Evaluation of Natural and Hatchery-Produced Kokanee in Flaming Gorge Reservoir, Wyoming-Utah

A Thesis

Presented in Partial Fulfillment of the Requirements for the

Degree of Master of Science

with a

Major in Natural Resources

in the

College of Graduate Studies

University of Idaho

by

Aaron R. Black

Approved by:

Major Professor: Michael C. Quist, Ph.D.

Committee members: Kenneth D. Cain, Ph.D.; Timothy R. Johnson, Ph.D.;
Mark A. Smith, M.S.

Department Administrator: Lisette P. Waits, Ph.D.

December 2021

Abstract

Kokanee *Oncorhynchus nerka* were first stocked in Flaming Gorge Reservoir (FGR), Wyoming-Utah, in 1963. In a system that uses supplemental stocking to enhance a popular sport fishery, an understanding of the contributions from natural and hatchery-produced fish is critically important so that hatchery resources can be appropriately allocated. The goal of this research was to identify the natal origin (i.e., natural, hatchery) of kokanee in FGR using otolith microchemistry. Return to the creel, composition of spawning aggregates, and growth of kokanee in Flaming Gorge Reservoir were evaluated with a focus on differences associated with natal origin. Kokanee otoliths collected from hatcheries ($n = 60$) and FGR ($n = 1{,}003$) were analyzed for the strontium isotope ratio, $^{87}Sr/^{86}Sr$, using laser ablation and a multi-collector inductively coupled plasma mass spectrometer. Kruskal-Wallis tests were conducted to compare the Sr isotope ratios from the otolith edge of kokanee sampled from hatcheries and FGR. Strontium isotope ratios differed for eleven out of twelve hatcheries ($P < 0.01$). The Wigwam Hatchery was not significantly different from FGR ($P = 0.84$). Model-based discriminant function analysis was used to assign a natal origin for kokanee caught in FGR. Hatchery contribution to the population at large varied from 21% to 50% among year classes. The percentage of hatchery kokanee in the creel (18-50%) was similar to what was observed in the population. Hatchery-produced kokanee contributed a higher proportion to tributary-spawning aggregates (40-90%) than shoreline-spawning aggregates (19-58%) by sample year. Growth of natural and hatchery kokanee was similar, suggesting similar performance in the system. Results from this study identify that hatchery supplementation contributes to the population and recreational harvest of kokanee in FGR. This research also provides insight on the ecology of kokanee that is useful for better understanding kokanee population dynamics in reservoir systems.

Acknowledgements

I want to first thank my advisor Dr. Michael C. Quist for his continued support and guidance during my master's program. I appreciate the support provided by John Walrath of the Wyoming Game and Fish Department not only during my field season but throughout my graduate program. I also thank Ryan Mosely of the Utah Division of Wildlife Resources for his assistance with data collection. I thank Justin Glessner from the University of California-Davis Interdisciplinary Center for Inductively-Coupled Plasma Mass Spectrometry, who taught me the ins-and-outs of mass spectrometry and was always very accommodating during my trips to Davis for otolith microchemistry analysis. I also want to thank Malte Willmes of the University of California-Davis for his additional support with microchemistry analysis. I thank my committee members, Mark Smith, Timothy Johnson, and Kenneth Cain for advice during my program. I thank lab technician, Kade Holling who spent countless hours preparing otoliths as well as an extended trip to Davis for microchemistry analysis. Lastly, I want to thank my fellow graduate students and research associates (Megan Heller, Susie Frawley, Will Lubenau, Darcy McCarrick, and Marta Ulaski) for their positive reinforcement, advice, and everlasting friendships.

Dedication

This work is dedicated to my family. Throughout the years, my family has provided endless love, support, and encouragement that allowed me to pursue my dreams.

Table of Contents

List of Tables

List of Figures

Thesis Organization

This thesis contains one chapter. This chapter describes the natal origin of kokanee in Flaming Gorge Reservoir along with relative contributions and performance to multiple aspects of the population.

Introduction

Stocking efforts to maintain or enhance a fishery can be challenging and costly for natural resource agencies (Yule and Luecke 1993; Martinez and Wiltzius 1995; Johnson and Martinez 2000). In systems that use stocking to supplement natural production, an understanding of the contributions from natural and hatchery-produced fish is critically important so that hatchery resources can be efficiently allocated. In western lakes and reservoirs, introduced kokanee *Oncorhynchus nerka* often serve as both a sport fish and prey resource (Wydoski and Bennett 1981; Martinez et al. 2009). Kokanee are non-anadromous Sockeye Salmon indigenous to northwestern North America and northeastern Asia (Nelson 1968). Kokanee are native to Alaska, Washington, Idaho, and Oregon in the United States, and the Yukon Territory and British Columbia in Canada. Introduced kokanee populations can become self-sustaining, but supplemental stocking is often needed when used for dual purposes (i.e., prey and sport fish; Wydoski and Bennett 1981; Rieman and Myers 1992). Flaming Gorge Reservoir, Wyoming-Utah, is one of many western reservoirs where kokanee have been introduced to serve a dual purpose.

Kokanee were first introduced to Flaming Gorge Reservoir in 1963 (Parsons and Hubert 1988a). After the initial stocking events in 1963 and 1964, kokanee were sustained primarily through natural recruitment until a supplemental hatchery program was initiated in 1991. Kokanee in the reservoir have been documented spawning in the Green River, Sheep Creek, and various shoreline locations around the reservoir (Parsons and Hubert 1988a, 1988b; Gipson and Hubert 1993). In recent years, spawning has been observed in the Henrys Fork River along with additional shoreline locations. Contributions of natural and hatchery-produced kokanee to the various spawning aggregates are unknown. Since initiation of the stocking program, the Wyoming Game and Fish Department (WGFD), Utah Division of Wildlife Resources (UDWR), and U.S. Fish and Wildlife Service (USFWS) hatcheries have stocked approximately 1 million age-0 kokanee (i.e., fingerlings) annually. The WGFD hatchery system annually produces about 1,200,000 kokanee, of which approximately 75% (900,000 age-0 kokanee) are stocked into Flaming Gorge Reservoir. In addition to the collaborative efforts to support a kokanee fishery, several studies have focused on habitat availability (Modde et al. 1997; Parsons and Hubert 1988a) and competition with Utah Chub *Gila ataria* (Schneidervin and Hubert 1987; Teuscher and Luecke 1996). Furthermore, reproductive characteristics (Parsons and Hubert 1988b; Gipson and Hubert 1993), survival, abundance, distribution, and size structure of kokanee in Flaming Gorge Reservoir have also been studied (Jeric 1996; Mosley et al. 2008). Despite these efforts, little is known about the relative contributions of natural and hatchery-produced kokanee to the population.

Maintaining an adequate balance between prey availability and harvestable fish in a system with supplemental hatchery production requires knowledge of differences in growth rates, natural recruitment, and harvest of natural and hatchery-produced fish (Yule and Luecke 1993; Martinez and Wiltzius 1995). Several methods may be used to differentiate wild and hatchery fish, including the use of chemical dyes and stains, stress-induced marks on otoliths, tags and marks, and otolith microchemistry (Paragamian et al. 1992; Kennedy et al. 1997). However, each identification method has limitations. Stains and dyes (e.g., oxytetracycline, casein) may not be absorbed equally by all individuals and some compounds degrade when exposed to light (Paragamian et al. 1992). Hatcheries may not have resources required to induce stress marks (e.g., thermal marks; Paragamian et al. 1992; Volk et al. 1999). Also, stress marks can become difficult to identify in older fish without proper equipment (Paragamian et al. 1992). Removal of fins and(or) implanting tags can be labor intensive, requires additional handling of fish, and may not be permanent (e.g., shed tags). For microchemistry to be useful, water chemistry must be different between areas specific to the question(s) being asked (Kennedy et al. 2000). Although the use of microchemistry has limitations, advances in technology and in our understanding of applications have made it a reliable and effective tool for understanding the ecology of fishes (Kennedy et al. 2000; Campana and Thorrold 2001; Kennedy et al. 2002; Barnett-Johnson et al. 2008; Chase et al. 2015). In systems where the water chemistry of hatcheries differs from receiving waters, microchemistry serves as a tool to discriminate between natural and hatchery-produced fish. In fact, previous research has suggested that strontium isotope ratios (i.e., $^{87}Sr/^{86}Sr$) can be used to identify natal origin of kokanee (i.e., natural, hatchery) in Flaming Gorge Reservoir (Wyoming Game and Fish Department, unpublished data).

Sagittal otoliths are the most commonly used hard structure for microchemistry analysis in fishes (Pracheil et al. 2014). Otolith microchemistry is useful for describing natal origin, life history variation, migration history, and stock discrimination through trace elements deposited in the otolith (Campana 1999; Thresher 1999; Kennedy et al. 2000, 2002; Barnett-Johnson et al. 2008). The environment-to-otolith pathway of ions starts with exchange at the gills or through ingestion where ions are transferred to blood plasma (Campana 1999; Payan et al. 2004; Whitledge 2017). Ions move from the blood plasma to the endolymph via active transport where each otolith is precipitated from the endolymphatic fluid. Otoliths are dominated by crystalline calcium carbonate ($CaCO_3$) with the remainder being a non-collagenous matrix (Campana 1999; Long and Grabowski 2017; Whitledge 2017). Nearly 40 elements have been detected in otoliths, with most microchemistry studies reporting consistent assay of five to ten elements (Thresher 1999).

Strontium is isostructural to calcium and capable of substituting for calcium in biological structures (Kennedy et al. 2000; Campana and Thorrold 2001). Strontium isotopic ratios in bedrock persist in surface water and are derived from invariable geological sources (Fisher and Stueber 1976). The strontium isotopic ratios observed in surface water are stable among years with potential for some level of seasonal variation (Kennedy et al. 2000, 2002; Brown and Severin 2009; Hegg et al. 2013). Even with seasonal variations, fish that reside in a region long enough to incorporate a clear chemical signature of the water can be distinguished from individuals among regions if chemical signatures of the regions are different (Kennedy et al. 2000; Heckel et al. 2020).

The objective of this research was to use strontium isotope ratios derived from ambient water and sagittal otoliths to assess the natal origin of kokanee in Flaming Gorge Reservoir. In addition, return to the recreational creel, composition of spawning aggregates, and growth of kokanee in Flaming Gorge Reservoir were evaluated to assess differences based on natal origin.

Study Area

Flaming Gorge Reservoir is located in southwestern Wyoming and northeastern Utah (Figure 1). The reservoir is formed by the impoundment of the Green River by Flaming Gorge Dam (completed in 1962) at Dutch John, Utah. The reservoir's primary purposes are water storage, flood control, hydropower, and recreation (Schneidervin and Hubert 1988; Gipson and Hubert 1993). When filled to capacity, the reservoir has a surface area of 17,000 hectares, a surface elevation of 1,841 m above sea level, is 145 km long, and has a maximum depth of 134 m (Schneidervin and Hubert 1987). Surface water temperatures often exceed

20˚C during the summer, but temperatures are approximately 5˚C at depths ≥ 30 m. Flaming Gorge Reservoir has three primary inputs: Green, Blacks Fork, and Henrys Fork rivers. The Green River contributes ~80% of the water volume to the reservoir, the Blacks Fork and Henrys Fork rivers contribute ~15% combined, and the remaining volume comes from various small tributaries (Madison and Waddell 1973). The outflow of Flaming Gorge Reservoir is the Green River and is the largest tributary to the Colorado River (Gray et al. 2011). Dissolved solids in the reservoir primarily originate from the Green River (~60% of the total dissolved solids), followed by the Blacks Fork and Henrys Fork rivers (~20% combined), and various small tributaries (Madison and Waddell 1973).

The Green River basin extends approximately 240 km eastward from the Wyoming Mountains to the Rawlins uplift with the Gros Ventre Mountains, Wind River Mountains, and Granite Mountains to the north and Uinta Mountains to the south (Surdam and Wolfbauer 1975). The Green River originates in the Wind River Mountains, whereas the Blacks Fork River and Henrys Fork River originate in the Uinta Mountains. The Green River formation was formed from the playa-lake complex of ancient "Lake Gosiute" during the Eocene era. A combination of Precambrian granite along with Paleozoic and Mesozic sedimentary rocks are exposed in the drainage basin. The Unita Mountains are classified as a thick siliciclastic succession formed during the Neoproterozoic era dominated by cross-bedded quartzite and sandstone, siltstone, and shale (Dehler et al. 2010).

Flaming Gorge Reservoir is co-managed by WGFD and UDWR. Sport fishes in the reservoir include Lake Trout *Salvelinus namaycush*, Smallmouth Bass *Micropterus dolomieu*, Rainbow Trout *Oncorhynchus mykiss*, Brown Trout *Salmo trutta,* Bonneville Cutthroat Trout *O. clarkia utah,* and kokanee (Haddix and Budy 2005; Mosley et al. 2008).

Although not considered a sport fish, Burbot *Lota lota* have increased in Flaming Gorge Reservoir since their initial detection in the early 2000s with unknown effects to other sport fishes (Gardunio et al. 2011). Following completion of the dam, management was initially focused on Rainbow Trout which declined in abundance as Utah Chubs became established (Stone and Eiserman 1979). Kokanee were introduced to Flaming Gorge Reservoir in 1963 to compete with Utah Chubs (Stone and Eiserman 1979; Teuscher and Luecke 1996). Brown Trout and Smallmouth Bass were introduced in 1967 in an effort to reduce Utah Chub abundance through piscivory. Lake Trout immigrated to the reservoir in the early 1970s from an upstream reservoir and fed almost extensively on Utah Chubs (Yule 1992; Yule and Luecke 1993; Teuscher and Leucke 1996). Although kokanee were initially stocked to compete with Utah Chubs, and later stocked to serve as an additional prey resource for Lake Trout, they are also a popular sport fish (Gipson and Hubert 1993). For nearly two decades, kokanee has been the dominant fish targeted by anglers in Flaming Gorge Reservoir.

Flaming Gorge Reservoir is typically divided into three regions for management and research purposes based on bathymetric, limnological, and biological characteristics (Stone and Eiserman 1979; Haddix and Budy 2005; Mosley et al. 2008). The Canyon Region begins at the dam and extends approximately 38 km upstream (Figure 1). The Canyon Region is characterized as deep (maximum depth = 134 m), well oxygenated, and oligotrophic-mesotrophic. The Open Hills Region extends 48 km upstream of the Canyon Region and has greater widths than the Canyon Region, moderate depths (maximum depth = 61 m), extensive wind mixing from prevailing northwestern winds, and is mesotrophic-eutrophic. The Inflow Region extends upstream from the border of the Open Hills Region continuing past the confluence of the Blacks Fork and Green rivers. The Inflow Region includes approximately 20 km upstream of the confluence into the Black Forks River arm and approximately 25 km upstream of the confluence into the Green River arm. The Inflow Region has a maximum depth of 24 m, high summer temperatures (e.g., >20°C surface temperatures), high turbidity, and is considered eutrophic with frequent blue-green algae blooms during the summer months (Yule 1992; Haddix and Budy 2005).

Methods

Water sampling

Water samples were collected during June and July 2020 from the reservoir, major tributaries, known spawning tributaries, and hatcheries that produced kokanee for Flaming Gorge Reservoir. Water samples were collected at five random locations in each region of the reservoir. Samples were also taken at the inflow of major tributaries and spawning tributaries to identify variation in chemical composition where the tributaries mix with the main body of the reservoir (Figure 1; Madison and Waddell 1973). Samples were taken at the surface and using a Kemmerer bottle at depths averaging 15.7 m (Wetzel and Likens 2000). Water samples taken from tributaries included samples from near the mouth, approximately midway from the mouth to the nearest upstream barrier, and just downstream of the nearest upstream barrier. Barriers that blocked fish movement included dams (e.g., diversion dams) and natural barriers (e.g., waterfalls). The Henrys Fork River was only sampled at the mouth and at the nearest barrier due to access limitations. Tributaries were sampled at base flow during July (Kennedy et al. 2000). Unfortunately, due to the short period of time that kokanee are present in spawning tributaries, a clear chemical signature representing the tributary could not be identified (Kennedy et al. 1997). Water chemistry results from tributaries were not included in further analysis. Samples taken from hatcheries included one sample from the water source before entering the hatchery and one water sample from holding tanks where fish were reared.

