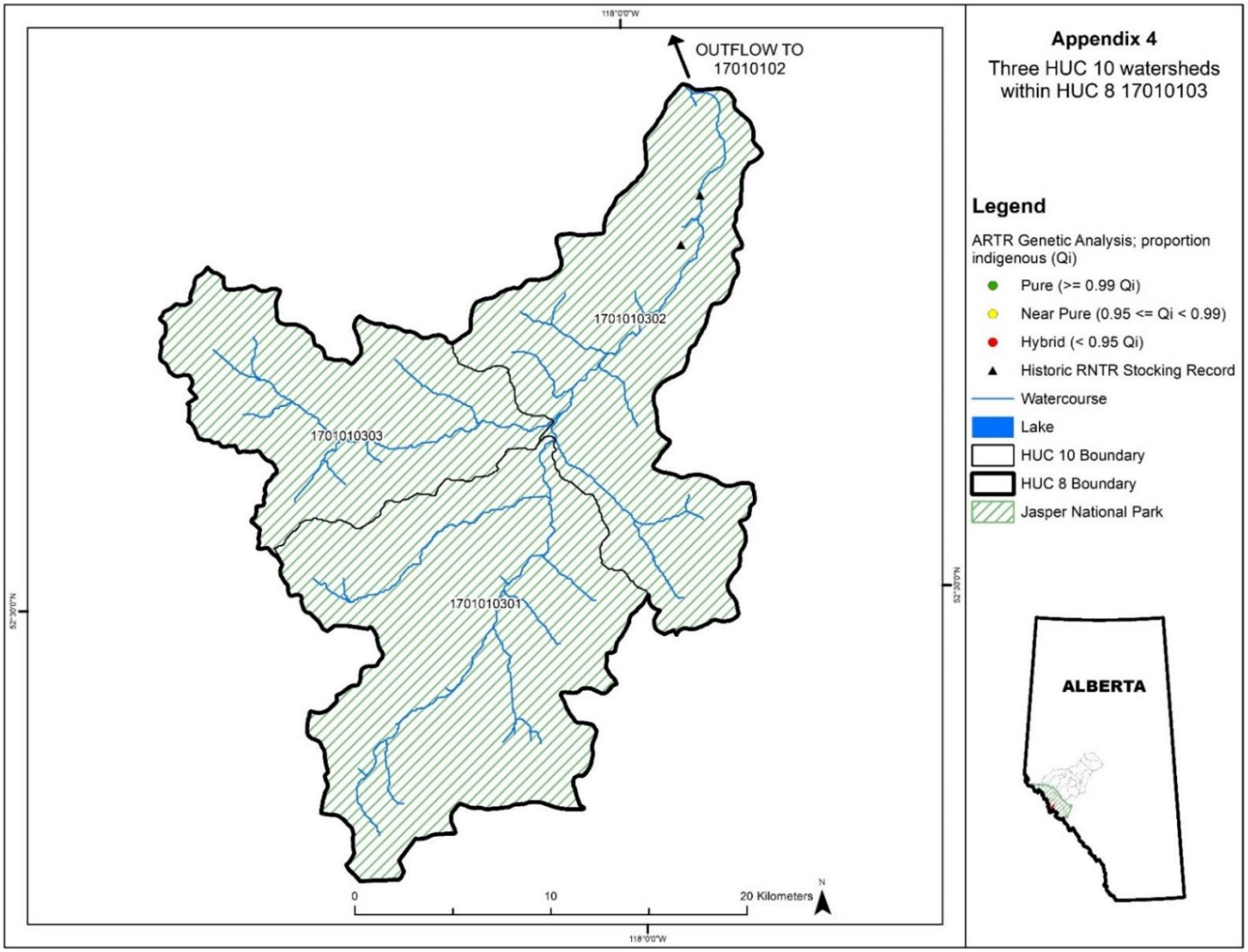

Figure A1.4. Athabasca Rainbow Trout Rainbow Trout distribution range in Jasper National Park including historic Rainbow Trout stocking information in three HUC 10 watersheds within HUC 8 17010103.

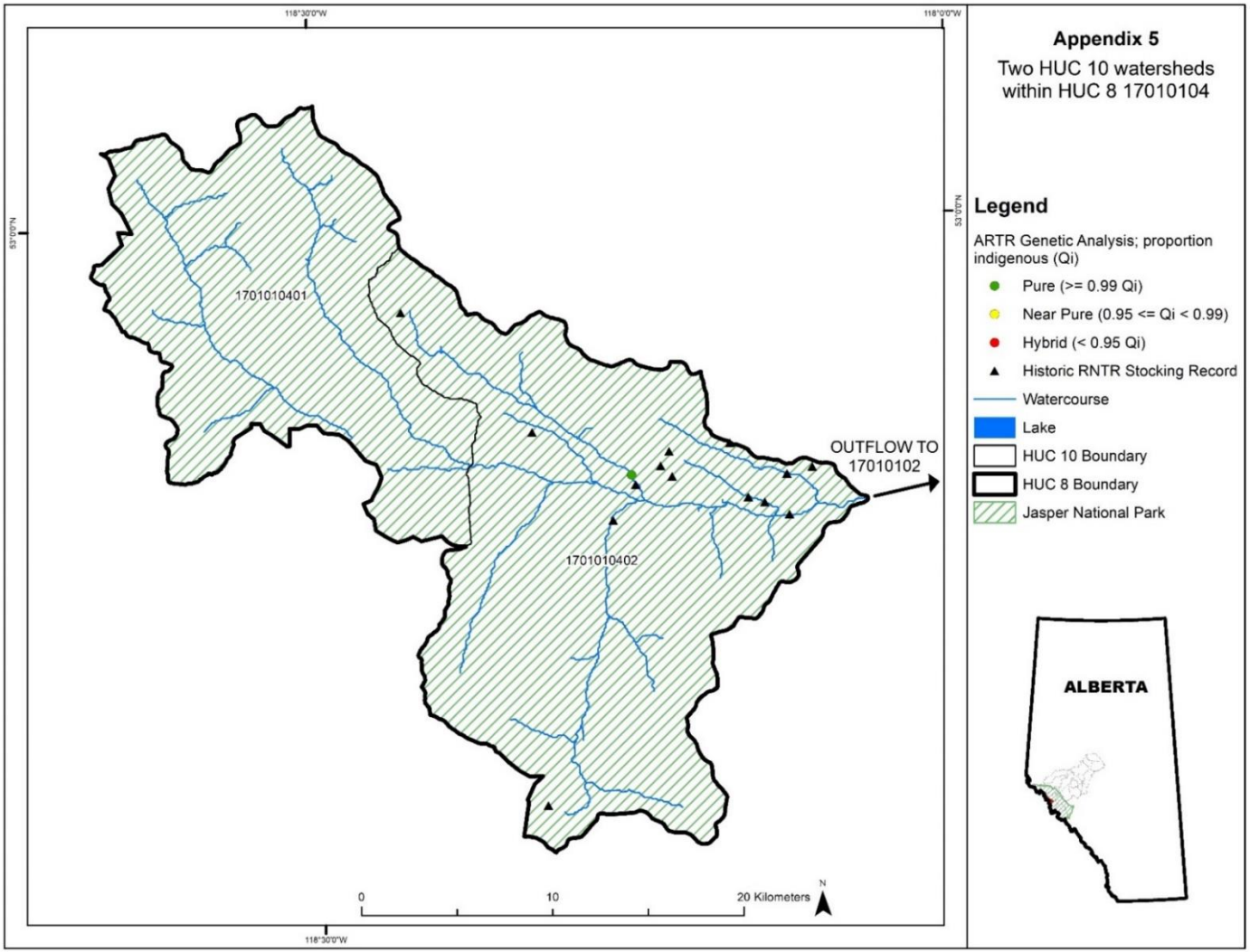

Figure A1.5. Athabasca Rainbow Trout distribution range in Jasper National Park including genetic and historic Rainbow Trout stocking information in two HUC 10 watersheds within HUC 8 17010104.