Vials (50 ml polypropylene), lids, and syringes (10 ml polypropylene) used for water samples were washed using a 6-N hydrochloric acid bath for two hours, followed by three rinses with ultrapure water and a 1% trace metal grade nitric acid bath for 24 hours (Kennedy et al. 2000; Barnett-Johnson et al. 2008; Heckel et al. 2020). Vials, lids, and syringes were then rinsed three times with ultrapure water (18.20 MΩ $^+$ cm), air dried, and stored in sterile Whirl Paks (Nasco, Fort Atkinson, WI). All water samples were filtered through 25 mm diameter, 2 µm syringe filters (GE, Pittsburgh, PA). Samples were prepared for microchemistry analysis by first dissolving the sample and purifying it through a specific ion-exchange resin, Sr resin (Eichrom Technologies, Inc. Lisle, IL) in a class 100 clean lab facility. The samples were then reconstituted in ultrapure sub-boiling double-distilled 2% nitric acid and analyzed for strontium isotopes (^{87}Sr/^{86}Sr). Strontium isotopes were identified using inductively coupled plasma mass spectrometry (ICP-MS) using a Nu Plasma HR (Nu032; North Wales, UK) multiple-collection, high-resolution, double-focusing plasma mass spectrometer system at the University of California-Davis. Replicate analysis of the National Institute of Standards and Technology standard reference material (SRM-987) was used to standardize analytical equipment and estimate error (McArthur et al. 2001).

Fish sampling

Otolith collection began in the summer of 2018 and continued through 2020. Mid-water curtain nets, trawls, creel surveys, sinking gill nets, and weirs were used to sample kokanee in Flaming Gorge Reservoir and its tributaries. Mid-water curtain nets (i.e., suspended monofilament gill nets) were used to capture age-1 and older kokanee in the reservoir. Trawls were used to capture age-0 and older kokanee in the reservoir. Creel surveys were used to sample angler-harvested fish. Sinking gill nets were used to capture shoreline-spawning kokanee and weirs were used to capture tributary-spawning kokanee. During the late spring and early summer of 2020, fish were sampled from hatcheries that produce kokanee for Flaming Gorge Reservoir.

Mid-water curtain nets were 61 meters long and consisted of eight, 7.6-meter-long panels with various mesh (1.90-, 2.54-, 3.17-, 3.81-, 4.44-, 5.08-, 5.71-, or 6.35-cm bar-measure mesh). Mid-water curtain nets were set in each region of the reservoir at various depths during mid-June to mid-July. Nets were set for 15 net nights in 2018, 20 net nights in 2019, and 36 net nights in 2020. Trawl surveys were conducted by UDWR in August 2020 using a mid-water collapsible trawl in each region of the reservoir. Data from trawl surveys were not included in the analysis since they sampled few kokanee ($n < 20$). Creel surveys were conducted between mid-June and early-July. Regardless of where creel surveys occurred, fish were assigned to the region of the reservoir where they were harvested. Shoreline-spawning aggregations were targeted in each region of the reservoir with short-duration sinking gill nets in September-October (48.7-m long; 1.8-m deep; 2.54-cm bar-measure mesh). Shoreline-spawning kokanee were not sampled in the Canyon Region in 2019 due to a missed spawning event. Tributary-spawning kokanee were captured with weirs in the Henrys Fork River and Sheep Creek in late-September and mid-October. Fish were sampled from weirs after gametes were collected by WGFD hatchery personnel. Tributary-spawning kokanee were not sampled from the Henrys Fork River in 2020. Fish were collected from each hatchery prior to stocking events in the spring and early summer of

2020. Not all hatcheries were producing kokanee when fish were being sampled for microchemistry analysis. As such, Rainbow Trout were used as surrogates (e.g., Boulder, Clark's Fork, Saratoga, Wigwam Hatcheries).

Kokanee were measured to the nearest millimeter (mid-eye-to-fork length [MEF]) and sagittal otoliths were removed. Otoliths were placed in a coin envelope and allowed to air dry. Otoliths were prepared at the University of Idaho and isotopic analysis was conducted at the University of California-Davis Interdisciplinary Center for Plasma Mass Spectrometry.

Otolith processing

Stratified random sampling was used to select up to five fish per 10-mm length category per region of the reservoir per sampling method. One otolith per fish was mounted sulcus acusticus side down on a microscope slide using Crystalbond 509-3 (Aremco, Valley Cottage, NY). A Buehler MetaServ 250 (Buehler, Lake Bluff, IL) grinder-polisher with 600-1,200 grit sandpaper and ultrapure water was used to sand otoliths (Thorrold et al. 1998; Hobbs et al. 2010; Chase et al. 2015; Heckel et al. 2020). Otoliths were sanded until the distal side of the otolith was flat. The otolith was then flipped over (i.e., sulcus acusticus side up) and sanded until the primordium and daily growth rings were clearly visible using a compound microscope. Multiple otoliths were mounted for isotopic analysis on petrographic slides using Crystalbond for laser ablation multi-collector ICP-MS (LA-MC-ICP-MS; Barnett-Johnson et al. 2008).

Otoliths were analyzed using LA-MC-ICP-MS at the University of California-Davis using a New Wave Research UP213 (New Wave Research, Fremont, CA) laser ablation system coupled with a NU Plasma multiple collection, high resolution, double focusing plasma mass spectrometer. The strontium isotope ratio (i.e., $^{87}Sr/^{86}Sr$) was measured using line scans starting approximately 100 µm on the dorsal side of the primordium and traveling through the primordium to the ventral edge. Settings for the line scans included a scanning speed of 5 µm/s, beam width of 40 µm, laser pulse frequency of 10 Hz, and 50-65% laser power. Values for the $^{87}Sr/^{86}Sr$ isotopic ratio were normalized for instrumental mass discrimination by monitoring the $^{86}Sr/^{88}Sr$ isotope ratio (assumed $^{86}Sr/^{88}Sr = 0.1194$). The interference of rubidium (^{87}Rb) on $^{87}Sr/^{86}Sr$ isotope ratio was corrected by monitoring the ^{85}Rb signal. Instrumental accuracy and precision were evaluated by analyzing a White Seabass *Atractoscion nobilis* otolith (i.e., SRM-987; mean $^{87}Sr/^{86}Sr = 0.70918$, SD = 0.0002 *n* = 436) and South China Sea Coral (mean $^{87}Sr/^{86}Sr = 0.70927$, SD = 0.0003 *n* = 134) compared to the modern seawater value of $^{87}Sr/^{86}Sr$ (0.70918; McArthur et al. 2001).

Krypton is an ever-present spectral interference when measuring strontium isotope values because of their similar atomic mass (Paton et al. 2007). Krypton interference is common due to contaminants in the carrier gas and impurities of argon which is used to generate the plasma for LA-MC-ICP-MS (Paton et al. 2007; Yang et al. 2012). Due to the omnipresence of krypton, internal corrections based on background measurements of different atomic masses prior to the laser firing are necessary when using LA-MC-ICP-MS. The background measurements are used to subtract interference of krypton through elimination until the mass of $^{84}Sr/^{88}Sr$ is equal to the assumed ratio of 0.00675 (Yang et al. 2012), while still iterating for the mass bias correction from $^{86}Sr/^{88}Sr$. This process removes considerable interference of mass 86 since the $^{86}Kr/^{84}Kr$ ratio is ~ 0.30 while the $^{86}Sr/^{84}Sr$ ratio is ~ 17.70. Mass 84 may still be an issue due to other factors such as calcium dimers and is typically ignored when analyzing for $^{87}Sr/^{86}Sr$ (Paton et al. 2007). When background krypton is not stable during the initial baseline measurements, it can cause over subtraction of krypton altering the $^{87}Sr/^{86}Sr$ value. In addition, when krypton transmission changes during the ablation of the unknown sample, this drift can also affect krypton corrections and the resulting $^{87}Sr/^{86}Sr$ value. Microchemistry analysis of kokanee otoliths occurred over two separate trips to the University of California-Davis. During the first trip, no issues associated with krypton interference were detected. However, interference of krypton was an issue during the second trip. These issues stemmed from the specialty gas distributor altering their main source of argon (due to Covid-19) leading to five-to ten-fold the amount of krypton in the argon supply. To reduce the krypton interference, a scrubbed high-purity argon cylinder was plumbed into the sample carrier gas reducing the interference to two-fold the normal amount. In addition, a linear model was constructed using the ^{83}Kr and $^{87}Sr/^{86}Sr$ values from the otolith edge to externally correct the issues associated with elevated krypton interference during the second trip.

After microchemistry analysis, the remaining otolith was used for ageing. Otoliths were mounted in epoxy (Koch and Quist 2007) and sectioned with an IsoMet Low Speed Saw (Buehler, Lake Bluff, IL) along the dorsoventral plane (Long and Grabowski 2017). Sections were polished to improve clarity using 400-1,000 grit sandpaper. Sections were aged using a dissecting microscope with transmitted light. Distance between annuli was measured with Image-Pro Plus software (Media Cybernetics, Rockville, MD) using standard methodologies for annulus identification (Quist et al. 2012; Long and Grabowski 2017).

Data analysis

Data from LA-MC-ICP-MS were reduced and analyzed using the IsoFishR application in R Statistical Software (Willmes et al. 2018; R Core Development Team 2020). Data were reduced at an integration time of 5 s, blank time of 30 s, minimum ^{88}Sr set to 0.05 V, and maximum ^{88}S set to 9.8 V. Line scans were smoothed for visual inspection using a ten-point moving average and outliers >2 SD were removed (Chase et al. 2015). Data were further analyzed by manually selecting a sample adjacent to the primordium to represent the natal region and a sample near the edge of the otolith to represent the signature of Flaming Gorge Reservoir (Barnett-Johnson et al. 2008; Brennan et al. 2015). Plots of smoothed data were used to visually inspect each otolith and identify shifts in isotopic ratios that reflected natal origin. Fish were initially classified as natural origin if no isotopic shift was evident through visual inspection of the line scan (Chase et al. 2015). When an isotopic shift was evident, fish were classified as hatchery origin. Summary statistics (i.e., mean, standard deviation) of ^{87}Sr/^{86}Sr were calculated for each manually selected region (Willmes et al. 2018).

Normality tests were conducted to assess the normality of the ^{87}Sr/^{86}Sr from water samples and otoliths. Assumptions of normality were violated so Kruskal-Wallis and post-hoc pairwise comparison tests (Dunn test; $\alpha = 0.05$) were conducted to compare the ^{87}Sr/^{86}Sr of water samples among regions and depths of Flaming Gorge Reservoir (Heckle et al. 2020). Linear regression was conducted to evaluate the relationship between the ^{87}Sr/^{86}Sr of water samples and ratios derived from the edge of otoliths (Bath et al. 2000; Kennedy et al. 2000; Barnett-Johnson et al. 2008; Muhlfeld et al. 2012; Heckel et al. 2020). Kruskal-Wallis and post-hoc pairwise comparisons tests (Wilcoxon ranked-sum tests; $\alpha = 0.05$) were conducted to compare the $^{87}Sr/^{86}Sr$ from the otolith edge among hatcheries and Flaming Gorge Reservoir (Young 2011; Cuevas et al. 2019). The Benjamini-Hochberg adjustment was used to adjust the type I error rate for all multiple comparisons (Benjamini and Hochberg 1995).

The relationship of $^{87}Sr/^{86}Sr$ signatures from water samples and otolith edge values were correlated but did not follow a 1:1 ratio ($r^2 = 0.78$; Figure 2). As such, otolith edge values were used to develop the training data sets for the model-based discriminate function analysis (DFA). The {Mclust} package in R (Fraley and Raftery 2002; Scrucca et al. 2016) was used to conduct a DFA. The DFA was used to evaluate whether $^{87}Sr/^{86}Sr$ values from hatchery otoliths and Flaming Gorge Reservoir could be used to infer natal origin of unknown kokanee caught in Flaming Gorge Reservoir. Values of $^{87}Sr/^{86}Sr$ were averaged from a 200 µm section of the otolith edge from known hatchery-origin fish ($n = 60$) and randomly selected kokanee from Flaming Gorge Reservoir ($n = 20$). These fish were used in the training data set. Discriminant function models were further tested using K-folds cross validation to investigate classification accuracy (Fraley and Raftery 2002; Scrucca et al. 2016).

Results from the DFA were used to describe growth of kokanee by natal origin. Growth of natural and hatchery-produced fish was described using mean back-calculated lengths at age (mm). Back-calculated lengths at age were estimated using the Dahl-Lea method:

$$L_i = L_c(S_i/S_c)$$

where L_i is the back-calculated length of the fish when ith increment was formed, L_c is the length of the fish at capture, S_i is the radius of the otolith at the ith increment, and S_c is the radius of the otolith at capture (Shoup and Michaletz 2017).

Results

The number of kokanee stocked in Flaming Gorge Reservoir averaged 1,603,095 (± SD; ± 288,899) annually from 2013-2020 (Table 1). Total length of stocked kokanee varied from 39 to 96 mm (74 ± 11 mm). In total, 2,677 kokanee (*n* = 831 for microchemistry analysis) varying from 146 to 510 mm MEF (366 ± 54 mm) were caught in the reservoir (Table 2). In spawning tributaries (i.e., Henrys Fork River, Sheep Creek), 446 kokanee (*n* = 172 for microchemistry) were caught and varied from 280 to 482 mm MEF (371 ± 35 mm).

Strontium isotope (i.e., $^{87}Sr/^{86}Sr$) signatures of water samples from Flaming Gorge Reservoir varied significantly among regions and by depth (Figure 3; $P \leq 0.01$). Post-hoc comparisons identified that the water chemistry from the Canyon Region at depth was significantly different from the Inflow Region surface sample ($P \leq 0.01$), Open Hills Region surface sample ($P \leq 0.01$), and Open Hills Region at depth ($P \leq 0.01$). No significant differences were identified for all other comparisons of water samples among depths and regions. Otolith edge values from hatcheries and Flaming Gorge Reservoir (*n* = 65) varied significantly ($X^2 = 58.3$, df = 12, $P \leq 0.01$; Figure 4). Flaming Gorge Reservoir was not significantly different from Wigwam Hatchery ($P = 0.84$) but was significantly different from all other hatcheries ($P \leq 0.01$).

Hatcheries were grouped as either having an $^{87}Sr/^{86}Sr$ signature that was significantly ($P \leq 0.01$) higher (i.e., Boulder, Clark Fork, Dan Speas hatcheries; hereafter presented as “over”) or lower (i.e., Daniel, Dubois, Jones Holes, Midway, Tillet, Saratoga, Whiterocks hatcheries; hereafter presented as “under”) than Flaming Gorge Reservoir. Auburn Hatchery had a uniquely low $^{87}Sr/^{86}Sr$ signature and was classified separately. The Wigwam Hatchery was grouped with Flaming Gorge Reservoir as “natural” origin given the lack of difference in

^{87}Sr/^{86}Sr. Regions of Flaming Gorge Reservoir were combined and classified as natural origin to reduce classification error.

Similarities in ^{87}Sr/^{86}Sr from kokanee in Flaming Gorge Reservoir and the Wigwam Hatchery added complexity. However, kokanee from the Wigwam Hatchery were only stocked in Flaming Gorge Reservoir in 2016 and 2018 representing 13% of the total kokanee stocked in 2016 and 10% in 2018 (Table 1). A DFA was conducted that included the Wigwam Hatchery in the training data set, as well as a second DFA that excluded the Wigwam Hatchery. Specifically, kokanee from the 2016 and 2018 year classes were completely removed from the analysis of the second DFA. The training data set that included fish from Wigwam Hatchery correctly classified the natal origin of kokanee with 95% accuracy or greater. Fish from the Auburn and over groups were classified with 100% accuracy while the under and natural groups were classified with 95% accuracy. Cross validation of the training data that included Wigwam Hatchery identified a 5% classification error. The training data set that excluded the Wigwam Hatchery correctly classified natal origin of kokanee with 97% accuracy or greater. The Auburn and over groups were classified with 100% accuracy. Fish representing the under and natural groups were classified with 97% accuracy. When cross validated, a 5% error was identified from the training dataset that excluded Wigwam Hatchery.