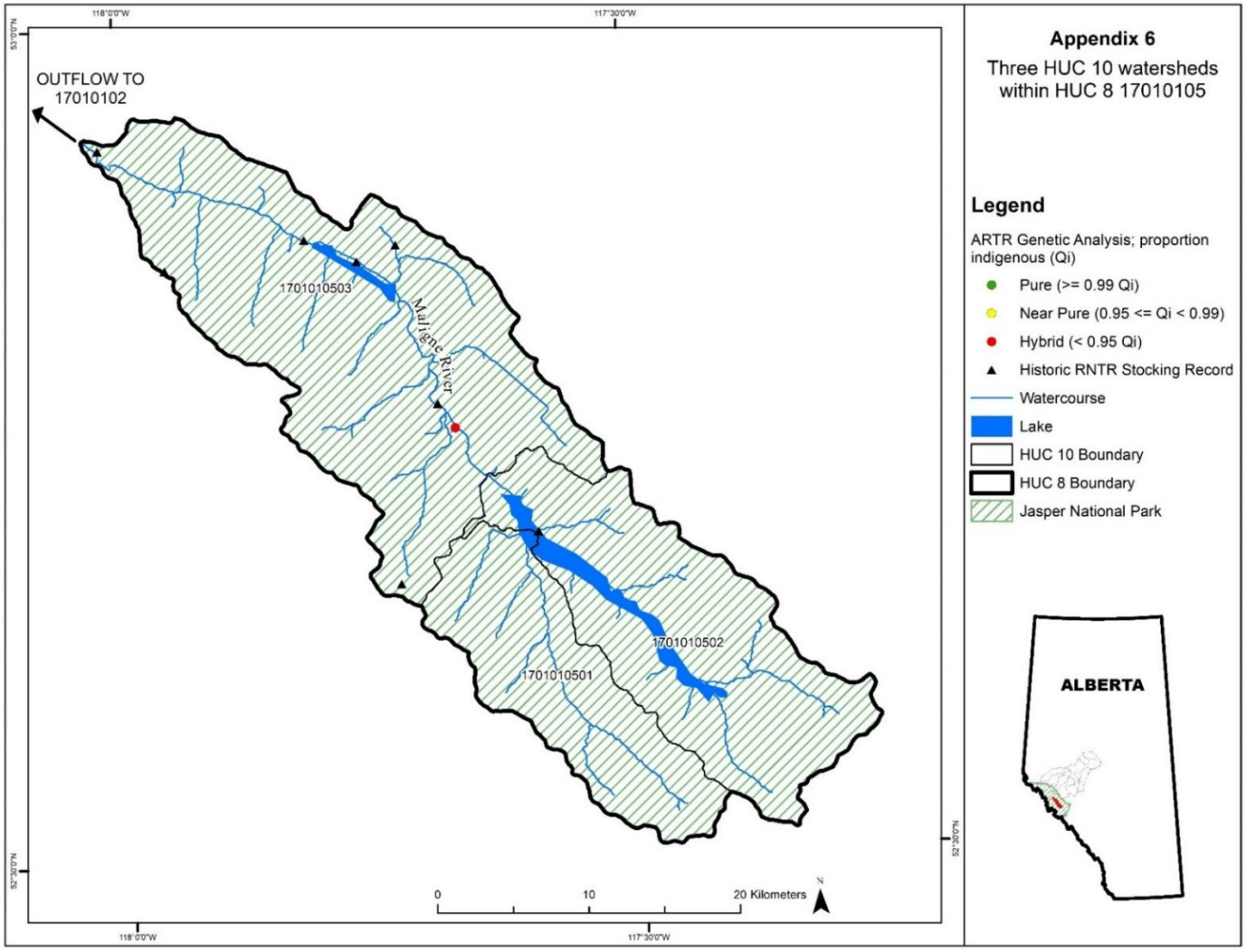

Figure A1.6. Athabasca Rainbow Trout distribution range in Jasper National Park including genetic and historic Rainbow Trout stocking information in three HUC 10 watersheds within HUC 8 17010105.

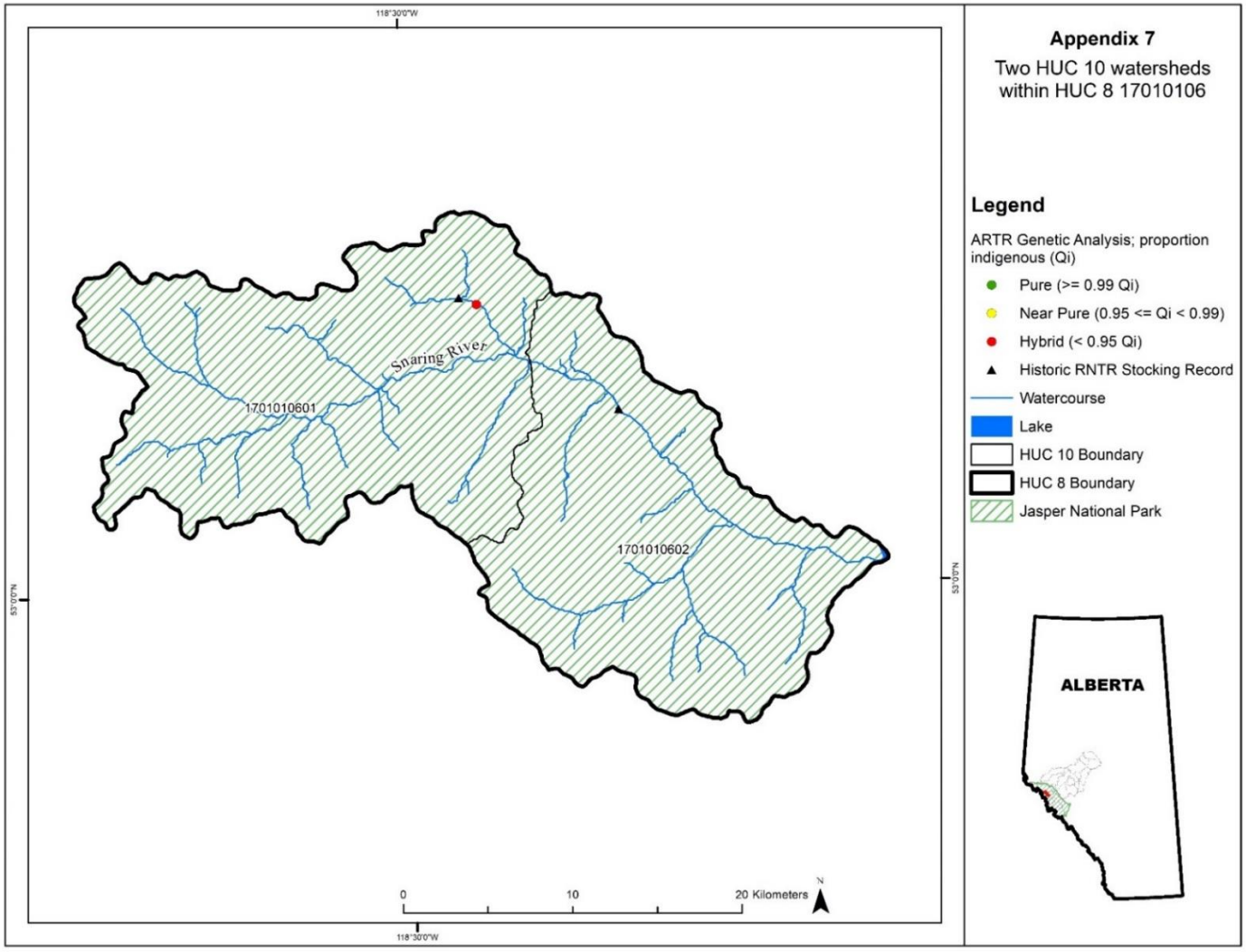

Figure A1.7. Athabasca Rainbow Trout distribution range in Jasper National Park including genetic and historic Rainbow Trout stocking information in two HUC 10 watersheds within HUC 8 17010106.

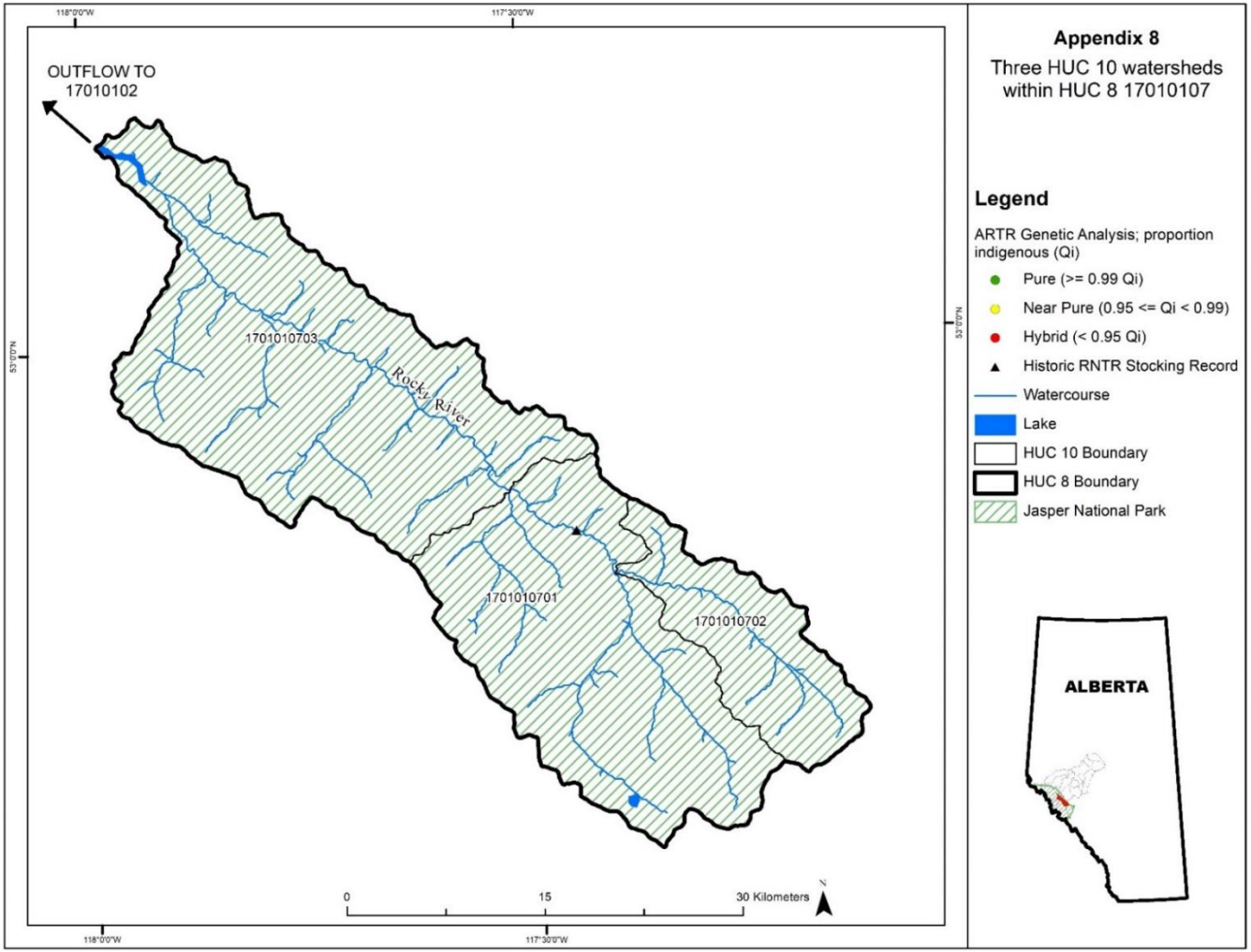

Figure A1.8. Athabasca Rainbow Trout distribution range in Jasper National Park including historic Rainbow Trout stocking information in three HUC 10 watersheds within HUC 8 17010107.