Using the DFA that included fish from Wigwam Hatchery, 1,003 kokanee were assigned a natal origin. Kokanee from 2013 to 2019 year classes were represented in the sample, but the 2013 and 2019 year classes had low sample sizes (*n* < 15) and were removed from further analyses. The contribution of hatchery kokanee varied from 14 to 56% across year classes and was similar regardless of whether fish from Wigwam Hatchery were included in the analysis (Figure 5). The highest percent of natural-origin kokanee was observed in 2014 and 2017 where they made up over 60% of fish in the system. The contributions of different hatchery groups also varied among years. Auburn fish often composed greater than 50% of the hatchery contributions to the population at large. Hatchery kokanee in the reservoir varied from 21 to 50% of the sample and was similar to what was observed in the creel (18 to 50%; Figure 6). Notably, natal contributions to the population and creel were similar (differed < 5%) using the alternative DFA that excluded Wigwam Hatchery.

Natal composition of shoreline-spawning (*n* = 239) and tributary-spawning (*n* = 172) aggregates were summarized by sample year (Figure 7). Using the DFA that included Wigwam Hatchery, hatchery contributions to shoreline-spawning aggregates varied from 19 to 58%. Tributary-spawning aggregates had higher contributions of hatchery-produced kokanee (40 to 90%) than those on the shoreline. The Auburn and under hatchery groups were present in both spawning aggregations across all sample years, making up over 75% of the hatchery contributions each year. Tributary-spawning aggregates were primarily composed of hatchery-origin fish, except in 2020 when a high percentage of natural-origin fish were observed. The alternate DFA produced slightly different percentages of natal contributions (differences of 0 to 26%), but overall trends were similar (Figure 7).

Patterns in the percentage of fish that were stocked relative to the percentage in the population was variable through time (Figure 8). Initially, “under” hatcheries tended to have fewer fish in the population than would be expected based on what was stocked. The opposite pattern was observed for the Auburn Hatchery where stocked kokanee appeared to compose a larger portion of the population than would be expected. Contributions of the “over” hatcheries observed in the population were similar to what was stocked for all year classes.

Kokanee sampled from Flaming Gorge Reservoir varied in age from 1 to 6 years, whereas kokanee sampled from spawning aggregates (i.e., shoreline and tributary) varied from 2 to 4 years. Over 90% of natural origin kokanee (92%) and 87% of hatchery kokanee were age 3 and 4 (Table 3). Few fish (*n* = 13) were age 5 or older, only one of which was estimated to originate from a hatchery. Older fish were represented by earlier year classes (i.e., 2014, 2015, 2016) while younger fish were typically represented by more recent year class (i.e., 2017, 2018; Figure 9). Kokanee in Flaming Gorge Reservoir exhibited fast growth, reaching 300 mm by age 3 (Table 3). Hatchery-produced kokanee were slightly larger on average than natural origin fish, but differences of the mean back-calculated length-at-age were generally less than 15 mm.

Discussion

Previous studies have used otolith microchemistry to identify life history variation and natal origin of anadromous (Kennedy et al. 2000, 2002; Barnett-Johnson et al. 2008; Brennan et al. 2015) and freshwater fishes (Muhlfeld et al. 2012; Heckel et al. 2020). In contrast, few studies have used otolith microchemistry to identify the contributions of natural and hatchery-produced fishes in a freshwater system (also see Marklevitz et al. 2016). Identifying contributions of hatchery-produced kokanee to Flaming Gorge Reservoir is of particular importance in Wyoming since most of the state’s production is allocated to the reservoir. This study identified that hatchery-produced kokanee contribute to all aspects of the population in Flaming Gorge Reservoir. Understanding natal contributions in the reservoir provides insight that fisheries managers can use to guide management decisions and future investigations on kokanee recruitment in the system.

A variety of biotic and abiotic factors have been shown to influence natural recruitment and stocking success of kokanee (Vinyard et al. 1982; Sissenwine 1984; Fielder 1992; Paragamian and Bowles 1995; Modde et al 1997; Weber and Faush 2003). For example, Paragamian and Bowles (1995) documented that stocking success of kokanee was linked to later stocking dates (e.g., June-August) in Lake Pend Oreille, Idaho. Prey diversity and abundance was higher later in the year which allowed hatchery-produced kokanee to successfully transition to wild prey items (Rieman and Falter 1981; Vinyard et al. 1982; Paragamian and Bowles 1995). Martinez and Wiltzuis (1995) found that water temperature influenced kokanee recruitment in Lake Granby, Colorado. Specifically, warmer water temperatures were associated with increased growth and survival of stocked kokanee. Unfortunately, many factors that may explain recruitment variability and stocking success were not available for Flaming Gorge Reservoir. As such, enhanced monitoring of factors that potentially influence recruitment and stocking success will be necessary to better understand variability in stocking success and recruitment in the system. Understanding factors such as prey availability and water temperature, among others, that influence fluctuations in recruitment may lead to alternative stocking strategies that further increase stocking success.

In a dual-purpose system, the return of hatchery kokanee to the creel is of utmost importance. Vulnerability of kokanee to angling is likely due to a variety of factors, particularly behavioral characteristics associated with feeding (Bryan and Larkin 1972; Miranda and Dorr 2000). For example, Dwyer and Piper (1984) identified that domesticated strains of Rainbow Trout had increased aggression, grew faster, and experienced higher exploitation than slower-growing wild strains in Three Forks Ponds, Montana. Similarly, Nuhfer and Alexander (1994) identified that Brook Trout *Salvelinus fontinalis* populations in Montmorency County, Michigan, with fast-growing, large individuals were more vulnerable to angling compared to populations with slow growth. Additionally, environmental factors (e.g., water temperature, light levels) have been identified to affect vulnerability to angling due to changes in fish behavior (Stoner 2004; Watz and Piccolo 2011). In Flaming Gorge Reservoir, the natal composition of the creel was similar to what was observed in the population at large. Growth was similar between natural and hatchery-produced kokanee in the reservoir suggesting that they occupy similar habitats simultaneously and are equally vulnerable to anglers.

In addition to identifying that hatchery resources return to the recreational creel, understanding their role as a prey resource is useful when used to serve a dual purpose (Wydoski and Bennett 1981). Declines of kokanee abundance have been documented in many systems where Lake Trout have been introduced due to increased predation (Martinez and Wiltzius 1995; Hansen et al. 2010; Schoen et al. 2012; Pate et al. 2014). For example, Schoen et al. (2012) identified that declines of kokanee abundance in Lake Chelan, Washington, was a result of increased Lake Trout predation. Similarly, Lake Trout predation significantly reduced kokanee abundance in Lake Pend Oreille (Hansen et al. 2010). Systems that have attributed kokanee declines to increased Lake Trout predation also have introduced *Mysis relicta* (hereafter mysis; Hansen et al 2010; Schoen et al. 2012; Corsi et al. 2019). Although mysis may positively influence kokanee growth (Lasenby et al. 1986), mysis also removes a recruitment bottleneck for Lake Trout (Stafford et al. 2002). Dissimilar to systems that have displayed declines in kokanee, mysis are not present in Flaming Gorge Reservoir. Previous research has identified that Lake Trout prey upon kokanee in Flaming Gorge Reservoir although piscivory is typically limited to Lake Trout greater than 600 mm (Yule and Luecke 1993). In addition, Yule and Luecke (1993) suggested that juvenile Lake Trout in the reservoir have limited access to small forage fish due to minimal spatial and temporal overlap. Though vulnerability to anglers may be similar between natal origins, the effects of Lake Trout predation on kokanee origins are still unknown in Flaming Gorge Reservoir. Although it was not a focus of this research, distinguishing predation rates between natal origins can be used to guide stocking strategies that balance predation rates and returns to the recreational creel. Future investigations focused on predation rates may be warranted if kokanee or Lake Trout abundance changes in the reservoir.

Understanding the natal composition of spawning aggregates can help guide stocking strategies that lead to a heterogenous population that is resilient to environmental changes (Burger et al. 2000; Carlson et al. 2016). In systems that use hatchery resources, the natal composition of spawning aggregates (i.e., shoreline, tributary) may be related to stocking strategies that influence homing ability and straying (Wagner 1969; Quinn 1993). For example, Wagner (1969) identified that steelhead *Oncorhynchus mykiss* smolts are more likely to return to the section of the river they were stocked than to other sections. In contrast, Quinn (1993) suggested that hatchery-produced fish stray more frequently than natural-origin fish, possibly due to variability in the endocrinological state of hatchery fish at the time of stocking. A variety of additional mechanisms (e.g., interrupted juvenile imprinting, adult sensory failure) may potentially influence straying of hatchery fish that ultimately affects natal composition of spawning aggregates (Keefer and Caudill 2014). In

Odell Lake, Oregon, Averett and Espinosa (1968) used marked fish and identified that shoreline-spawning aggregates of kokanee consisted of mostly natural-origin fish whereas tributary-spawning aggregates were predominately hatchery fish. In addition, movement of hatchery fish along the shoreline prior to spawning suggested that kokanee were searching for suitable spawning locations due to the lack of natal sites in the lake (Averett and Espinosa 1968). In contrast, natural-origin kokanee in Kootenay Lake, British Columbia, returning to natal streams displayed low straying rates (less than 3%) among spawning locations (Vernon 1957). In Flaming Gorge Reservoir, shoreline-spawning aggregates contained higher percentages of natural fish, whereas tributary-spawning aggregates were dominated by hatchery kokanee in most years. In 2020, the reduced contributions of hatchery kokanee compared to previous years may be due to the weak year class of hatchery fish in 2017. Although the different spawning aggregates were typically dominated by either natural or hatchery-origin, kokanee from both natal origins were present in both spawning aggregates across all sample years. Identifying mechanisms to explain the observed natal contributions to spawning aggregates becomes challenging due to data constraints as well as limited information of spawning aggregates in Flaming Gorge Reservoir. Hatcheries could not be distinguished from one another using otolith microchemistry due to similar strontium isotope ratios. In addition, it is currently unknown if recruitment success of natural-origin kokanee results from shoreline or tributary-spawning aggregates. Straying rates of kokanee in the system are unknown but may provide possible explanations of the natal composition to spawning aggregates. Identifying how stocking strategies influence natal origin composition and success of various spawning aggregates would be advantageous in ensuring a genetically diverse broodstock, as well as identifying areas that may need protection or enhancement to promote spawning success. The use of traditional methods (e.g., marking, tagging) or new developing methods (e.g., parentage-based tagging) to evaluate stocking strategies may be necessary if concerns related to spawning aggregations arise.

Growth of wild and hatchery fishes is highly variable across species and systems (Dwyer and Piper 1984; Hoffman and Bettoli 2005; Meyer et al. 2012; Zorn 2015). For instance, Hoffman and Bettoli (2005) recognized that hatchery-origin Largemouth Bass *Micropterus salmoides* grew faster than wild fish in Chickamauga Lake, Tennessee. In contrast, Zorn (2015) identified no difference in growth between natural and hatchery-origin Walleye *Sander vitreus* in Lake Michigan. Observed differences (or similarities) of growth between natural and hatchery-produced fish may be influenced by behaviors that are learned and(or) artificially selected for in the hatchery system (Dwyer and Piper 1984; Metcalfe et al. 2003). For instance, Metcalfe et al. (2003) identified that strains of domesticated Atlantic Salmon *Salmo salar* reared in a hatchery exhibited more aggressive behaviors than wild salmon. Peery and Bjornn (2004) reported similar results of aggressive behavior between natural and hatchery Chinook Salmon *Oncorhynchus tshawytscha* in experimental flumes at the Hayden Research Station, Lemhi, Idaho. Hatchery-produced fish may also perform differently based on the characteristics of receiving waters such as available prey and water temperature (Martinez and Wiltzuis 1995; Paragamian and Bowles 1995). Although factors influencing growth were not evaluated, the current study identified that growth of natural and hatchery-produced kokanee was similar in Flaming Gorge Reservoir. Kokanee in Flaming Gorge Reservoir are reared from broodstock captured in natural systems and stocked as fingerlings. The source of broodstock coupled with a limited time in the hatchery, may contribute to similarities in growth between natural and hatchery-produced kokanee in the system. In addition to similar growth between natural and hatchery-origin kokanee, it is worth noting that kokanee grew relatively fast in Flaming Gorge Reservoir compared to kokanee in other systems (Markevich 2008; Branigan et al. 2019). Markevich (2008) reported the fork-length of age-3 kokanee captured from Kronotskoe Lake, Russia, averaged about 190 mm. Additionally, age-3 kokanee sampled from Lake Pend Oreille and Mirror Lake, Idaho displayed total lengths less than 300 mm (Branigan et al. 2019). For comparison, natural and hatchery-origin kokanee in Flaming Gorge Reservoir were greater than 300 mm MEF at age-3. The fast growth of kokanee observed in Flaming Gorge Reservoir suggests biotic and abiotic conditions that promote fast growth are available to kokanee regardless of natal origin. Similarly, the fast growth observed for both natal origins may diminish any advantages one natal origin may have over another. Investigations identifying conditions in the hatchery and(or) factors of Flaming Gorge Reservoir that influence growth may be necessary if changes in growth of kokanee are observed.

This study provided valuable information regarding the contributions of natal origin to multiple aspects of the kokanee fishery in Flaming Gorge Reservoir. Hatchery-produced kokanee contributed to the population at large, the creel, and spawning aggregations. Although factors related to stocking success and recruitment of wild fish were not addressed in this study, my results can be used to guide management of kokanee in the future. Further investigations focused on factors contributing to stocking success (e.g., predation, prey density) would be particularly useful. Although this research was focused on Flaming Gorge Reservoir, my results contribute broadly to our understanding of the ecology of kokanee in reservoir systems.

References

Averett, R. C., and F. A. Espinosa. 1968. Site selection and time of spawning by two groups of kokanee in Odell Lake, Oregon. The Journal of Wildlife Management 32:76-81.

Barnett-Johnson, R., T. E. Pearson, F. C. Ramos, C. B. Grimes, and R. B. McFarlane. 2008. Tracking natal origins of salmon using isotopes, otoliths, and landscape geology. Limnology and Oceanography 53:1633–1642.

Bath, G. E., S. R. Thorrold, C. M. Jones, S. E. Campana, J. W. McLaren, and J. W. H. Lam. 2000. Strontium and barium uptake in aragonite otoliths of marine fish. Geochemica et Cosmochimica Acta 64:1705–1714.

Benjamini, Y., and Y. Hochberg. 1995. Controlling the false discovery rate: a practical and powerful approach to multiple testing. Journal of the Royal Statistical Society, Series B (Methodological) 57:289–300.

Brennan, S. R., C. E. Zimmerman, D. P. Fernandez, T. E. Cerling, M. V. McPhee, and M. J. Wooler. 2015. Strontium isotopes delineate fine-scale natal origin and migration histories of Pacific salmon. Science Advances [online serial] 1 (4): e1400124. DOI: 10.1126/sciadv.1400124.

Brown, R. J., and K. P. Severin. 2009. Otolith chemistry analyses indicate that water Sr:Ca is the primary factor influencing otolith Sr:Ca for freshwater and diadromous fish but not for marine fish. Canadian Journal of Fisheries and Aquatic Science 66:1790–1808.

Burger, C. V., K. T. Scribner, W. J. Spearman, C. O. Swanton, and D. E. Campton. 2000. Genetic contributions of three introduced life history forms of Sockeye Salmon to colonization of Frazer Lake, Alaska. Canadian Journal of Fisheries and Aquatic Sciences 57:2096-2111.

Branigan, P. R., K. A. Meyer, N. C. Wahl, M. P. Corsi, and A. M. Dux. Accuracy and precision of age estimates obtained from three calcified structures of known-age kokanee. North American Journal of Fisheries Management 39:498-508.

Bryan, J. E., and P. A. Larkin. 1972. Food specialization by individual trout. Journal of the Fisheries Board of Canada 29:1615-1624.

Carlson, A. K., M. J. Fincel, and D. S. Graeb. 2016. Otolith microchemistry reveals natal origins of Walleyes in Missouri River reservoirs. North American Journal of Fisheries Management 36:341-350.

Campana, S. E. 1999. Chemistry and composition of fish otoliths: pathways, mechanisms and application. Marine Ecology Progress Series 188:263–297.

Campana, S. E., and S. R. Thorrold. 2001. Otoliths, increments, and elements: keys to a comprehensive understanding of fish populations? Canadian Journal of Fisheries and Aquatic Science 58:30–38.

Chase, N. M., C. A Caldwell, S. A. Carleton, W. R. Gould, and J. A. Hobbs. 2015. Movement patterns and dispersal potential of Pecos Bluntnose Shiner (*Notropis simus pecosensis*) revealed using otolith microchemistry. Canadian Journal of Fisheries and Aquatic Science 72:1575–1583.

Corsi, M. P., M. J. Hanse, M. C. Quist, D. J. Schill, and A. M. Dux. 2019. Influences of Lake Trout (*Salvelinus namaycush*) and *Mysis diluviana* on kokanee (*Oncorhynchus nerka*) in Lake Pend Oreille, Idaho. Hydrobiologia 840:351-362.

Cuevas, M. J., K. Górski, L. R. Castro, A. Vivancos, and M. Reid. 2019. Otolith elemental composition reveals separate spawning areas of Anchoveta, *Engraulis ringens*, off central Chile and northern Patagonia. Scientia Marina 84:317–326.

Dehler, C. M., C. M. Fanning, P. K. Link, E. M. Kingsbury, and D. Rybczynski. 2010. Maximum depositional age and provenance of the Uinta Mountain group and Big Cottonwood formation, northern Utah: Paleogeography of rifting western Laurentia. Geological Society of America Bulletin 122:1686–1699.

Dwyer, W. P., and R. G. Piper. 1984. Three-year hatchery and field evaluation of four strains of Rainbow Trout. North American Journal of Fisheries Management 4:216-221.

Fiedler, D. G. 1992. Evaluation of stocking Walleye fry and fingerlings and factors affecting their success on Lower Lake Oahe, South Dakota. North American Journal of Fisheries Management 12:336-345.

Fisher, R. S., and A. M. Stueber. 1976. Strontium isotopes in selected streams within the Susquehanna River basin. Water Resources Research 12:1061–1068.

Fraley, C., and A. E. Raftery. 2002. Model-based clustering, discriminant analysis, and estimation. Journal of the American Statistical Association 97:611–631.

Gardunio, E. I., C. A. Myrick, R. A. Ridenour, R. M. Keith, and C. J. Amadio. 2011. Invasion of illegal introduced Burbot in the upper Colorado River Basin, USA. Journal of Applied Ichthyology 27:36–42.

Gipson, R. D., and W. A. Hubert. 1993. Spawning-site selection by kokanee along the shoreline of Flaming Gorge Reservoir, Wyoming-Utah. North American Journal of Fisheries Management 13:475–482.

Gray, S. T., J. J. Lukas, and C. A. Woodhouse. 2011. Millennial-length records of streamflow from three major upper Colorado River tributaries. Journal of the American Water Resources Association 47:702–712.

Haddix, T., and P. Budy. 2005. Factors that limit growth and abundance of Rainbow Trout across ecological distinct areas of Flaming Gorge Reservoir, Utah-Wyoming. North American Journal of Fisheries Management 25:1082–1094.

Hansen, M. J., D. Schill, J. Fredricks, and A. Dux. 2010. Salmonid predator-prey dynamics in Lake Pend Oreille, Idaho, USA. Hydrobiologia 650:85-100.

Heckel. J. W., IV, M. C. Quist, C. J. Watkins, and A. M. Dux. 2020. Life history structure of Westslope Cutthroat Trout: inferences from otolith microchemistry. Fisheries Research 222.

Hegg, J. C., B. P. Kennedy, P. M. Chittaro, and R. W. Zable. 2013. Spatial structuring of an evolving life-history strategy under altered environmental conditions. Oecologia 172:1017–1029.

Hobbs, J. A., L. S. Lewis, N. Ikemiyagi, T. Sommer, and R. D. Baxter. 2010. The use of otolith strontium isotopes ($^{87}Sr/^{86}Sr$) to identify nursery habitat for a threatened estuarine fish. Environmental Biology of Fishes 89:557–569.

Hoffman, K. J., and P. W. Bettoli. 2005. Dispersal, mortality and contributions of Largemouth Bass stocked into Chichamauga Lake, Tennessee. North American Journal of Fisheries Management 25:1518-1527.

Jeric, R. J. 1996. Physical factors influencing survival to emergence and time of emergence of shoreslope-spawned kokanee salmon in Flaming Gorge Reservoir, Utah-Wyoming. Master’s thesis. Utah State University, Logan, Utah.

Johnson, B. M., and P. J. Martinez. 2000. Trophic economics of Lake Trout management in reservoirs of differing productivity. North American Journal of Fisheries Management 20:127–143.

Keefer, M. L., and C. C. Caudill. 2014. Homing and straying by anadromous salmonids: a review of mechanisms and rates. Reviews in Fish Biology and Fisheries 24:333-368.

Kennedy, B. P., C. L. Folt, J. D. Blum, and C. P. Chamberlain. 1997. Natural isotope markers in salmon. Nature 387:766–767.

Kennedy, B. P., J. D. Blum, C. L. Folt, and K. H. Nislow. 2000. Using natural strontium isotopic signatures as fish markers: methodology and application. Canadian Journal of Fisheries and Aquatic Science 57:2280–2292.

Kennedy, B. P., A. Klaue, J. D. Blum, C. L. Folt, and K. H. Nislow. 2002. Reconstructing the lives of fish using Sr isotopes in otoliths. Canadian Journal of Fisheries and Aquatic Science 59:925–929.

Koch, J. D., and M. C. Quist. 2007. A technique for preparing fin rays and spines for age and growth analysis. North American Journal of Fisheries Management 27:782–784.

Lasenby, D. C., T. G. Northcote, and M. Fürst. 1986. Theory, practice, and effects of Mysis relicta introductions to North American and Scandinavian lakes. Canadian Journal of Fisheries and Aquatic Sciences 43:1277-1284.

Long, J. M., and T. B. Grabowski. 2017. Otoliths. Pages 189-219 *in* M. C. Quist, and D. A. Isermann, editors. Age and growth of fishes: principles and techniques. American Fisheries Society, Bethesda, Maryland.

Madison, R. J., and K. M. Waddell. 1973. Chemical quality of surface water in the Flaming Gorge Reservoir area, Wyoming and Utah. U.S. Geological Survey Water-Supply Paper 2009–C, Washington D.C., USA.

Markevich, G. N. 2008. Age structure and growth of resident kokanee *Oncorchynchus nerka* of natural and introduced populations in lakes of Kamchatka. Journal of Ichthyology 48:452-459.

Marklevitz, S. A. C., B. J. Fryer, J. Johnson, D. Gonder, and Y. E. Morbey. 2016. Otolith microchemistry reveals spatio-temporal heterogeneity of natal sources and inter-basin migrations of Chinook Salmon in Lake Huron. Journal of Great Lakes research 42:668–677.

Martinez, P. J., and W. J. Wiltzius. 1995. Some factors affecting a hatchery-sustained kokanee population in a fluctuating Colorado reservoir. North American Journal of Fisheries Management 15:220–228.

Martinez, P. J., P. E. Bigelow, M. A. Deleray, W. A. Fredenberg, B. S. Hansen, N. J. Horner, S. K. Lehr, R. W. Schneidervin, S. A. Tolentino, and A. E. Viola. 2009. Western Lake Trout woes. Fisheries 34:424–442.

McArthur, J. M., R. J. Howarth, and T. R. Bailey. 2001. Strontium isotope stratigraphy: LOWESS Version 3: best fit to the marine Sr-istotope curve for 0-509 MA and accompanying look-up table for deriving numerical age. Journal of Geology 109:155–170.

Metcalfe, N. B., S. K. Valdimarsson, and I. J. Morgan. 2003. The relative roles of domestication, rearing environment, prior residence and body size in deciding territorial contests between hatchery and wild juvenile salmon. Journal of Applied Ecology 40:535-544.

Meyer, K. A., B. High, and F. S. Elle. 2012. Effects of stocking catchable-sized hatchery Rainbow Trout on wild Rainbow Trout abundance, survival, growth, and recruitment. Transactions of the American Fisheries Society 141:224-237.

Miranda, L. E., and B. S. Dorr. 2000. Size selectivity of crappie angling. North American Journal of Fisheries Management 20:706-710.

Modde, T., R. J. Jeric, W. A. Hubert, and R. D. Gipson. 1997. Estimating the impacts of reservoir elevation changes on kokanee emergence in Flaming Gorge Reservoir, Wyoming-Utah. North American Journal of Fisheries Management 17:470–473.

Mosley, R., L. Marthe, and R. Schneidervin. 2008. Abundance, distribution, and size structure of pelagic kokanee salmon on Flaming Gorge Reservoir in 2008, Utah-Wyoming. Utah Department of Natural Resources, Division of Wildlife Resources, Salt Lake City.

Muhlfeld C. C., S. R. Thorrold, T. E. Mchon, and B. Martoz. 2012. Estimating Westslope Cutthroat Trout (*Oncorhynchus clarkia lewisi*) movements in a river network using strontium iscoscapes. Canadian Journal of Fisheries and Aquatic Sciences 69:906–915.

Nelson, J. S. 1968. Distribution and nomenclature of North America kokanee, *Oncorhynchus nerka*. Journal Fisheries Research Board of Canada 25:409–414.

Nuhfer, A. J., and G. R. Alexander. 1994. Growth, survival, and vulnerability to angling of three wild Brook Trout strains exposed to different angler exploitation. North American Journal of Fisheries Management 14:423-434.

Pate, W. M., B. M. Johnson, J. M. Lepak, D. Braunch. 2014. Managing for coexistence of kokanee and trophy Lake Trout in a montane reservoir. North American Journal of Fisheries Management 34: 908-922.

Paragamian, V. L., E. C. Bowles, and B. Hoelscher. 1992. Use of daily growth increments on otoliths to assess stocking of hatchery-reared kokanees. Transactions of the American Fisheries Society 121:785–791.

Paragamian, V. L., and E. C. Bowles. 1995. Factors affecting survival of kokanees stocked in Lake Pend Oreille, Idaho. North American Journal of Fisheries Management 15:208–215.

Parsons, B. G. M., and W. A. Hubert. 1988 (a). Influence of habitat availability on spawning site selection by kokanee in streams. North American Journal of Fisheries Management 8:426–431.

Parsons, B. G., and W.A. Hubert. 1988 (b). Reproductive characteristics of two kokanee stocks in tributaries on Flaming Gorge Reservoir, Utah and Wyoming. Great Basin Naturalist 48:46–50.

Paton. C., J. D. Woodhead, J. M. Herget, D. Phillips, and S. Shee. 2007. Strontium isotope analysis of kimberlitic groundmass perovskite via LA-MC-ICM-MS. Geostandards and geoanalytical research 31:321–330.

Payan, P., H. De Pontual, G. Bœuf, and N. Mayer-Gostan. 2004. Endolymph chemistry and otolith growth in fish. Comptes Rendus Palevol 3:535–547.

Peery, C. A., and T. C. Bjornn. 2004. Interactions between natural and hatchery Chinook Salmon parr in a laboratory stream channel. Fisheries Research 66:311-324.

Pracheil, B. M., J. D. Hogan, J. Lyons, and P. B. McIntyre. 2014. Using hard-part microchemistry to advance conservation and management of North American freshwater fisheries. Fisheries 39:451–465.

Quinn, T. P. 1993. A review of homing and straying of wild and hatchery-produced salmon. Fisheries Research 18:29-44.

Quist, M. C., M. A. Pegg, and D. R. DeVries. 2012. Age and growth. Pages 677-731 *in* A. Zale, D. Parrish, and T. Sutton, editors. Fisheries techniques, 3rd edition. American Fisheries Society, Bethesda, Maryland.

R Core Team. 2020. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna. Available: www.R-project.org.

Rieman, B. E., and C. M. Falter. 1981. Effects of the establishment of *Mysis relicta* on the macrozooplankton of a large lake. Transactions of the American Fisheries Society 110:613-620.

Rieman, B. E., and D. L. Myers. 1992. Influence of fish density and relative productivity on growth of kokanee in ten oligotrophic lakes and reservoirs in Idaho. Transactions of the American Fisheries Society 121:178–191.

Schoen, E. R., D. A. Beauchamp, and N. C. Overman. 2012. Quantifying latent impacts of an introduced piscivore: pulsed predatory inertia of Lake Trout and decline of kokanee. Transactions of the American Fisheries Society 141:1191-1206.

Scrucca, L., M. Fop, T. B. Murphy, and A. E. Raftery. 2016. Mclust 5: clustering, classification and density estimation using Gaussian finite mixture models. The R Journal 8:289–317.

Shoup. D. E., and P. H. Michaletz. 2017. Growth estimation: summarization. Pages 233-264 *in* M. C. Quist, and D. A. Isermann, editors. Age and growth of fishes: principles and techniques. American Fisheries Society, Bethesda, Maryland.

Schneidervin, R. W., and W. A Hubert. 1987. Diet overlap among zooplanktophagous fishes in Flaming Gorge Reservoir, Wyoming-Utah. North American Journal of Fisheries Management 7:379–385.

Schneidervin, R. W., and W. A. Hubert. 1988. Zooplankton density in Flaming Gorge Reservoir, 1965 to 1966 and 1983 to 1984. Southwestern Association of Naturalist 33:465–472.

Sissenwine, M. P. 1984. Why do fish populations vary? Pages 59-94 *in* R. M. May editor. Exploitation of marine communities. Springer-Verlag, Berlin.

Stafford, C. P., J. A. Stanford, F. R. Hauer, and E. B. Brother. 2002. Changes in Lake Trout growth associated with *Mysis relicta* establishment: A retrospective analysis using otoliths. Transactions of the American Fisheries Society 131: 994-1003.

Stone, R. C., and F. Eiserman. 1979. Background of Flaming Gorge Reservoir fisheries investigations. Utah State Division of Wildlife Resources, publication 78–9, Salt Lake City, and Wyoming Game and Fish Department, Laramie.

Stoner, A. W. 2004. Effects of environmental variables on fish feeding ecology: implications for the performance of baited fishing gear and stock assessment. Journal of Fish Biology 65:1145-1471.

Surdam, R. C., and C. A. Wolfbauer. 1975. Green River formation, Wyoming: A playa-lake complex. Geological Society of America Bulletin 86:335–345.

Thresher, R. E. 1999. Elemental composition of otoliths as a stock delineator in fishes. Fisheries Research 43:165–204.

Teuscher, D., and C. Luecke. 1996. Competition between kokanees and Utah Chub in Flaming Gorge Reservoir, Utah-Wyoming. Transaction of the American Fisheries Society 125:505–511.

Thorrold, S. R., C. M. Jones, P. K. Swart, and T. E. Targett. 1998. Accurate classification of juvenile Weakfish *Cynoscion regalis* to estuarine nursery areas based on chemical signatures in otoliths. Marine Ecology Progress Series 173:253–265.

Vinyard, G. L., R. W. Drenner, and D. A. Hanzel. 1982. Feeding success of hatcher-reared kokanee salmon when presented with zooplankton prey. The Progressive Fish-Culturist 44:37-39.

Vernon, E. H. 1957. Morphometric comparisons of three races of kokanee (*Oncorhynchus nerka*) within a large British Columbia Lake. Journal of Fisheries Board of Canada 14:573-598.

Volk, E. C., S. L. Schroder, and J. J. Grimm. 1999. Otolith thermal marking. Fisheries Research 43:205–219.

Wagner, H. H. 1969. Effects of stocking locations of juvenile steelhead trout, *Salmo gairdnerii*, on adult catch. Transactions of the American Fisheries Society 98:27-34.

Watz, J., and J. J. Piccolo. 2011. The role of temperature in the prey capture probability of drift-feeding juvenile Brown Trout (*Salmo trutta*). Ecology of Freshwater Fish 20:393-399.

Weber, E. D., and K. D. Fausch. 2003. Interactions between hatchery and wild salmonids in streams: differences in biology and evidence for competition. Canadian Journal of Fisheries and Aquatic Science 60:1018-1036.

Wetzel, R. G., and G. E. Likens. 2000. Composition and biomass of phytoplankton. Limnological analyses, 3rd edition. Springer Publishing, New York.

Whitledge, G. W. 2017. Morphology, composition, and growth of structures used for age estimation. Pages 9-31 *in* M. C. Quist, and D. A. Isermann, editors. Age and growth of fishes: principles and techniques. American Fisheries Society, Bethesda, Maryland.

Willmes, M., K. M. Ransom, L. S. Lewis, C. T. Denny, J. J. G. Glessner, and J. A. Hobbs. 2018. IsoFishR: An application for reproducible data reductions and analysis of strontium isotope ratios (^{87}Sr/^{86}Sr) obtained via laser-ablation MC-ICP-MS. PLOS ONE [online serial] 13: e0204519.