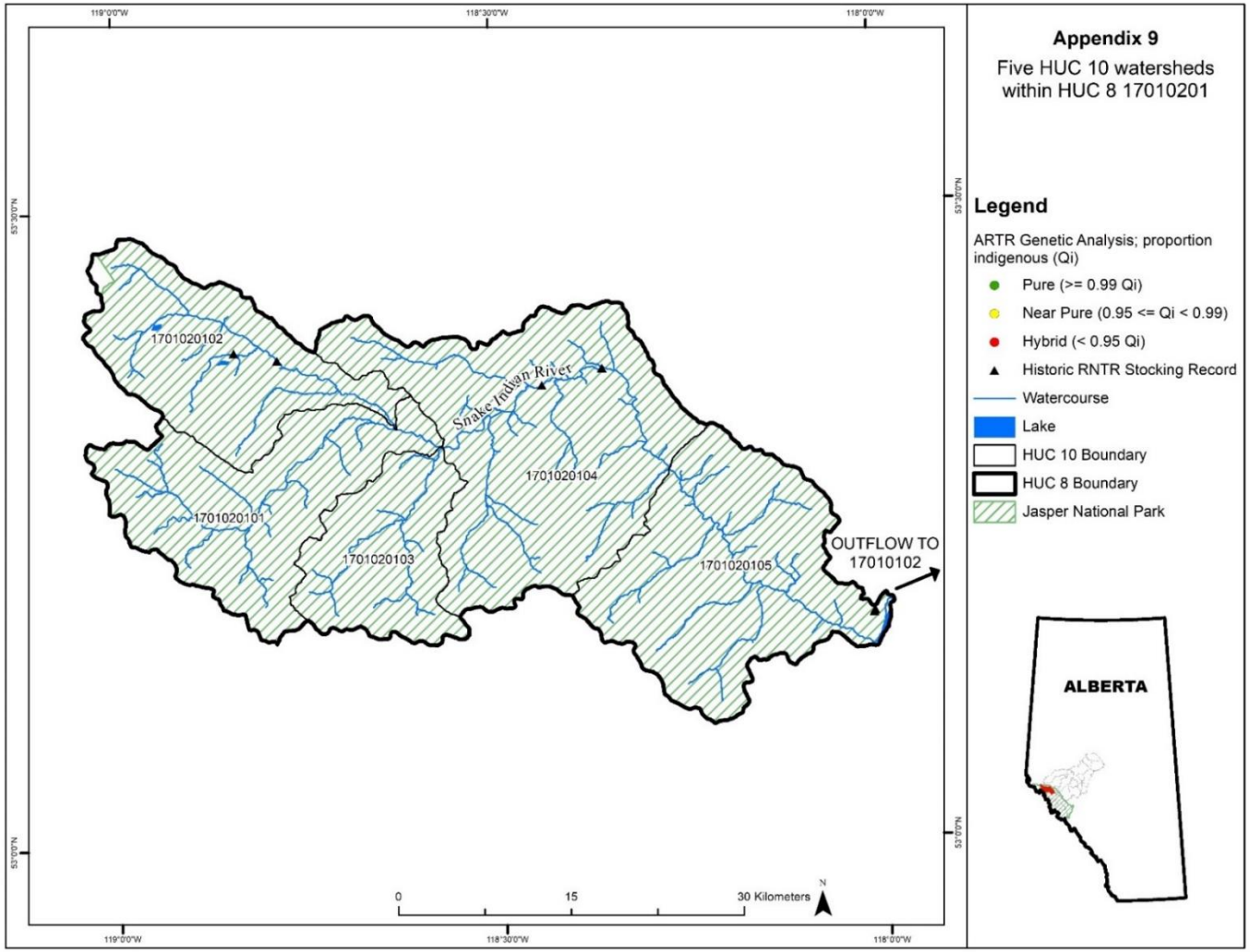

Figure A1.9. Athabasca Rainbow Trout distribution range in Jasper National Park including genetic and historic Rainbow Trout stocking information in five HUC 10 watersheds within HUC 8 17010201.

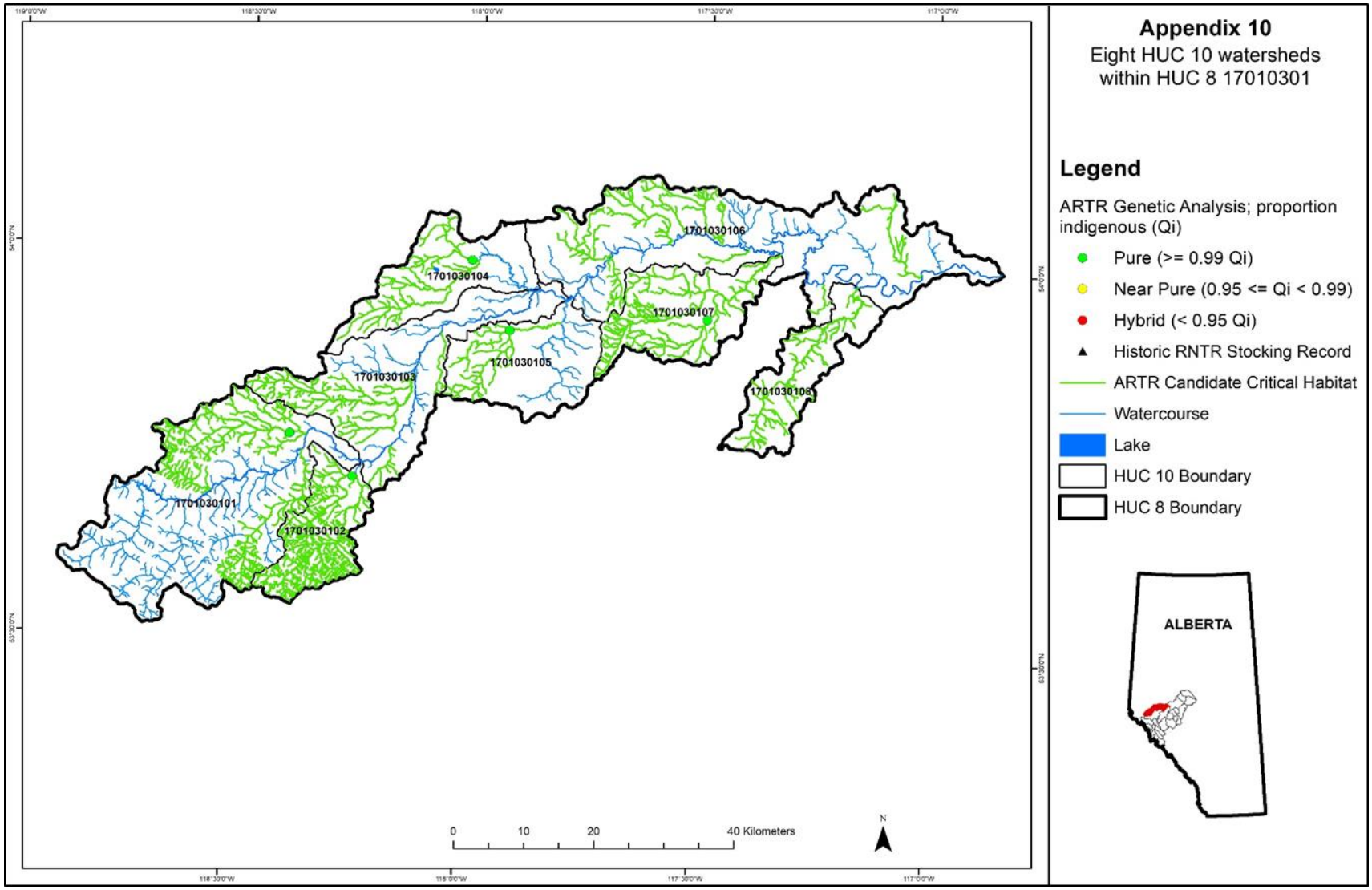

Figure A1.10. Candidate Critical Habitat for Athabasca Rainbow Trout including genetic information at eight HUC 10 watersheds within HUC 8 17010301.