Wydoski, R. S., and D. H. Bennett. 1981. Forage species in lakes and reservoirs of the western United States. Transaction of the American Fisheries Society 110:764–771.

Yang, Y., F. Wu, Z. Liu, Z. Chu, L. Xie, and J. Yang. 2012. Evaluation of Sr chemical purification techniques for natural geological samples using common cation-exchange and Sr-specific extraction chromatographic resin prior to MC-ICP-MS or TIMS measurement. Journal of Analytical Atomic Spectrometry 27:516–522.

Young, M. K. 2011. Generation-scale movement patterns of Cutthroat Trout (*Oncorhynchus clarkii pleuriticus*) in a stream network. Canadian Journal of Fisheries and Aquatic sciences 65:941–951.

Yule, D. L. 1992. Investigations of forage fish and Lake Trout (*Salvelinus namaycush*) interactions in Flaming Gorge Reservoir, Wyoming-Utah. Master's thesis. Utah State University, Logan, Utah.

Yule, D. L., and C. Luecke. 1993. Lake Trout consumption and recent changes in the fish assemblage of Flaming Gorge Reservoir. Transaction of the American Fisheries Society 122:1058–1069.

Zorn, T. G. 2015. Contributions of hatchery-reared Walleyes to populations in Northern Green Bay, Lake Michigan. North American Journal of Aquaculture 77:409-422.

Table 1. Kokanee stocking records from 2013-2020. Agencies include Wyoming Game and Fish Department (WGFD), Utah Division of Wildlife Resources (UDWR), U.S. Fish and Wildlife Service (USFWS). Hatcheries are separated by hatchery group identified using a DFA. The number stocked is the total number of kokanee stocked from an individual hatchery in a particular year. Mean length (total length) and average Julian stocking date are averages from all stocking events of an individual hatchery each year. Annual contributions are the percentage of kokanee an individual hatchery contributed to Flaming Gorge Reservoir in a particular year.

Hatchery	Agency	Year	Number stocked	Mean length (mm)	Average Julian stocking date	Annual contribution (%)
Auburn						
Auburn	WFGD	2013	168,320	66	134	17
		2014	446,892	65	141	29
		2015	310,906	88	139	19
		2016	381,600	85	154	29
		2017	559,260	73	150	30
		2018	389,010	100	159	27
		2019	345,266	57	142	19
		2020	259,254	73	140	20
Auburn Isolation		2018	28,160	50	130	2
Over						
Boulder Isolation		2,014	29,040	68	136	2
Clark's Fork		2017	137,840	88	137	7
		2019	130,440	80	129	7
Dan Speas		2015	161,621	59	137	10
		2016	76,330	98	142	5
		2017	149,582	88	143	8
		2018	74,515	80	141	5
		2019	359,818	58	140	20
		2020	586,228	78	134	32
Under						
Daniel		2013	81,432	53	150	8
		2014	66,720	72	152	4
		2015	88,823	60	132	5
		2016	87,619	50	142	6
		2020	9,075	99	125	1

Table 1 cont'd.

Hatchery	Agency	Year	Number stocked	Mean length (mm)	Average Julian stocking date	Annual contribution (%)
			Under			
Dubois	WGFD	2018	14,026	89	163	1
Jones Hole	USFWS	2013	359,400	82	127	37
		2014	354,609	83	124	23
		2015	439,697	82	149	37
		2016	282,442	88	148	19
		2017	341,664	85	151	19
		2018	338,920	88	150	21
		2019	592,389	95	150	32
		2020	437,029	87	153	24
Midway	UDWR	2017	64,080	76	96	3
		2018	48,342	46	115	3
Saratoga	USFWS	2013	80,800	65	140	8
Tillet	WGFD	2017	99,962	81	151	5
		2018	82,320	64	141	5
Whiterocks	UDWR	2013	281,860	82	114	29
		2014	665,500	76	107	43
		2015	622,201	87	86	38
		2016	442,392	83	105	29
		2017	362,575	80	117	27
		2018	439,880	68	114	27
		2019	392,568	81	124	22
		2020	432,620	86	128	24
			"Natural"			
Wigwam	WGFD	2016	190,750	76	143	13
		2018	160,650	75	129	10

Table 2. Locations of where kokanee were captured in regions of Flaming Gorge Reservoir (i.e., Inflow, Open Hills, Canyon) and spawning tributaries (i.e., Henrys Fork River, Sheep Creek). Sample size (*n*) and associated minimum (min), maximum (max), and average mid-eye-to-fork length for each capture method are included.

			Mid-eye-to-fork length (mm)		
Location	Capture method	*n*	Min	Max	Average
Inflow	Suspended gill net	343	146	510	340
	Creel	346	260	468	389
	Sinking gillnet	269	302	479	393
Open Hills	Suspended gill net	270	175	488	358
	Creel	299	224	455	366
	Sinking gill net	324	237	479	392
Canyon	Suspended gill net	296	148	457	334
	Creel	330	213	455	343
	Sinking gill net	200	314	482	383
Henrys Fork River	Weir	149	301	447	377
Sheep Creek	Weir	297	280	482	368

Table 3. Comparisons of growth using back-calculated lengths-at-age (mm) of natural and hatchery-produced kokanee. Natal origins of kokanee were assigned using the model-based discriminate function analysis that excluded the Wigwam Hatchery. Back-calculated length was estimated using the Dahl-Lea method. Mean lengths (mean [SD; *n*]) are estimated mid-eye-to-fork length (mm).

	Age (years)					
Natal origin	1	2	3	4	5	6
Natural	104.3 (22; 319)	211.3 (32; 319)	303.1 (30; 303)	372.1 (25; 180)	423.6 (14; 9)	480.6 (9; 3)
Hatchery	111.7 (21; 199)	225.8 (36; 196)	316.3 (35; 173)	373.4 (29; 75)	429.0 (- ; 1)	-

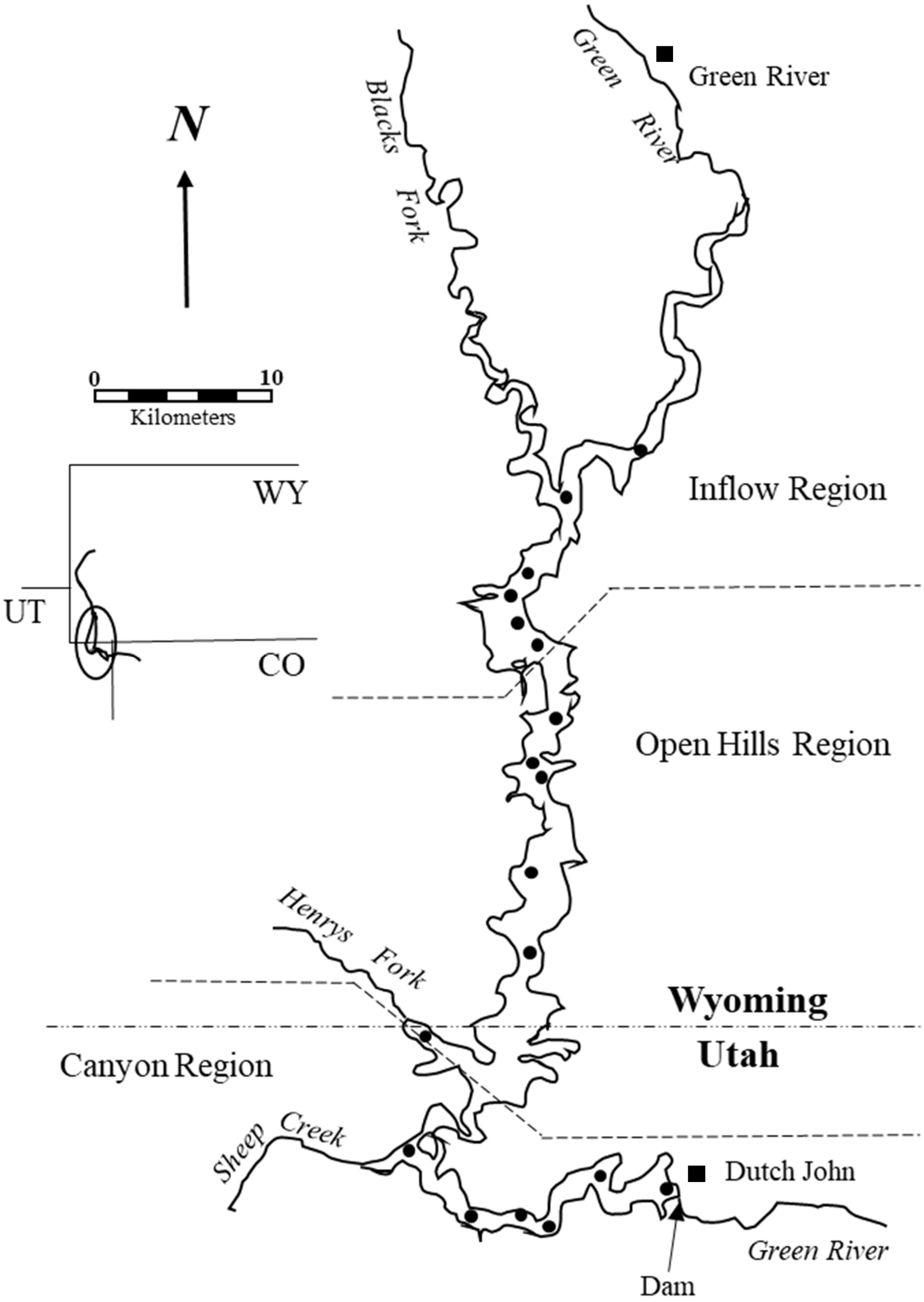

Figure 1. Flaming Gorge Reservoir, WY-UT with major tributaries and separated by region. Location of water sample collected in 2020 are symbolized by black circles.

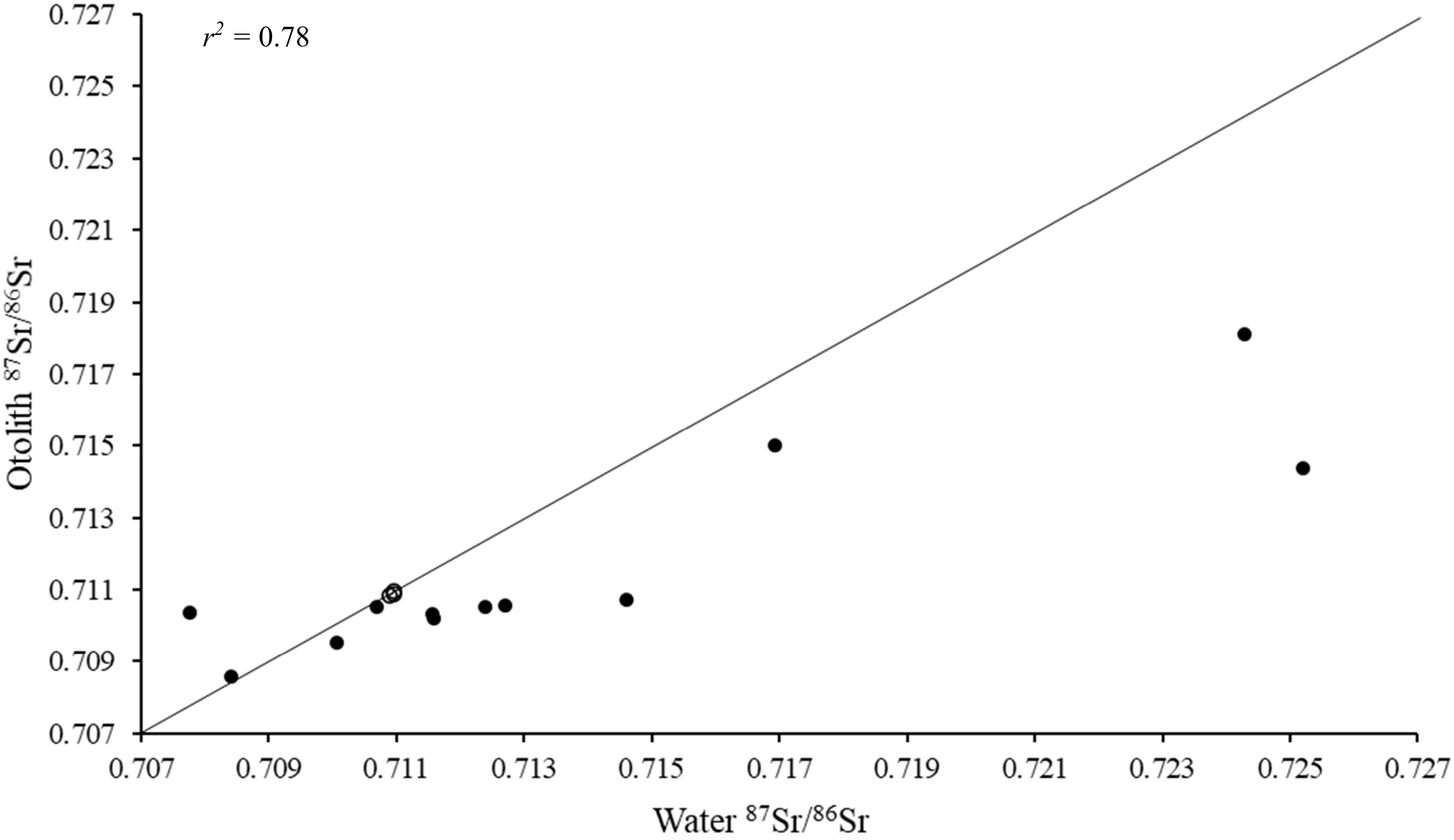

Figure 2. The linear relationship of $^{87}Sr/^{86}Sr$ ratios in water to otolith edge samples from kokanee and Rainbow Trout collected from 12 hatcheries. The solid line represents a 1:1 relationship between water and otolith values. Solid circles (●) represent hatcheries and open circles (○) represent regions of Flaming Gorge Reservoir.

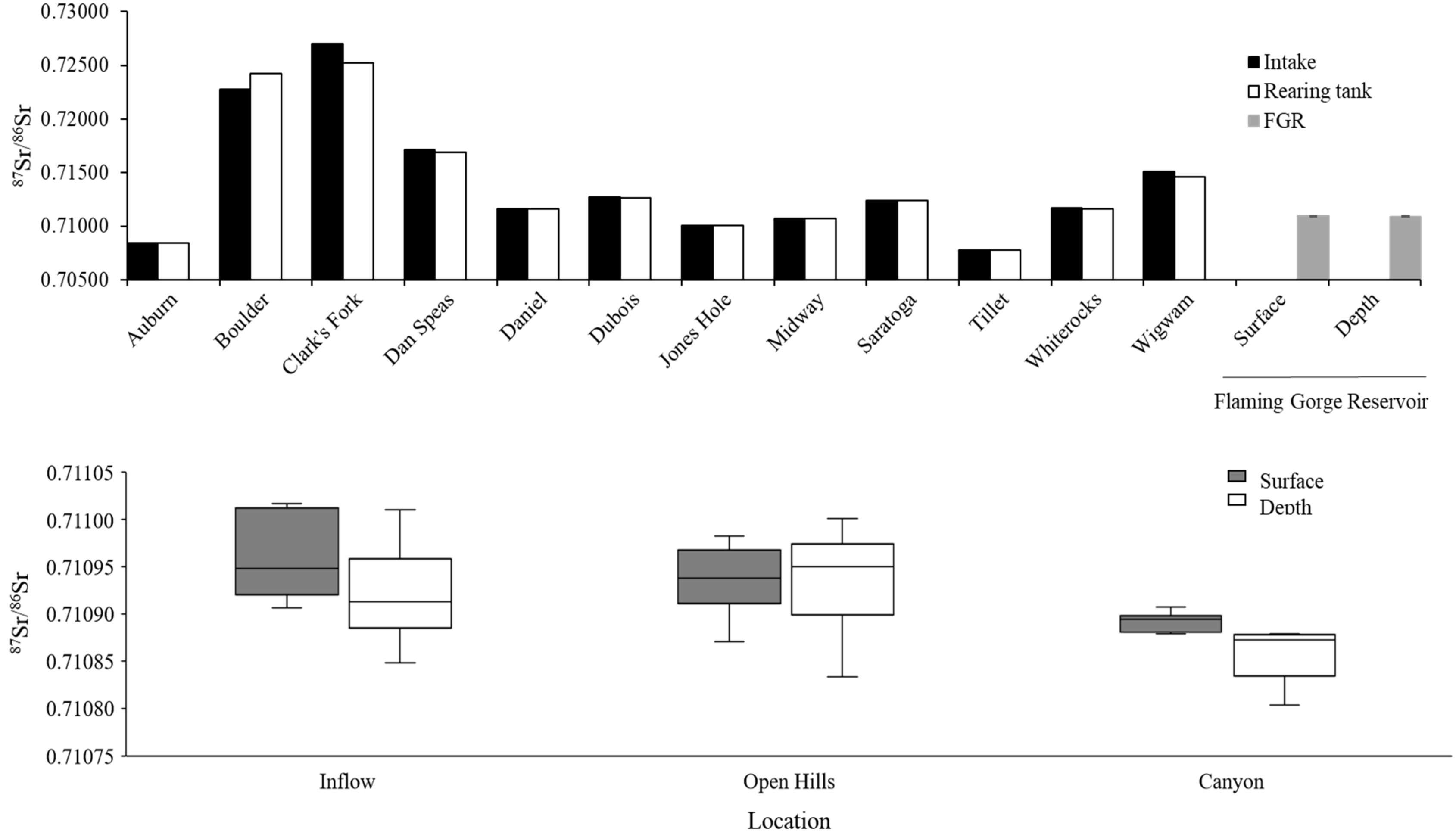

Figure 3. Strontium isotope ratios (i.e., $^{87}Sr/^{86}Sr$) of water samples collected from hatcheries and Flaming Gorge Reservoir. The top panel is the $^{87}Sr/^{86}Sr$ from the intake and rearing tanks of each hatchery and the average $^{87}Sr/^{86}Sr$ from surface samples and samples at depth in Flaming Gorge Reservoir. The bottom panel is the difference of $^{87}Sr/^{86}Sr$ of water samples taken on the surface and at depths averaging 15.7 m for each region of Flaming Gorge Reservoir.