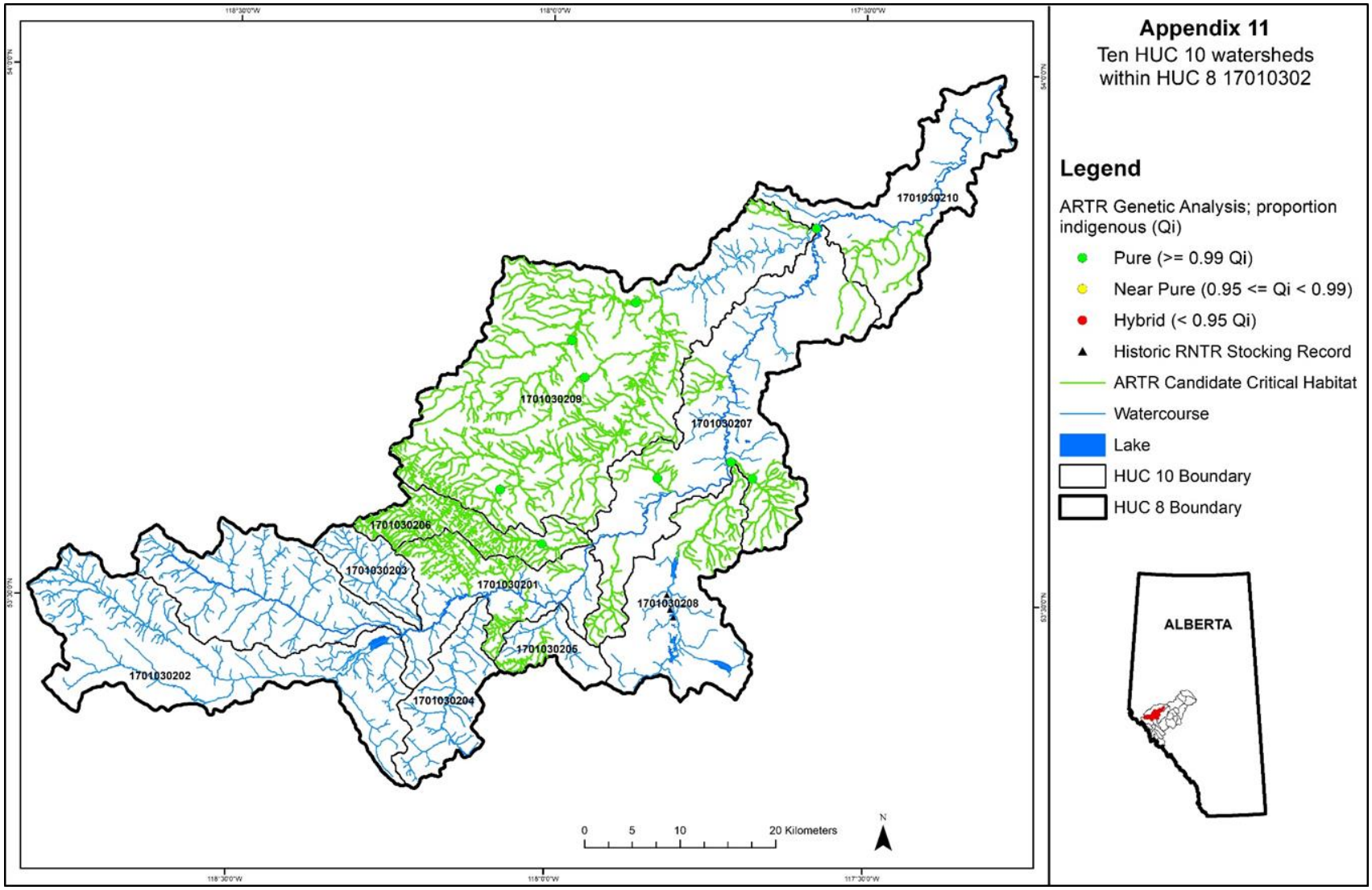

Figure A1.11. Athabasca Rainbow Trout genetic analysis at ten HUC 10 watersheds within HUC 8 17010302.

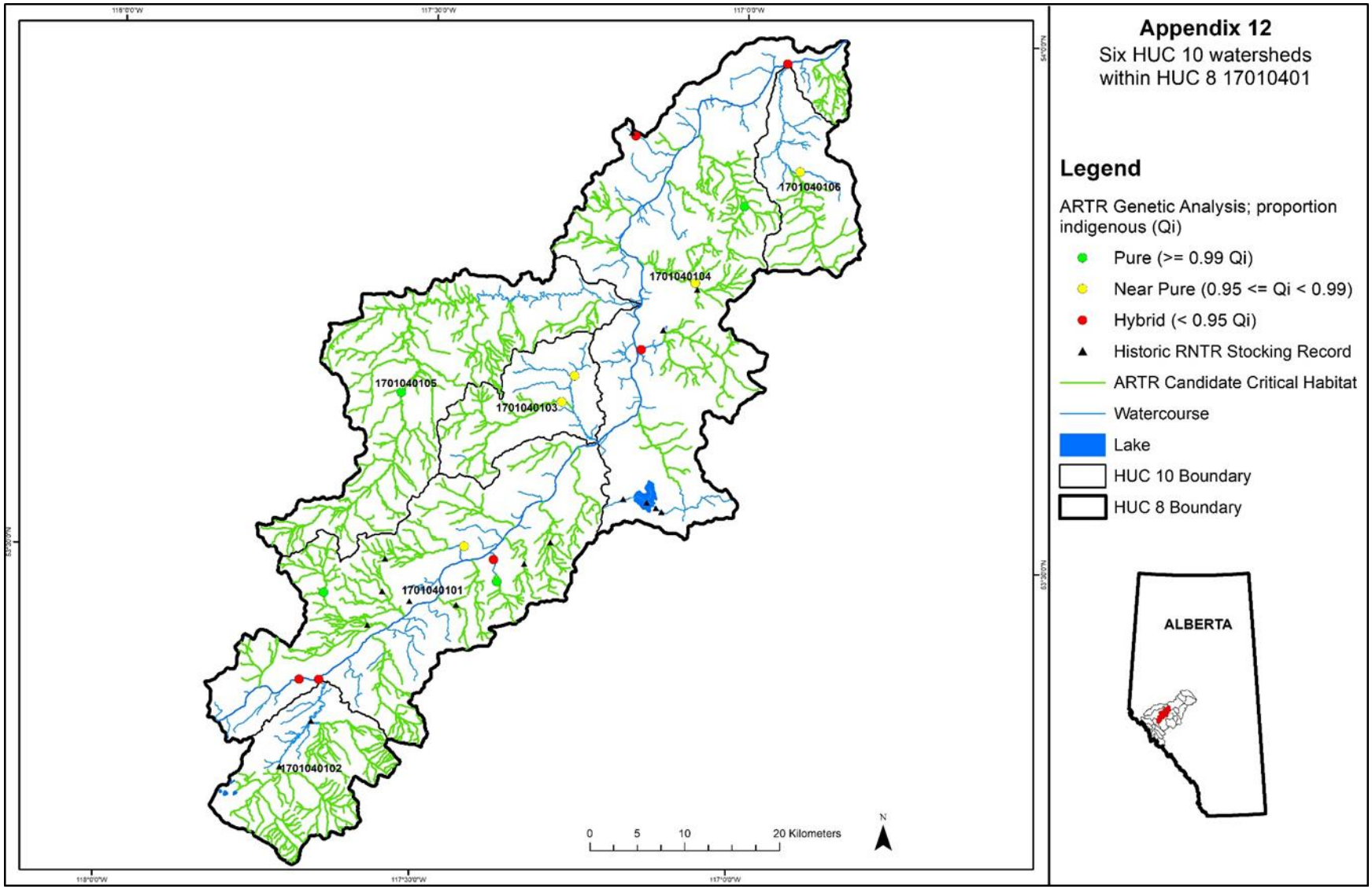

Figure A1.12. Candidate Critical Habitat for Athabasca Rainbow Trout including genetic and historic Rainbow Trout stocking information at six HUC 10 watersheds within HUC 8 17010401.

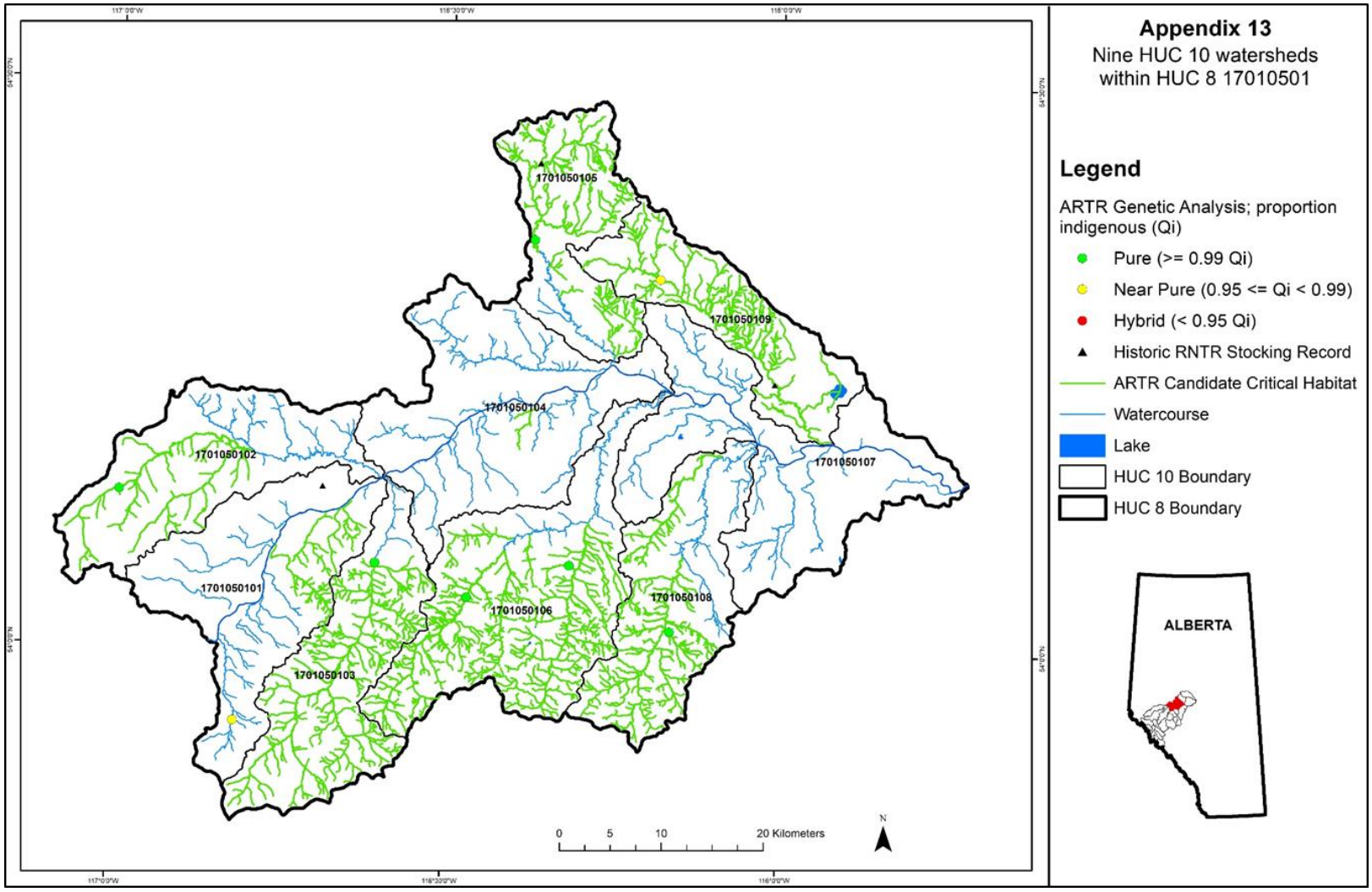

Figure A1.13. Candidate Critical Habitat for Athabasca Rainbow Trout including genetic and historic Rainbow Trout stocking information at nine HUC 10 watersheds within HUC 8 17010501.

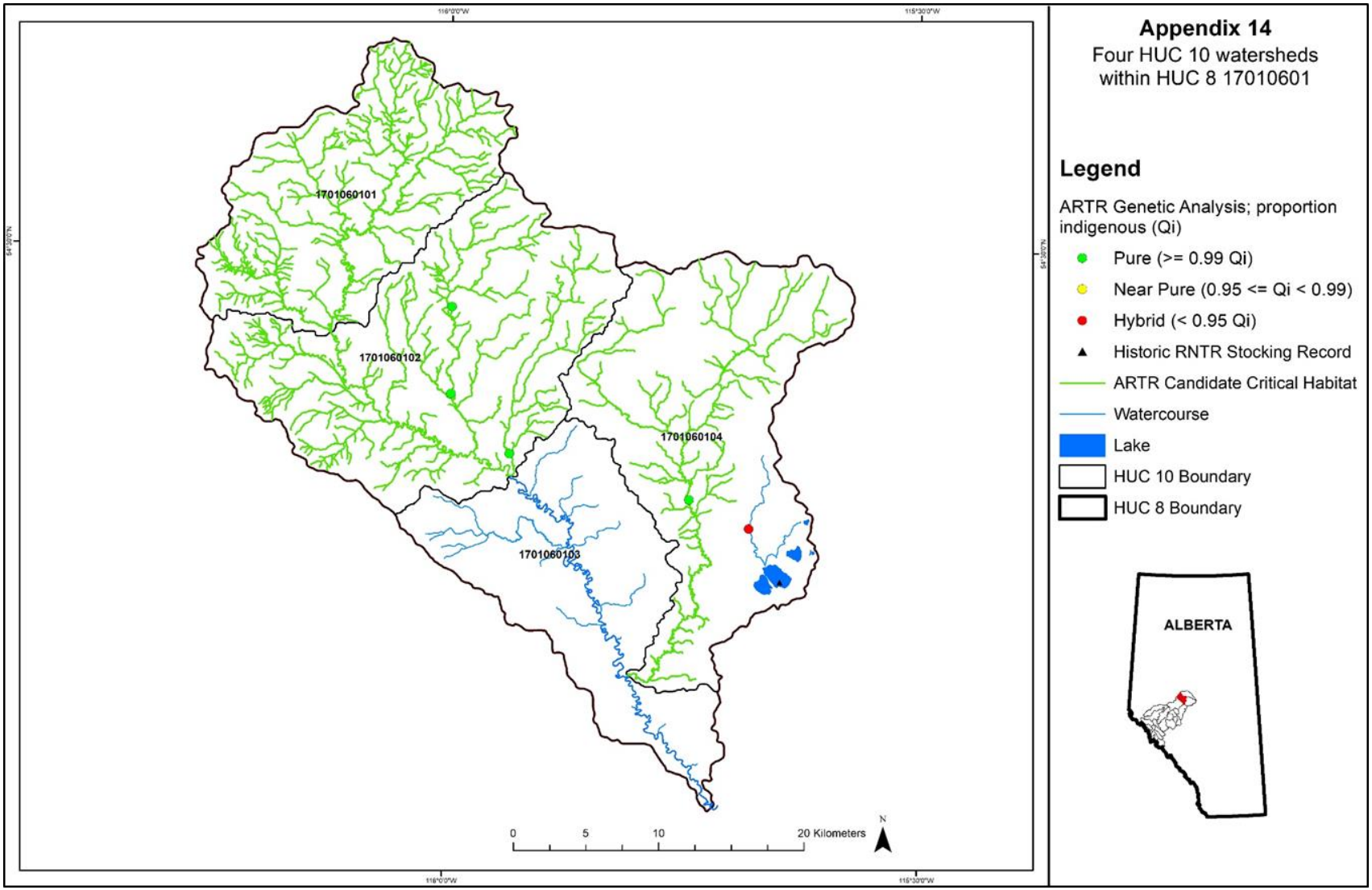

Figure A1.14. Candidate Critical Habitat for Athabasca Rainbow Trout including genetic and historic Rainbow Trout stocking information at four HUC 10 watersheds within HUC 8 17010601.

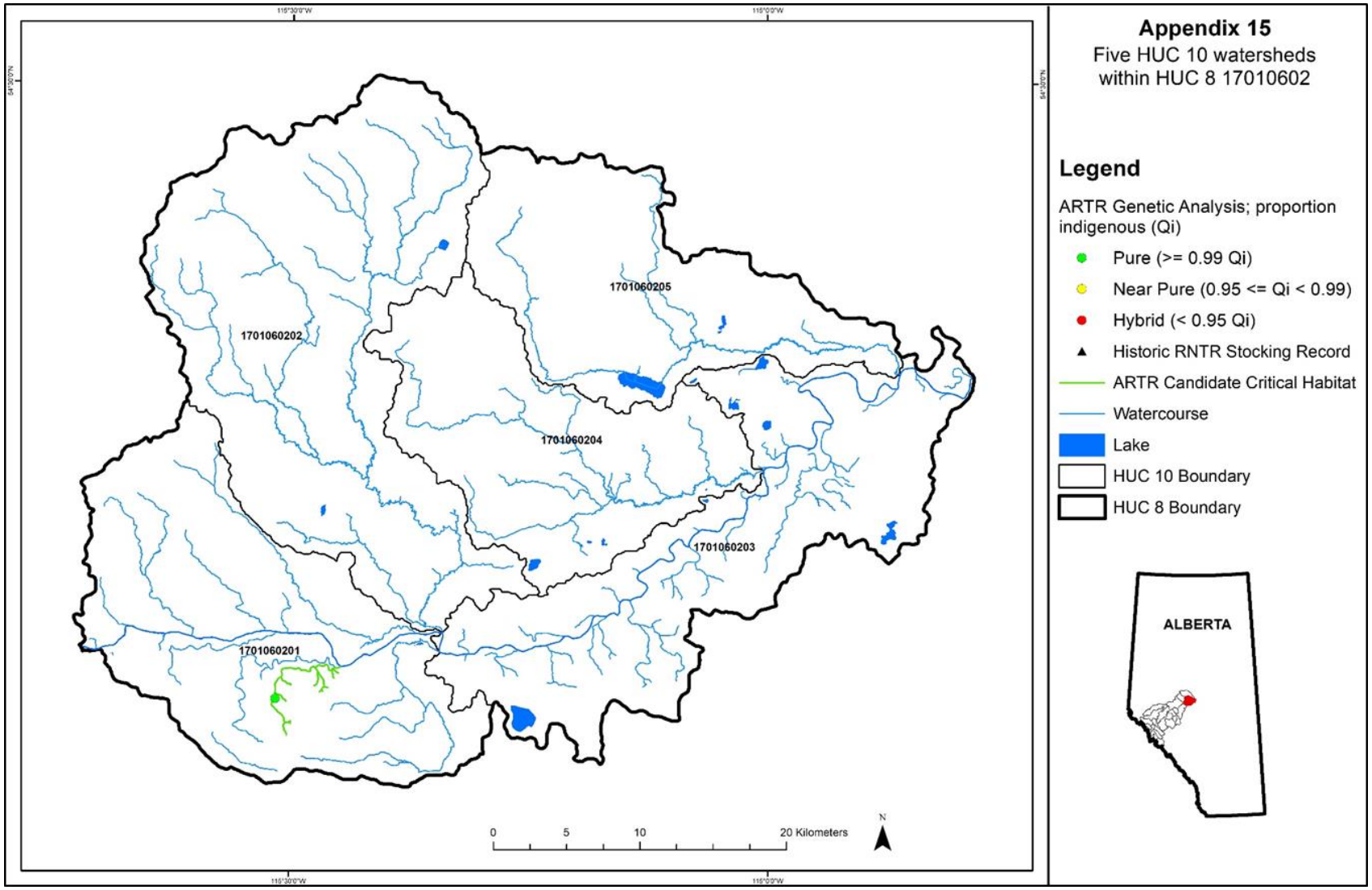

Figure A1.15. Candidate Critical Habitat for Athabasca Rainbow Trout including genetic and historic Rainbow Trout stocking information at five HUC 10 watersheds within HUC 8 17010602.