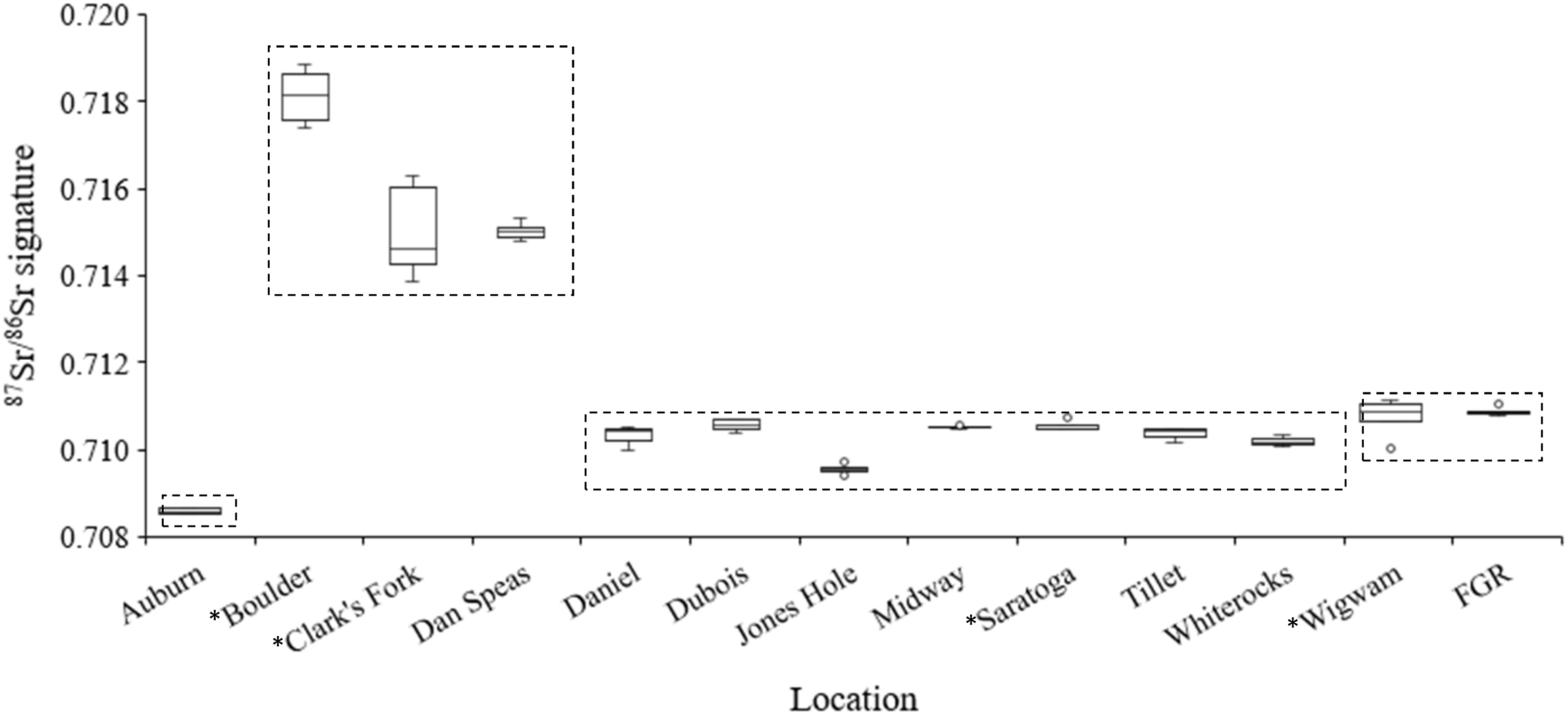

Figure 4. Spatial variability in ^{87}Sr/^{86}Sr values from otolith edge values collected from each hatchery, and random selected otolith edge values from kokanee captured in Flaming Gorge Reservoir (n = 65). Dashed black boxes represent groupings of hatcheries for model-based discriminate function analysis. * Hatchery samples that used Rainbow Trout as surrogates

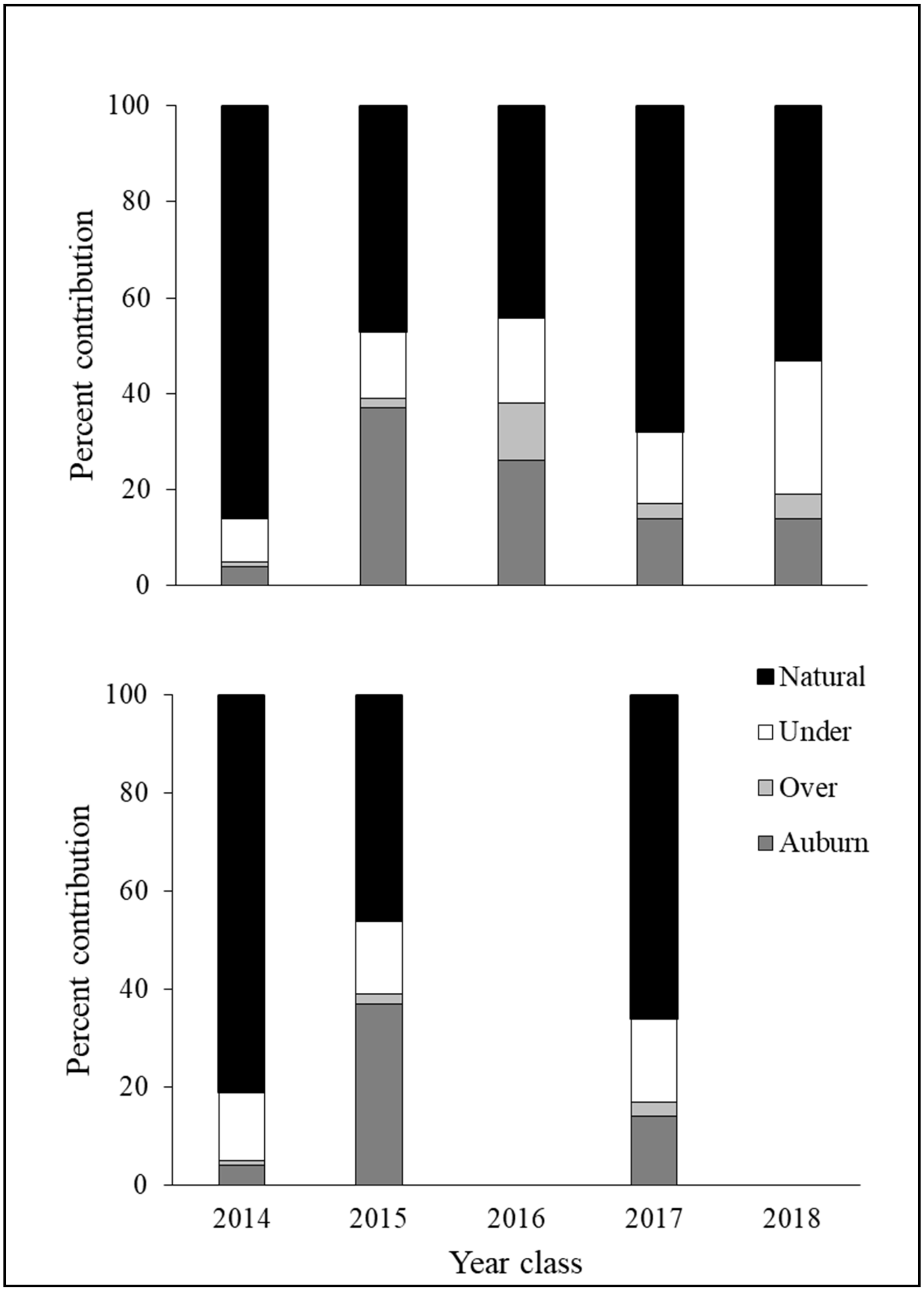

Figure 5. The percent of kokanee assigned to natal origin based on $^{87}Sr/^{86}Sr$ signature of all aged fish analyzed for microchemistry from 2018 to 2020 by year class. Model-based discriminant function analysis was used to assign fish to natal origin. The top panel is assignment using the discriminant function analysis including the Wigwam Hatchery. The bottom panel is the assignment using the discriminant function analysis excluding the Wigwam Hatchery and no assignments to 2016 and 2018 year classes.

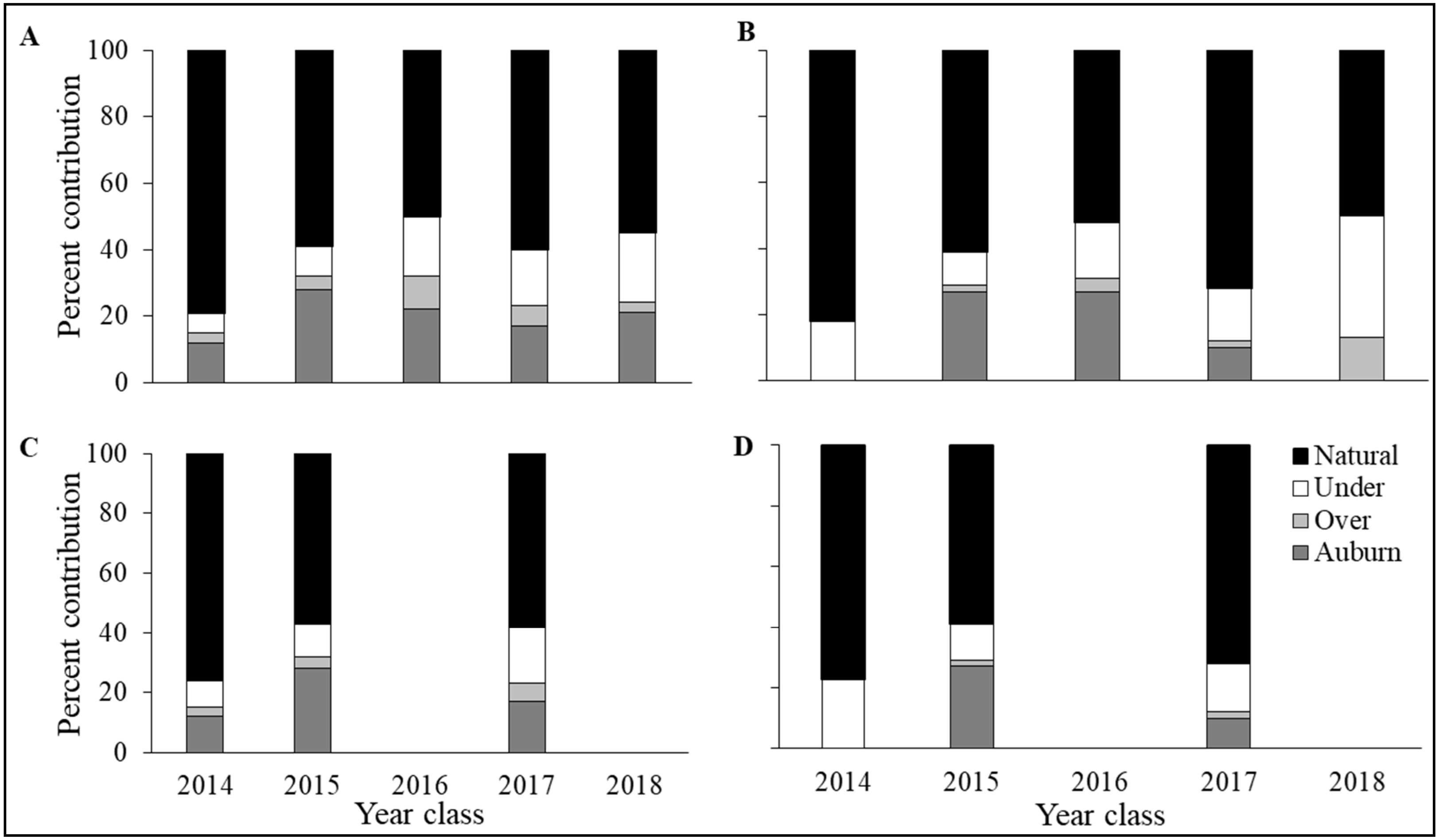

Figure 6. The percent of kokanee assigned to natal origin based on $^{87}Sr/^{86}Sr$ signature of fish sampled from 2018-2020 using suspended gill nets by year class (panel A and C) and creel surveys (panels B and D). Model-based discriminant function analysis was used to assign fish to natal origin. Panel A and B are assignment using the discriminant function analysis including the Wigwam Hatchery. Panel C and D are assignments using the discriminant function analysis excluding the Wigwam Hatchery and no assignments to 2016 and 2018 year classes.

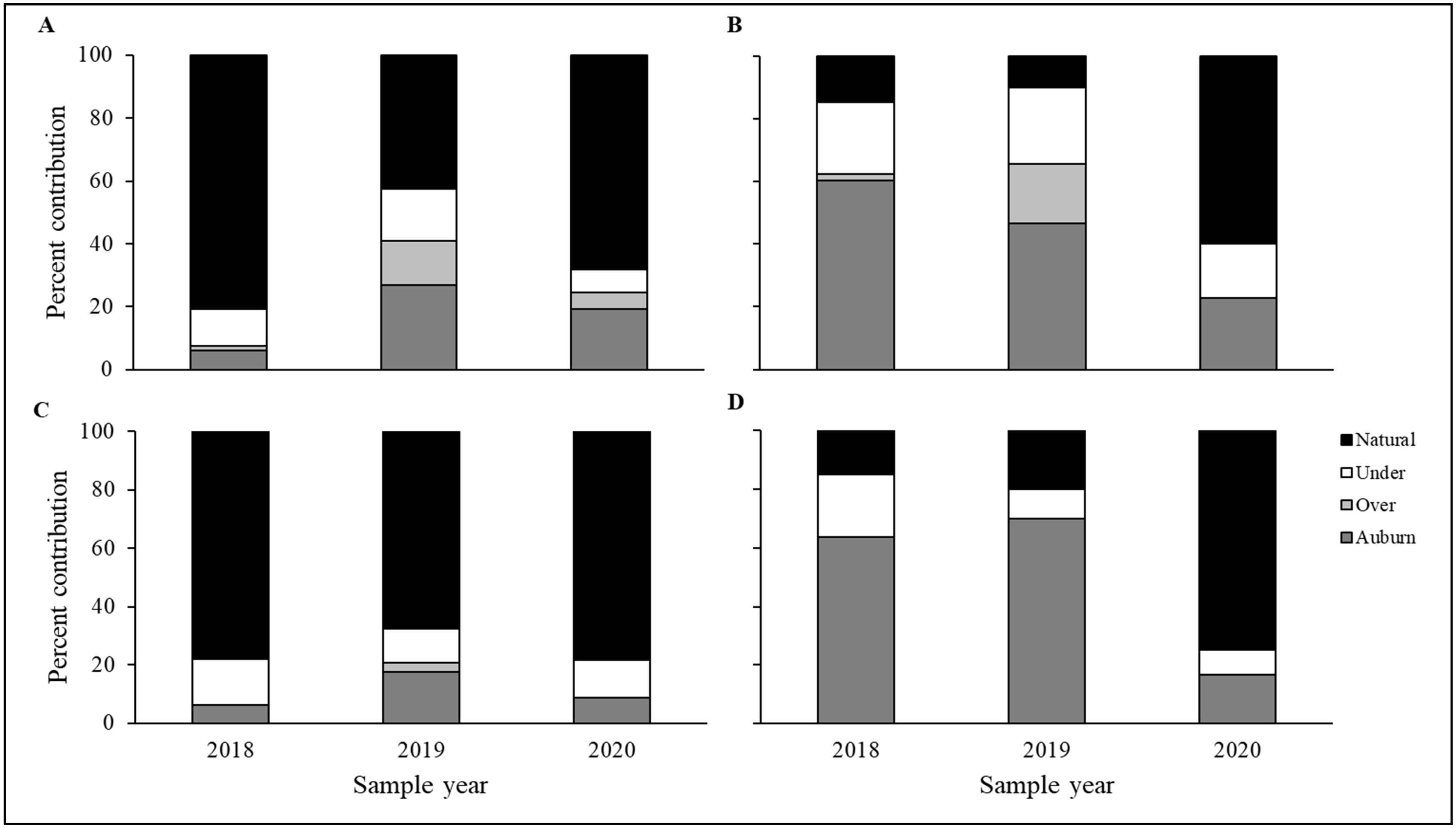

Figure 7. The percent of kokanee assigned to natal origin based on ^{87}Sr/^{86}Sr signature of fish sampled from 2018-2020 from shoreline-spawning aggregates (panel A and C) and tributary-spawning aggregates (panel B and D) by sample year. Model-based discriminant function analysis was used to assign fish to natal origin. Panels A and B are estimated origins using the discriminate function analysis that included the Wigwam Hatchery. Panels C and D are estimated origins using the discriminate function analysis the excluded the Wigwam Hatchery and no assignments to 2016- and 2018-year classes.

Figure 8. Difference between percent of hatchery fish stocked and percent of hatchery fish observed from sampling events using natal assignment from discriminate function analysis. Includes sample years 2018-2020 for suspended gill net surveys. Each year class includes all ages, each line represents a different hatchery group.

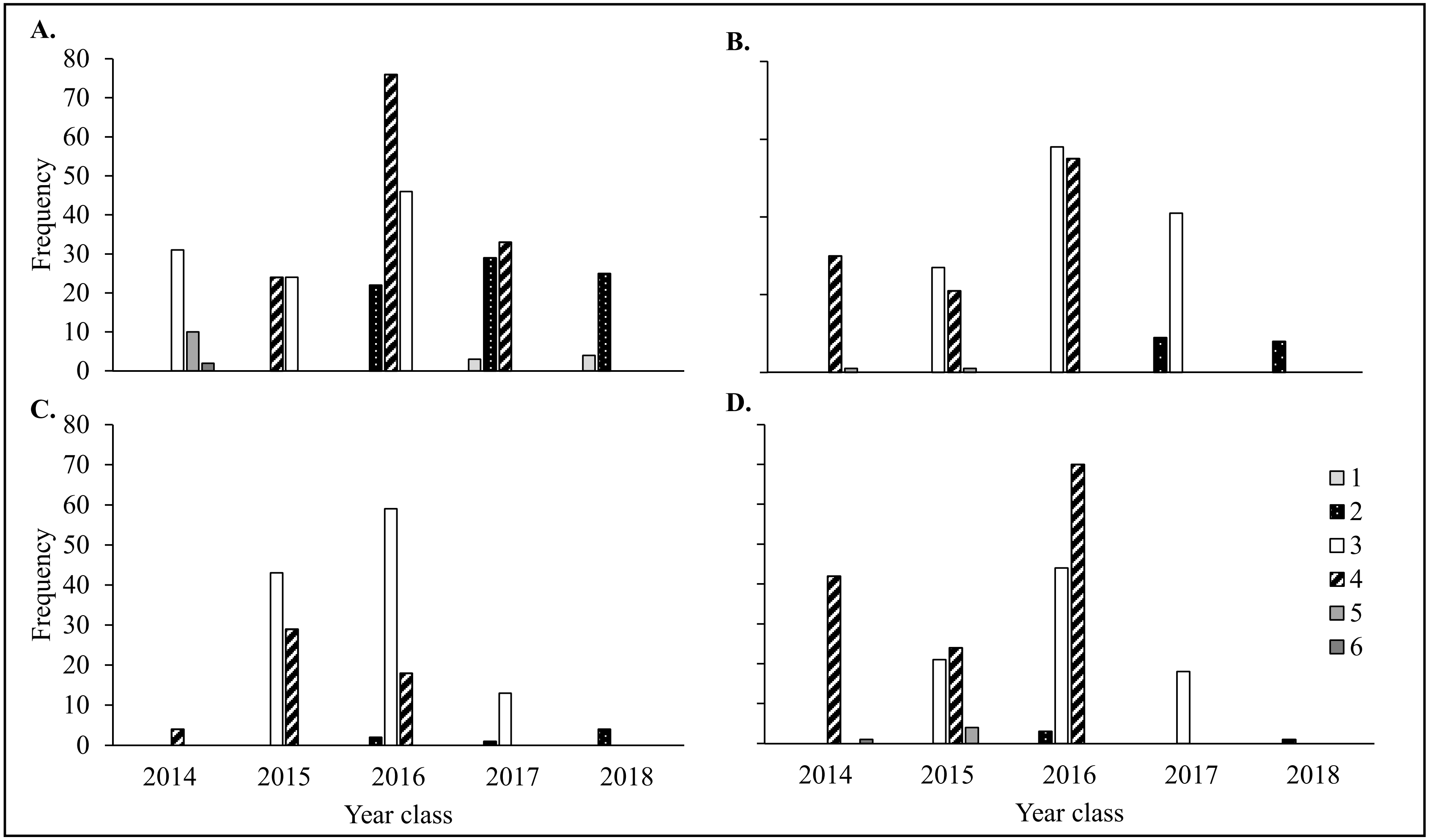

Figure 9. Age-frequency distribution of kokanee by year class sampled in Flaming Gorge Reservoir, Wyoming-Utah during 2018-2020. Each panel represents the age-frequency by sampling method. Panel A represents suspended gill nets, panel B represents recreational creel survey, panel C represents tributary-spawning kokanee sampled with weirs, and panel D represents shoreline spawning kokanee sampled with sinking gill nets.

Appendix A. Sample year, Flaming Gorge Reservoir (FGR) region, sample method, along with the ^{87}Sr/^{86}Sr mean and standard deviation from the natal region of the otolith from individual fish. Age at capture, mid-eye-to-fork (MEF) length at capture, and classification from model-based discriminate function analysis (DFA) are also included. Classifications are from the DFA that included the Wigwam Hatchery and the DFA that excluded the Wigwam Hatchery with no natal assignment to the 2016 and 2018 year classes.

							Classification	
Sample year	FGR region	Sample method	Natal region ^{87}Sr/^{86}Sr mean	Natal region ^{87}Sr/^{86}Sr SD	Age at capture	MEF length (mm)	DFA with Wigwam	DFA without Wigwam
2018	Inflow	Suspended gill net	0.71067	0.00006	1	179	Wild	Under
2018	Inflow	Suspended gill net	0.70869	0.00004	1	190	Auburn	Auburn
2018	Inflow	Suspended gill net	0.70867	0.00005	2	230	Auburn	-
2018	Inflow	Suspended gill net	0.70866	0.00008	2	237	Auburn	-
2018	Inflow	Suspended gill net	0.70959	0.00005	2	264	Under	-
2018	Inflow	Suspended gill net	0.70877	0.00006	2	250	Auburn	-
2018	Inflow	Suspended gill net	0.70862	0.00007	2	255	Auburn	-
2018	Inflow	Suspended gill net	0.70981	0.00005	2	260	Under	-
2018	Inflow	Suspended gill net	0.71101	0.00006	2	289	Wild	-
2018	Inflow	Suspended gill net	0.70862	0.00010	3	302	Auburn	Auburn
2018	Inflow	Suspended gill net	0.70961	0.00020	3	322	Under	Under
2018	Inflow	Suspended gill net	0.71118	0.00012	3	329	Wild	Wild
2018	Inflow	Suspended gill net	0.71084	0.00007	3	355	Wild	Wild
2018	Inflow	Suspended gill net	0.71088	0.00012	4	358	Wild	Wild
2018	Inflow	Suspended gill net	0.72217	0.00056	3	366	Over	Over
2018	Inflow	Suspended gill net	0.70866	0.00009	3	365	Auburn	Auburn
2018	Inflow	Suspended gill net	0.71089	0.00006	4	368	Wild	Wild
2018	Inflow	Suspended gill net	0.70966	0.00012	3	376	Under	Under
2018	Inflow	Suspended gill net	0.71089	0.00012	4	383	Wild	Wild
2018	Inflow	Suspended gill net	0.70861	0.00009	4	401	Auburn	Auburn
2018	Inflow	Suspended gill net	0.71091	0.00005	4	401	Wild	Wild
2018	Inflow	Suspended gill net	0.71093	0.00009	4	405	Wild	Wild

Appendix A. cont’d

							Classification	
Sample year	FGR region	Sample method	Natal region $^{87}Sr/^{86}Sr$ mean	Natal region $^{87}Sr/^{86}Sr$ SD	Age at capture	MEF length (mm)	DFA with Wigwam	DFA without Wigwam
2018	Inflow	Suspended gill net	0.71100	0.00006	4	415	Wild	Wild
2018	Inflow	Suspended gill net	0.71077	0.00011	4	425	Wild	Wild
2018	Inflow	Suspended gill net	0.71082	0.00004	4	433	Wild	Wild
2018	Inflow	Creel	0.70865	0.00005	3	299	Auburn	Auburn
2018	Inflow	Creel	0.70864	0.00008	3	309	Auburn	Auburn
2018	Inflow	Creel	0.71073	0.00010	3	337	Wild	Wild
2018	Inflow	Creel	0.71079	0.00006	4	352	Wild	Wild
2018	Inflow	Creel	0.71097	0.00006	4	358	Wild	Wild
2018	Inflow	Creel	0.71083	0.00011	4	360	Wild	Wild
2018	Inflow	Creel	0.71086	0.00005	4	363	Wild	Wild
2018	Inflow	Creel	0.70865	0.00004	3	365	Auburn	Auburn
2018	Inflow	Creel	0.71080	0.00009	4	367	Wild	Wild
2018	Inflow	Creel	0.71084	0.00006	4	371	Wild	Wild
2018	Inflow	Creel	0.71087	0.00009	4	371	Wild	Wild
2018	Inflow	Creel	0.71085	0.00005	4	372	Wild	Wild
2018	Inflow	Creel	0.71087	0.00005	4	374	Wild	Wild
2018	Inflow	Creel	0.71088	0.00010	4	383	Wild	Wild
2018	Inflow	Creel	0.71086	0.00004	3	384	Wild	Wild
2018	Inflow	Creel	0.71088	0.00007	4	388	Wild	Wild
2018	Inflow	Creel	0.71100	0.00010	4	388	Wild	Wild
2018	Inflow	Creel	0.71085	0.00007	4	389	Wild	Wild
2018	Inflow	Creel	0.71089	0.00004	4	392	Wild	Wild
2018	Inflow	Creel	0.71090	0.00004	4	395	Wild	Wild
2018	Inflow	Creel	0.71086	0.00006	4	395	Wild	Wild
2018	Inflow	Creel	0.71087	0.00005	4	396	Wild	Wild
2018	Inflow	Creel	0.71098	0.00008	4	397	Wild	Wild

Appendix A. cont’d

							Classification	
Sample year	FGR region	Sample method	Natal region ^{87}Sr/^{86}Sr mean	Natal region ^{87}Sr/^{86}Sr SD	Age at capture	MEF length (mm)	DFA with Wigwam	DFA without Wigwam
2018	Inflow	Creel	0.71092	0.00009	4	400	Wild	Wild
2018	Inflow	Creel	0.71088	0.00005	4	405	Wild	Wild
2018	Inflow	Creel	0.70865	0.00009	3	406	Auburn	Auburn
2018	Inflow	Creel	0.71085	0.00009	4	407	Wild	Wild
2018	Inflow	Creel	0.71090	0.00015	4	411	Wild	Wild
2018	Inflow	Creel	0.71087	0.00012	4	411	Wild	Wild
2018	Inflow	Creel	0.71091	0.00010	4	411	Wild	Wild
2018	Inflow	Creel	0.71083	0.00006	4	413	Wild	Wild
2018	Inflow	Creel	0.70856	0.00006	3	422	Auburn	Auburn
2018	Inflow	Creel	0.71064	0.00007	4	422	Under	Under
2018	Inflow	Creel	0.71080	0.00009	4	427	Wild	Wild
2018	Inflow	Creel	0.71072	0.00011	4	428	Wild	Wild
2018	Inflow	Creel	0.71071	0.00016	4	437	Wild	Under
2018	Inflow	Creel	0.71064	0.00020	4	442	Under	Under
2018	Inflow	Creel	0.71072	0.00012	4	444	Wild	Wild
2018	Inflow	Creel	0.71082	0.00015	5	457	Wild	Wild
2018	Inflow	Sinking gill net	0.70972	0.00008	2	308	Under	-
2018	Inflow	Sinking gill net	0.70980	0.00008	2	327	Under	-
2018	Inflow	Sinking gill net	0.71091	0.00012	4	345	Wild	Wild
2018	Inflow	Sinking gill net	0.70868	0.00004	3	372	Auburn	Auburn
2018	Inflow	Sinking gill net	0.70969	0.00009	3	372	Under	Under
2018	Inflow	Sinking gill net	0.71092	0.00011	4	380	Wild	Wild
2018	Inflow	Sinking gill net	0.71097	0.00023	4	380	Wild	Wild
2018	Inflow	Sinking gill net	0.71077	0.00019	4	380	Wild	Wild
2018	Inflow	Sinking gill net	0.71096	0.00009	4	383	Wild	Wild
2018	Inflow	Sinking gill net	0.71091	0.00005	4	393	Wild	Wild

Appendix A. cont’d

							Classification	
Sample year	FGR region	Sample method	Natal region $^{87}Sr/^{86}Sr$ mean	Natal region $^{87}Sr/^{86}Sr$ SD	Age at capture	MEF length (mm)	DFA with Wigwam	DFA without Wigwam
2018	Inflow	Sinking gill net	0.71085	0.00005	4	394	Wild	Wild
2018	Inflow	Sinking gill net	0.71074	0.00004	4	397	Wild	Wild
2018	Inflow	Sinking gill net	0.71085	0.00005	4	399	Wild	Wild
2018	Inflow	Sinking gill net	0.71090	0.00007	4	400	Wild	Wild
2018	Inflow	Sinking gill net	0.71090	0.00010	3	408	Wild	Wild
2018	Inflow	Sinking gill net	0.71093	0.00007	4	413	Wild	Wild
2018	Inflow	Sinking gill net	0.71089	0.00008	4	415	Wild	Wild
2018	Inflow	Sinking gill net	0.71084	0.00012	4	416	Wild	Wild
2018	Inflow	Sinking gill net	0.71083	0.00010	4	417	Wild	Wild
2018	Inflow	Sinking gill net	0.71091	0.00009	4	427	Wild	Wild
2018	Inflow	Sinking gill net	0.71104	0.00021	4	428	Wild	Wild
2018	Inflow	Sinking gill net	0.71093	0.00012	4	435	Wild	Wild
2018	Open Hills	Suspended gill net	0.70963	0.00011	2	241	Under	-
2018	Open Hills	Suspended gill net	0.70864	0.00005	2	254	Auburn	-
2018	Open Hills	Suspended gill net	0.70858	0.00009	2	259	Auburn	-
2018	Open Hills	Suspended gill net	0.70863	0.00006	2	259	Auburn	-
2018	Open Hills	Suspended gill net	0.71021	0.00013	2	260	Under	-
2018	Open Hills	Suspended gill net	0.70864	0.00007	2	271	Auburn	-
2018	Open Hills	Suspended gill net	0.70875	0.00006	2	274	Auburn	-
2018	Open Hills	Suspended gill net	0.71107	0.00004	3	297	Wild	Wild
2018	Open Hills	Suspended gill net	0.70867	0.00007	3	313	Auburn	Auburn
2018	Open Hills	Suspended gill net	0.71090	0.00009	4	329	Wild	Wild
2018	Open Hills	Suspended gill net	0.71095	0.00008	4	362	Wild	Wild
2018	Open Hills	Suspended gill net	0.70868	0.00006	3	370	Auburn	Auburn
2018	Open Hills	Suspended gill net	0.71081	0.00006	4	376	Wild	Wild
2018	Open Hills	Suspended gill net	0.71092	0.00005	4	377	Wild	Wild