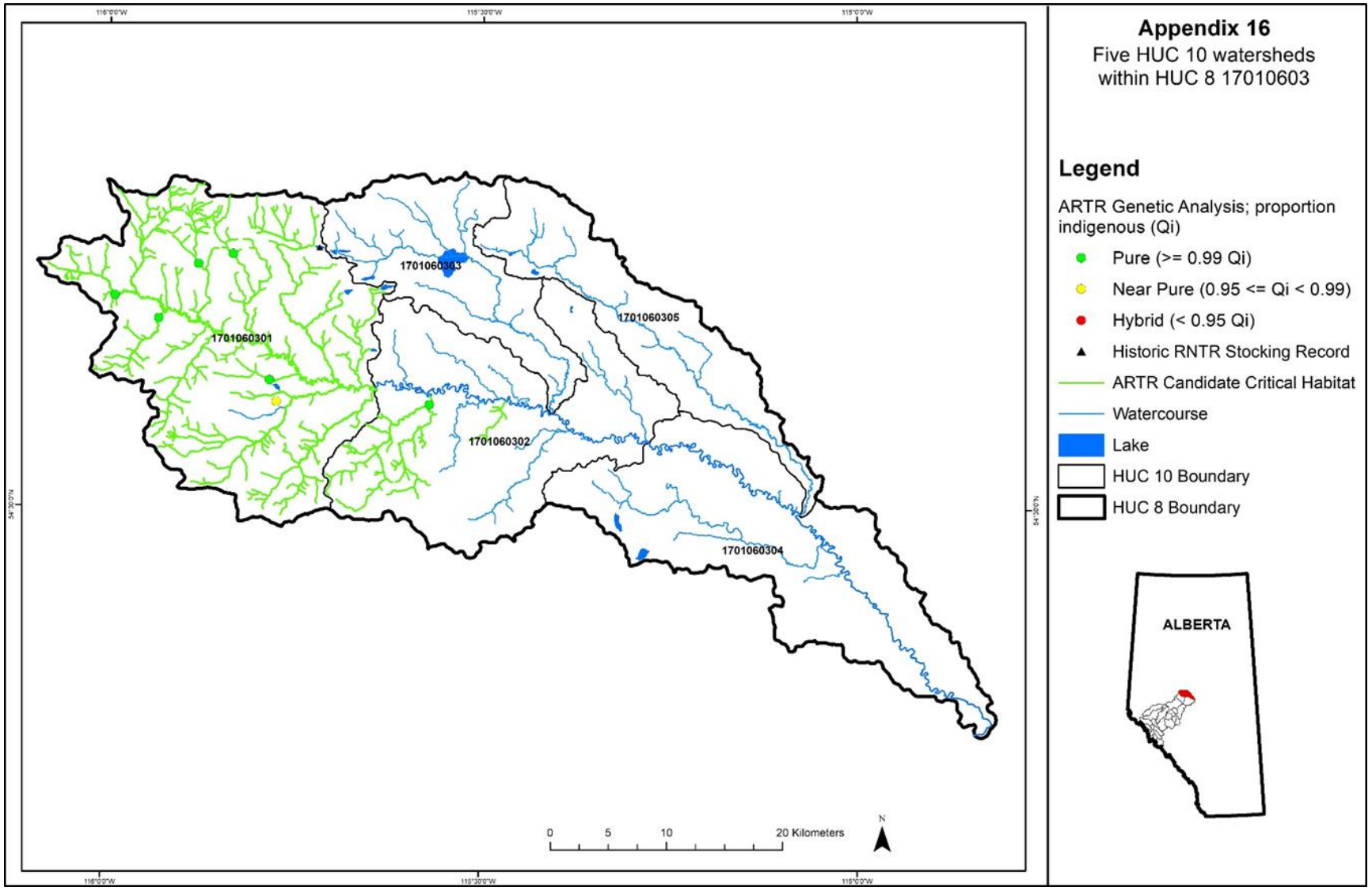

Figure A1.16. Candidate Critical Habitat for Athabasca Rainbow Trout including genetic and historic Rainbow Trout stocking information at five HUC 10 watersheds within HUC 8 17010603.

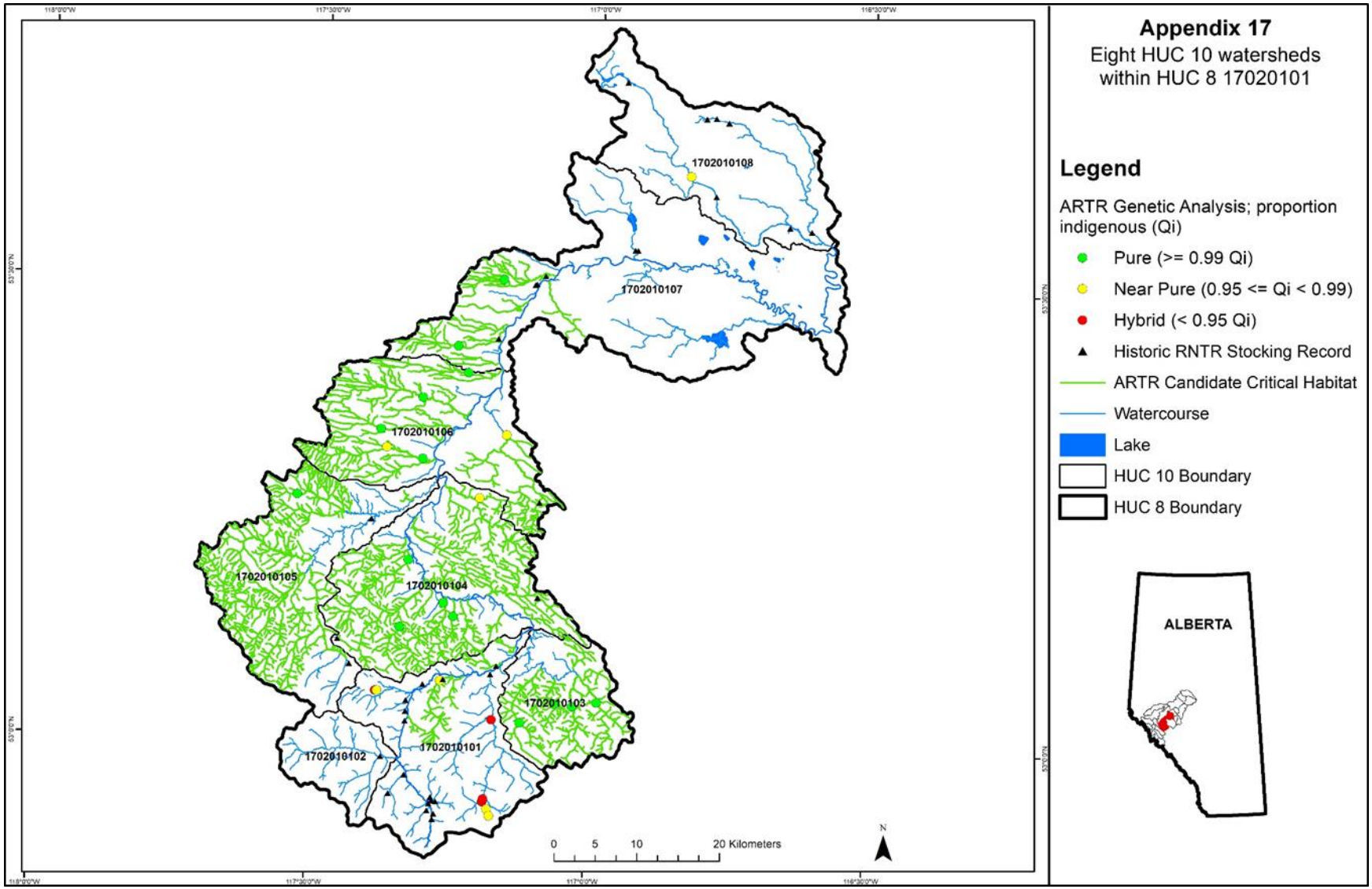

Figure A1.17. Candidate Critical Habitat for Athabasca Rainbow Trout including genetic and historic Rainbow Trout stocking information at eight HUC 10 watersheds within HUC 8 17020101.

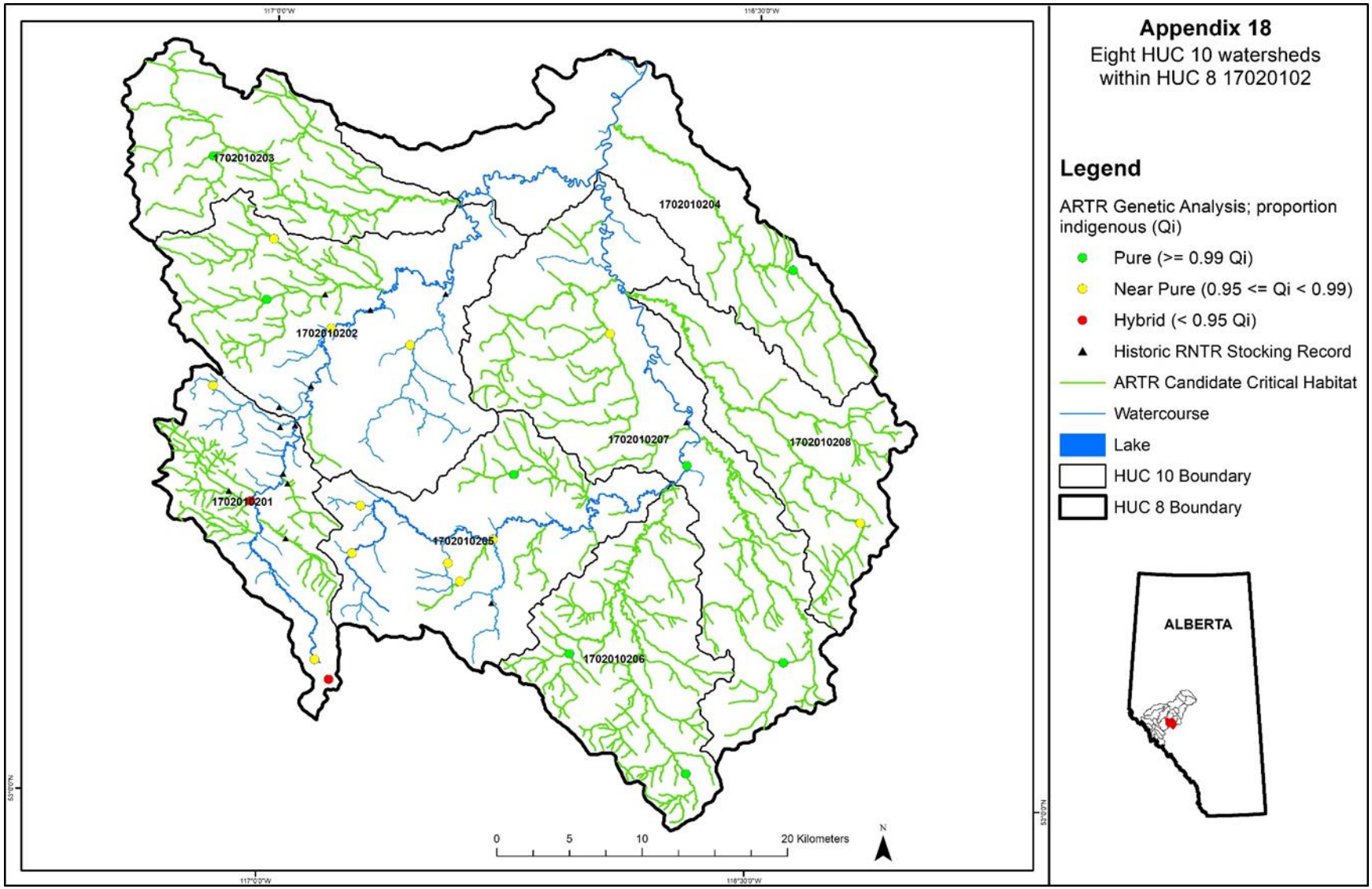

Figure A1.18. Candidate Critical Habitat for Athabasca Rainbow Trout including genetic and historic Rainbow Trout stocking information at eight HUC 10 watersheds within HUC 8 17020102.

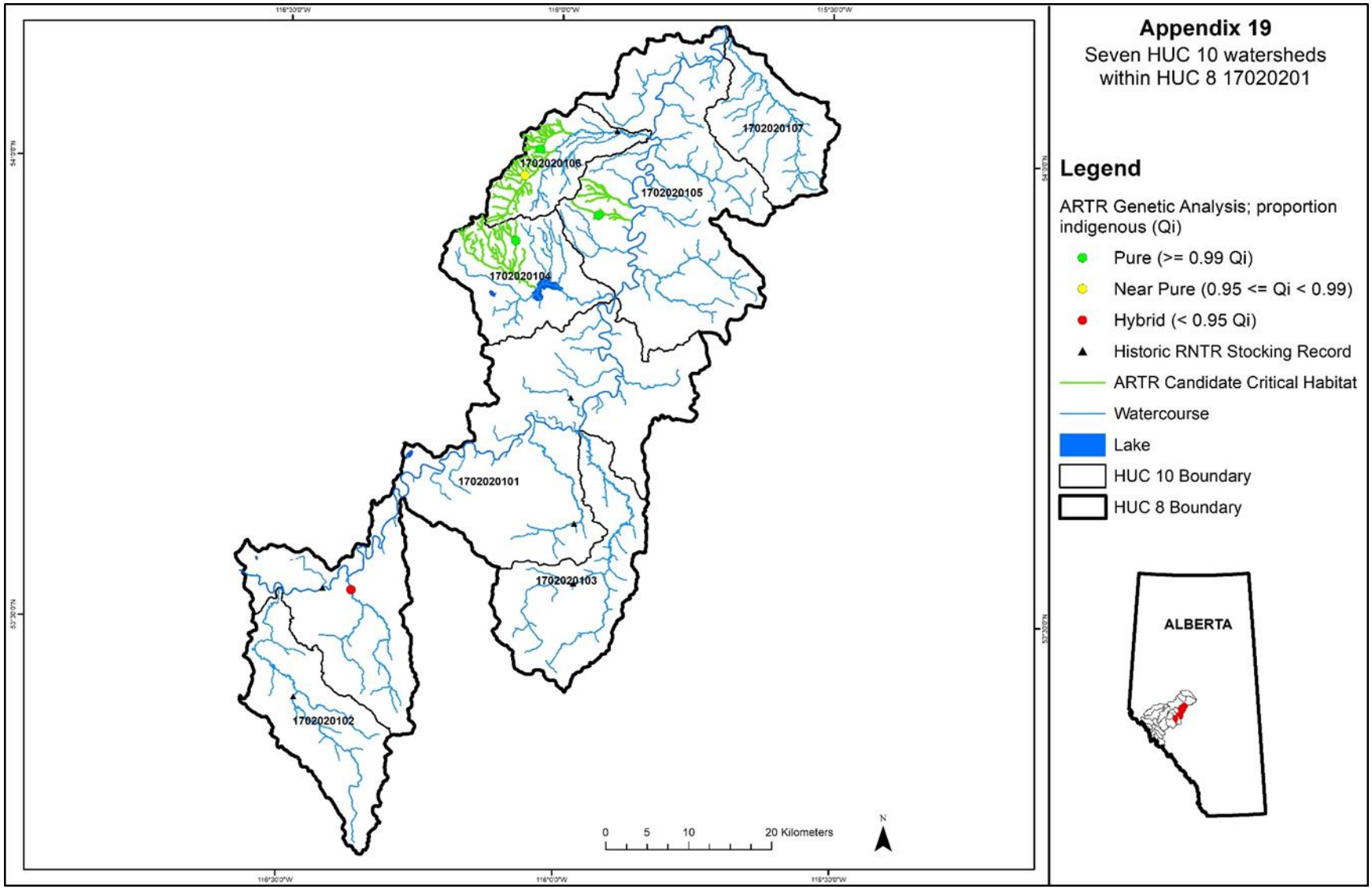

Figure A1.19. Candidate Critical Habitat for Athabasca Rainbow Trout including genetic and historic Rainbow Trout stocking information at seven HUC 10 watersheds within HUC 8 17020201.

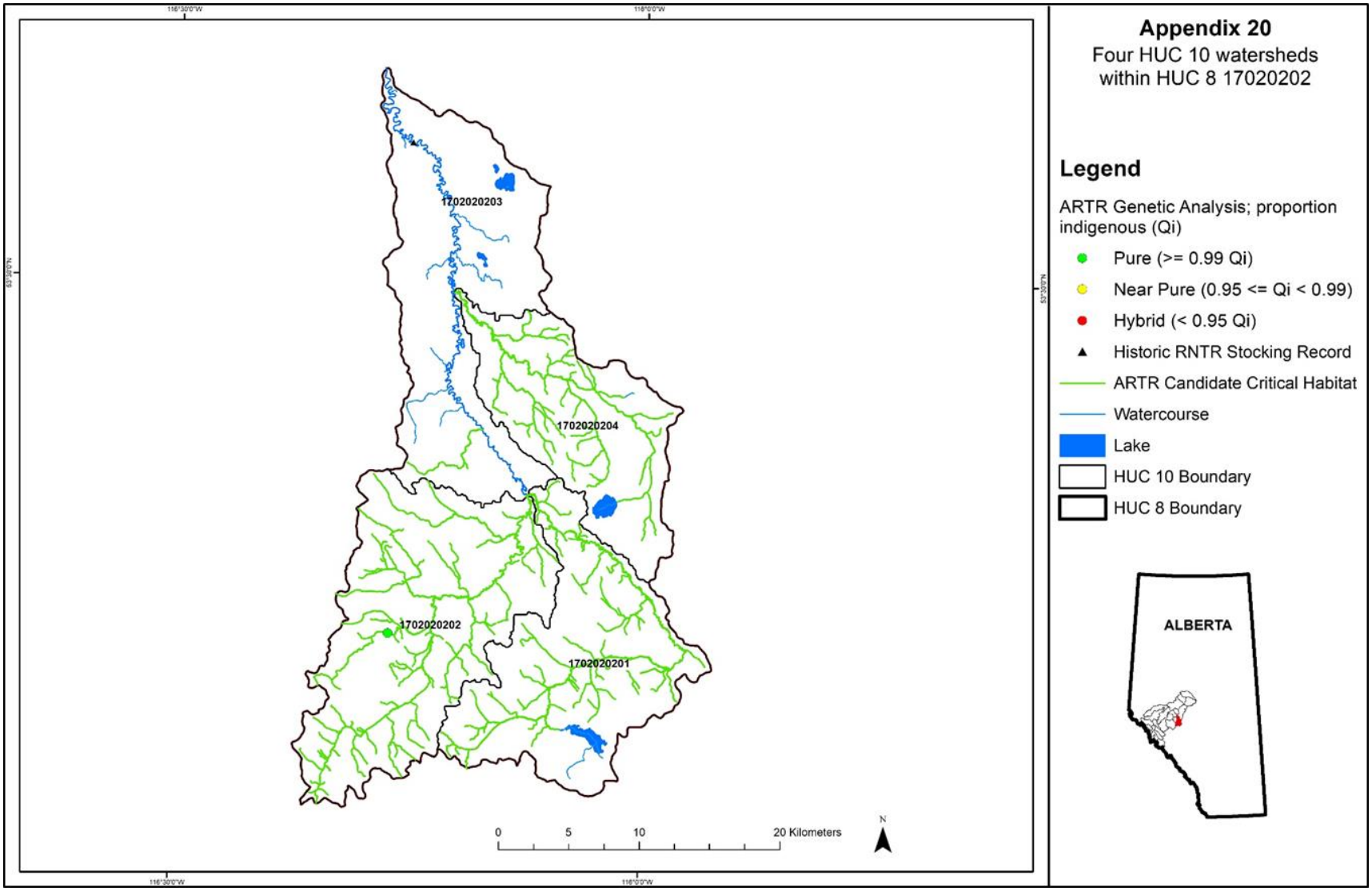

Figure A1.20. Candidate Critical Habitat for Athabasca Rainbow Trout including genetic and historic Rainbow Trout stocking information at four HUC 10 watersheds within HUC 8 17020202.

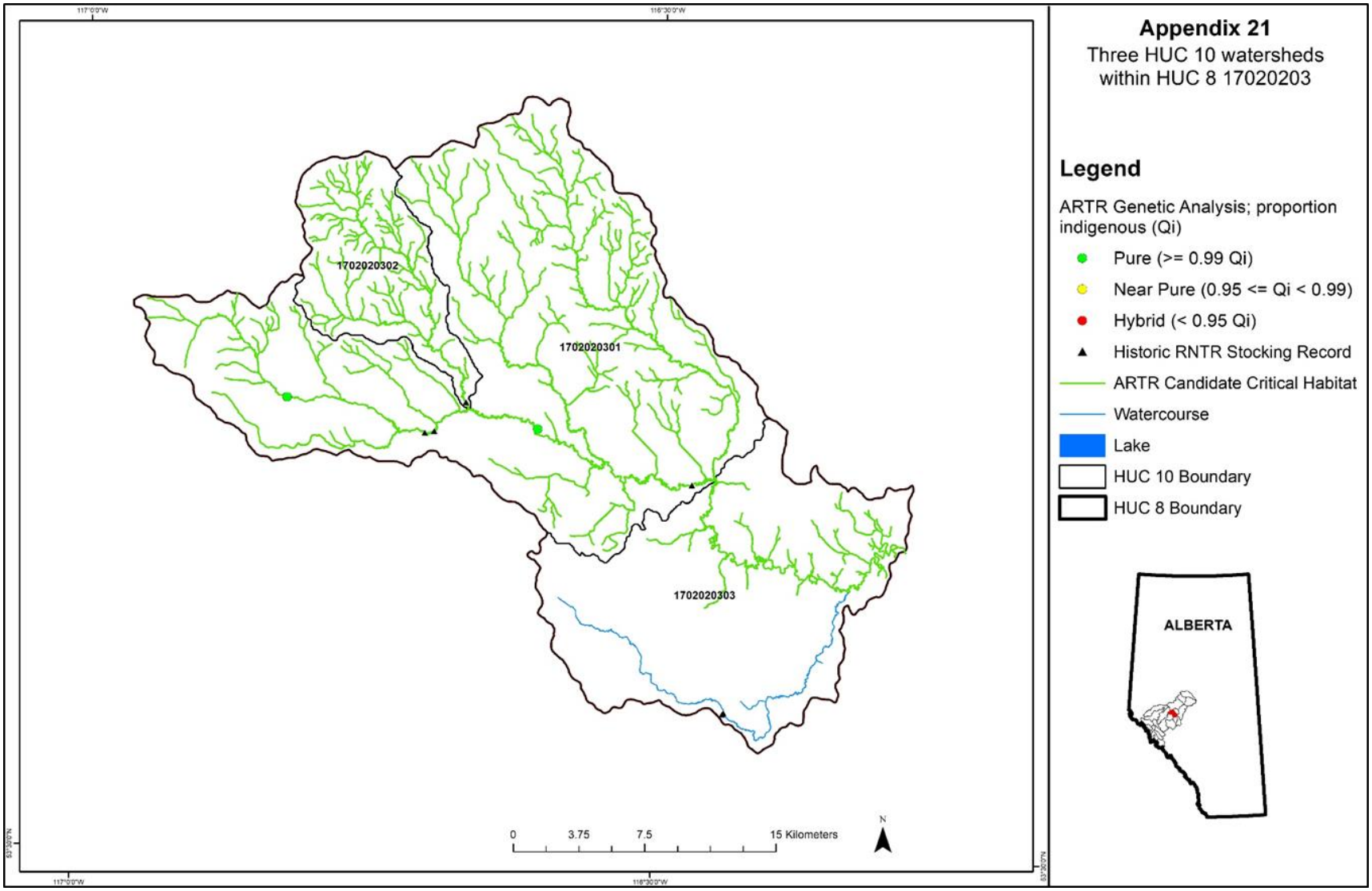

Figure A1.21. Candidate Critical Habitat for Athabasca Rainbow Trout including genetic and historic Rainbow Trout stocking information at three HUC 10 watersheds within HUC 8 17020203.

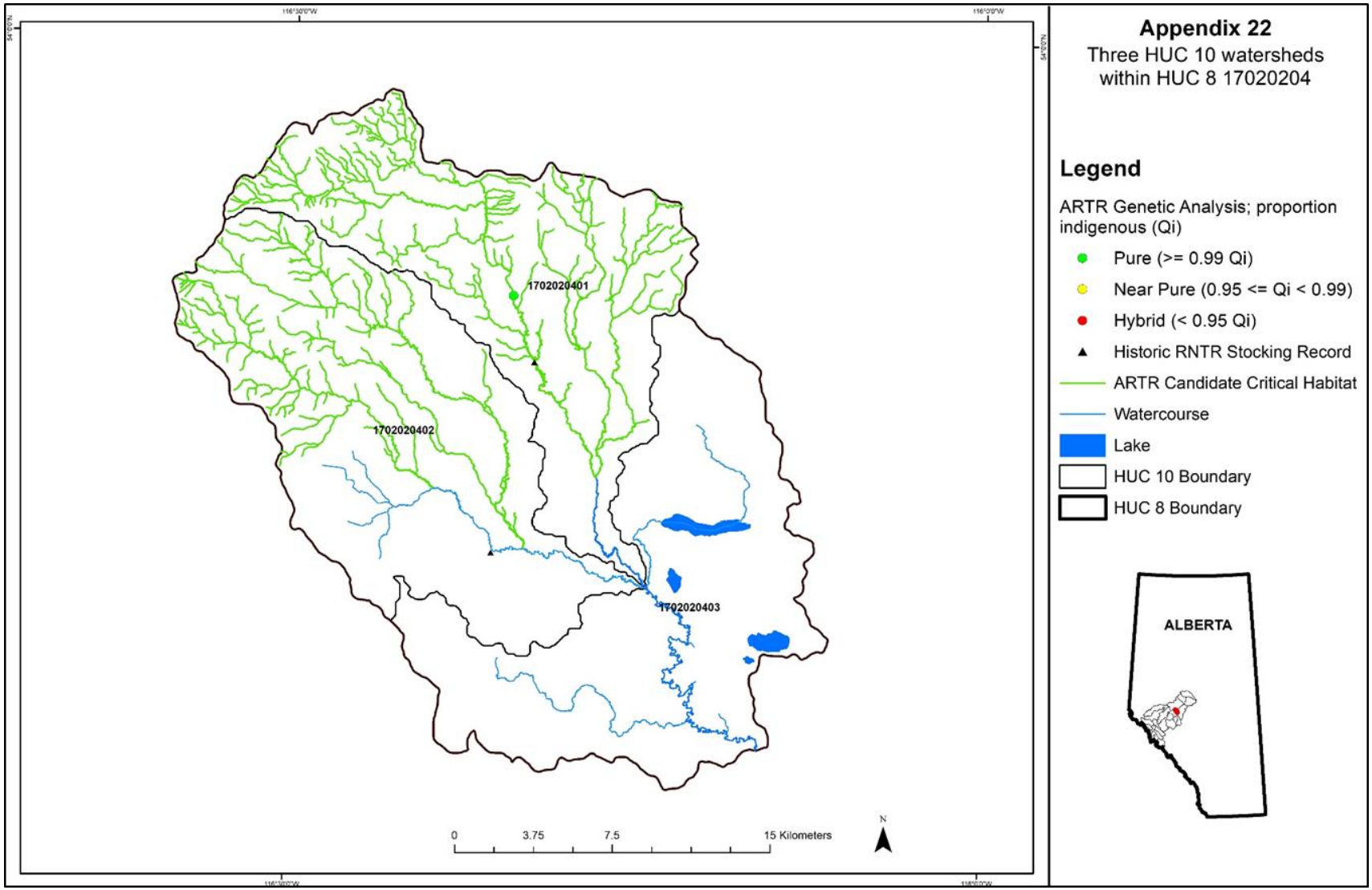

Figure A1.22. Candidate Critical Habitat for Athabasca Rainbow Trout including genetic and historic Rainbow Trout stocking information at three HUC 10 watersheds within HUC 8 17020204.

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