Appendix A. cont'd

Sample year	FGR region	Sample method	Natal region $^{87}Sr/^{86}Sr$ mean	Natal region $^{87}Sr/^{86}Sr$ SD	Age at capture	MEF length (mm)	Classification DFA with Wigwam	 DFA without Wigwam
2018	Open Hills	Suspended gill net	0.71094	0.00010	4	378	Wild	Wild
2018	Open Hills	Suspended gill net	0.71087	0.00006	4	383	Wild	Wild
2018	Open Hills	Suspended gill net	0.71698	0.00040	4	385	Over	Over
2018	Open Hills	Suspended gill net	0.70871	0.00006	3	387	Auburn	Auburn
2018	Open Hills	Suspended gill net	0.71097	0.00014	4	387	Wild	Wild
2018	Open Hills	Suspended gill net	0.71048	0.00008	4	396	Under	Under
2018	Open Hills	Suspended gill net	0.71085	0.00006	4	397	Wild	Wild
2018	Open Hills	Suspended gill net	0.71091	0.00008	4	411	Wild	Wild
2018	Open Hills	Suspended gill net	0.70964	0.00015	2	242	Under	-
2018	Open Hills	Creel	0.71103	0.00006	3	316	Wild	Wild
2018	Open Hills	Creel	0.70838	0.00013	3	325	Auburn	Auburn
2018	Open Hills	Creel	0.71058	0.00013	4	340	Under	Under
2018	Open Hills	Creel	0.70906	0.00008	3	345	Under	Under
2018	Open Hills	Creel	0.71059	0.00020	4	346	Under	Under
2018	Open Hills	Creel	0.71081	0.00013	3	350	Wild	Wild
2018	Open Hills	Creel	0.71040	0.00017	4	361	Under	Under
2018	Open Hills	Creel	0.71039	0.00012	4	361	Under	Under
2018	Open Hills	Creel	0.70921	0.00041	3	363	Under	Under
2018	Open Hills	Creel	0.71041	0.00019	4	365	Under	Under
2018	Open Hills	Creel	0.71051	0.00021	4	374	Under	Under
2018	Open Hills	Creel	0.71060	0.00024	4	378	Under	Under
2018	Open Hills	Creel	0.71038	0.00021	4	381	Under	Under
2018	Open Hills	Creel	0.71063	0.00012	4	382	Under	Under
2018	Open Hills	Creel	0.71068	0.00010	4	384	Wild	Under
2018	Open Hills	Creel	0.71051	0.00015	3	393	Under	Under
2018	Open Hills	Creel	0.71070	0.00011	4	395	Wild	Under

Appendix A. cont’d

							Classification	
Sample year	FGR region	Sample method	Natal region ^{87}Sr/^{86}Sr mean	Natal region ^{87}Sr/^{86}Sr SD	Age at capture	MEF length (mm)	DFA with Wigwam	DFA without Wigwam
2018	Open Hills	Creel	0.71081	0.00018	4	396	Wild	Wild
2018	Open Hills	Creel	0.71083	0.00026	3	400	Wild	Wild
2018	Open Hills	Creel	0.71083	0.00017	5	434	Wild	Wild
2018	Open Hills	Creel	0.71086	0.00016	4	438	Wild	Wild
2018	Open Hills	Creel	0.71084	0.00006	4	449	Wild	Wild
2018	Open Hills	Sinking gill net	0.71595	0.00042	2	294	Over	-
2018	Open Hills	Sinking gill net	0.71098	0.00010	3	335	Wild	Wild
2018	Open Hills	Sinking gill net	0.70975	0.00008	3	343	Under	Under
2018	Open Hills	Sinking gill net	0.70867	0.00005	3	352	Auburn	Auburn
2018	Open Hills	Sinking gill net	0.71075	0.00014	3	360	Wild	Wild
2018	Open Hills	Sinking gill net	0.70988	0.00008	3	360	Under	Under
2018	Open Hills	Sinking gill net	0.71068	0.00008	3	360	Wild	Under
2018	Open Hills	Sinking gill net	0.71093	0.00015	3	361	Wild	Wild
2018	Open Hills	Sinking gill net	0.71100	0.00015	4	372	Wild	Wild
2018	Open Hills	Sinking gill net	0.71099	0.00006	4	378	Wild	Wild
2018	Open Hills	Sinking gill net	0.70990	0.00007	3	380	Under	Under
2018	Open Hills	Sinking gill net	0.70977	0.00008	3	380	Under	Under
2018	Open Hills	Sinking gill net	0.71102	0.00008	4	380	Wild	Wild
2018	Open Hills	Sinking gill net	0.71062	0.00014	3	388	Under	Under
2018	Open Hills	Sinking gill net	0.71096	0.00007	4	399	Wild	Wild
2018	Open Hills	Sinking gill net	0.70874	0.00004	4	400	Auburn	Auburn
2018	Open Hills	Sinking gill net	0.71087	0.00009	3	347	Wild	Wild
2018	Open Hills	Sinking gill net	0.71087	0.00009	4	404	Wild	Wild
2018	Open Hills	Sinking gill net	0.71097	0.00007	4	410	Wild	Wild
2018	Open Hills	Sinking gill net	0.71082	0.00007	4	411	Wild	Wild
2018	Open Hills	Sinking gill net	0.71079	0.00015	4	412	Wild	Wild

Appendix A. cont’d

							Classification	
Sample year	FGR region	Sample method	Natal region $^{87}Sr/^{86}Sr$ mean	Natal region $^{87}Sr/^{86}Sr$ SD	Age at capture	MEF length (mm)	DFA with Wigwam	DFA without Wigwam
2018	Open Hills	Sinking gill net	0.71084	0.00010	4	413	Wild	Wild
2018	Open Hills	Sinking gill net	0.71070	0.00008	4	420	Wild	Under
2018	Open Hills	Sinking gill net	0.71085	0.00010	4	420	Wild	Wild
2018	Open Hills	Sinking gill net	0.71066	0.00009	4	425	Wild	Under
2018	Open Hills	Sinking gill net	0.71091	0.00012	4	427	Wild	Wild
2018	Open Hills	Sinking gill net	0.70870	0.00008	4	442	Auburn	Auburn
2018	Open Hills	Sinking gill net	0.71100	0.00010	4	444	Wild	Wild
2018	Open Hills	Sinking gill net	0.71087	0.00009	5	453	Wild	Wild
2018	Open Hills	Sinking gill net	0.71090	0.00006	4	454	Wild	Wild
2018	Open Hills	Sinking gill net	0.71097	0.00009	4	458	Wild	Wild
2018	Canyon	Suspended gill net	0.70941	0.00010	1	203	Under	Under
2018	Canyon	Suspended gill net	0.71711	0.00015	2	245	Over	-
2018	Canyon	Suspended gill net	0.71096	0.00002	2	252	Wild	-
2018	Canyon	Suspended gill net	0.71607	0.00021	2	254	Over	-
2018	Canyon	Suspended gill net	0.70976	0.00007	2	266	Under	-
2018	Canyon	Suspended gill net	0.71095	0.00008	2	275	Wild	-
2018	Canyon	Suspended gill net	0.71098	0.00010	2	299	Wild	-
2018	Canyon	Suspended gill net	0.71103	0.00014	3	301	Wild	Wild
2018	Canyon	Suspended gill net	0.71090	0.00011	3	302	Wild	Wild
2018	Canyon	Suspended gill net	0.71007	0.00019	3	307	Under	Under
2018	Canyon	Suspended gill net	0.71039	0.00009	2	311	Under	-
2018	Canyon	Suspended gill net	0.71106	0.00011	3	312	Wild	Wild
2018	Canyon	Suspended gill net	0.71038	0.00017	3	319	Under	Under
2018	Canyon	Suspended gill net	0.71131	0.00015	3	327	Wild	Wild
2018	Canyon	Suspended gill net	0.71131	0.00015	3	419	Wild	Wild
2018	Canyon	Suspended gill net	0.70881	0.00003	3	329	Auburn	Auburn

Appendix A. cont'd

							Classification	
Sample year	FGR region	Sample method	Natal region $^{87}Sr/^{86}Sr$ mean	Natal region $^{87}Sr/^{86}Sr$ SD	Age at capture	MEF length (mm)	DFA with Wigwam	DFA without Wigwam
2018	Canyon	Suspended gill net	0.70883	0.00005	3	334	Auburn	Auburn
2018	Canyon	Suspended gill net	0.70883	0.00005	4	428	Auburn	Auburn
2018	Canyon	Suspended gill net	0.71017	0.00020	4	430	Under	Under
2018	Canyon	Suspended gill net	0.71080	0.00009	3	343	Wild	Wild
2018	Canyon	Suspended gill net	0.71094	0.00009	4	358	Wild	Wild
2018	Canyon	Suspended gill net	0.71087	0.00006	4	360	Wild	Wild
2018	Canyon	Suspended gill net	0.70868	0.00004	4	366	Auburn	Auburn
2018	Canyon	Suspended gill net	0.71089	0.00009	4	372	Wild	Wild
2018	Canyon	Suspended gill net	0.71092	0.00009	3	378	Wild	Wild
2018	Canyon	Suspended gill net	0.71089	0.00006	3	382	Wild	Wild
2018	Canyon	Suspended gill net	0.71077	0.00019	4	383	Wild	Wild
2018	Canyon	Suspended gill net	0.71090	0.00013	4	383	Wild	Wild
2018	Canyon	Suspended gill net	0.71080	0.00008	4	384	Wild	Wild
2018	Canyon	Suspended gill net	0.71073	0.00010	3	397	Wild	Wild
2018	Canyon	Suspended gill net	0.71091	0.00008	4	410	Wild	Wild
2018	Canyon	Suspended gill net	0.70861	0.00012	4	451	Auburn	Auburn
2018	Canyon	Creel	0.70854	0.00007	3	305	Auburn	Auburn
2018	Canyon	Creel	0.71077	0.00005	3	313	Wild	Wild
2018	Canyon	Creel	0.71077	0.00008	3	320	Wild	Wild
2018	Canyon	Creel	0.71014	0.00013	3	323	Under	Under
2018	Canyon	Creel	0.71068	0.00014	3	325	Wild	Under
2018	Canyon	Creel	0.71076	0.00012	3	330	Wild	Wild
2018	Canyon	Creel	0.70857	0.00007	3	336	Auburn	Auburn
2018	Canyon	Creel	0.71075	0.00006	3	337	Wild	Wild
2018	Canyon	Creel	0.71077	0.00004	3	351	Wild	Wild
2018	Canyon	Creel	0.71077	0.00003	3	352	Wild	Wild

Appendix A. cont’d

							Classification	
Sample year	FGR region	Sample method	Natal region ^{87}Sr/^{86}Sr mean	Natal region ^{87}Sr/^{86}Sr SD	Age at capture	MEF length (mm)	DFA with Wigwam	DFA without Wigwam
2018	Canyon	Creel	0.71081	0.00005	4	352	Wild	Wild
2018	Canyon	Creel	0.70861	0.00005	3	352	Auburn	Auburn
2018	Canyon	Creel	0.71059	0.00007	3	360	Under	Under
2018	Canyon	Creel	0.71111	0.00005	4	362	Wild	Wild
2018	Canyon	Creel	0.71107	0.00006	4	362	Wild	Wild
2018	Canyon	Creel	0.71109	0.00009	4	363	Wild	Wild
2018	Canyon	Creel	0.71107	0.00003	4	370	Wild	Wild
2018	Canyon	Creel	0.71099	0.00005	4	372	Wild	Wild
2018	Canyon	Creel	0.71104	0.00005	4	372	Wild	Wild
2018	Canyon	Creel	0.71099	0.00003	3	372	Wild	Wild
2018	Canyon	Creel	0.71109	0.00006	4	374	Wild	Wild
2018	Canyon	Creel	0.71104	0.00012	4	380	Wild	Wild
2018	Canyon	Creel	0.71101	0.00004	4	383	Wild	Wild
2018	Canyon	Creel	0.71125	0.00017	4	384	Wild	Wild
2018	Canyon	Creel	0.71108	0.00005	4	386	Wild	Wild
2018	Canyon	Creel	0.71106	0.00005	4	397	Wild	Wild
2018	Canyon	Creel	0.71113	0.00004	4	400	Wild	Wild
2018	Canyon	Creel	0.71110	0.00008	4	414	Wild	Wild
2018	Canyon	Sinking gill net	0.71082	0.00005	3	354	Wild	Wild
2018	Canyon	Sinking gill net	0.71082	0.00005	3	365	Wild	Wild
2018	Canyon	Sinking gill net	0.71086	0.00004	3	379	Wild	Wild
2018	Canyon	Sinking gill net	0.71096	0.00006	4	384	Wild	Wild
2018	Canyon	Sinking gill net	0.71089	0.00005	3	386	Wild	Wild
2018	Canyon	Sinking gill net	0.71084	0.00007	3	387	Wild	Wild
2018	Canyon	Sinking gill net	0.71081	0.00011	3	392	Wild	Wild
2018	Canyon	Sinking gill net	0.71071	0.00006	4	394	Wild	Under

Appendix A. cont'd

							Classification	
Sample year	FGR region	Sample method	Natal region $^{87}Sr/^{86}Sr$ mean	Natal region $^{87}Sr/^{86}Sr$ SD	Age at capture	MEF length (mm)	DFA with Wigwam	DFA without Wigwam
2018	Canyon	Sinking gill net	0.71086	0.00006	4	404	Wild	Wild
2018	Canyon	Sinking gill net	0.71085	0.00008	3	410	Wild	Wild
2018	Canyon	Sinking gill net	0.71081	0.00006	4	410	Wild	Wild
2018	Canyon	Sinking gill net	0.71093	0.00006	4	423	Wild	Wild
2018	Canyon	Sinking gill net	0.71103	0.00004	4	425	Wild	Wild
2018	Canyon	Sinking gill net	0.71088	0.00006	4	425	Wild	Wild
2018	Henrys Fork River	Weir	0.70873	0.00006	3	301	Auburn	Auburn
2018	Henrys Fork River	Weir	0.70871	0.00006	3	330	Auburn	Auburn
2018	Henrys Fork River	Weir	0.70865	0.00004	3	336	Auburn	Auburn
2018	Henrys Fork River	Weir	0.70875	0.00005	3	338	Auburn	Auburn
2018	Henrys Fork River	Weir	0.70870	0.00005	3	338	Auburn	Auburn
2018	Henrys Fork River	Weir	0.70870	0.00006	3	340	Auburn	Auburn
2018	Henrys Fork River	Weir	0.70863	0.00008	3	345	Auburn	Auburn
2018	Henrys Fork River	Weir	0.70875	0.00007	3	355	Auburn	Auburn
2018	Henrys Fork River	Weir	0.70875	0.00006	3	356	Auburn	Auburn
2018	Henrys Fork River	Weir	0.70864	0.00008	3	357	Auburn	Auburn
2018	Henrys Fork River	Weir	0.71089	0.00007	3	359	Wild	Wild
2018	Henrys Fork River	Weir	0.70869	0.00006	3	360	Auburn	Auburn
2018	Henrys Fork River	Weir	0.70866	0.00004	3	365	Auburn	Auburn
2018	Henrys Fork River	Weir	0.70869	0.00004	3	373	Auburn	Auburn
2018	Henrys Fork River	Weir	0.70873	0.00005	3	375	Auburn	Auburn
2018	Henrys Fork River	Weir	0.70871	0.00005	3	378	Auburn	Auburn
2018	Henrys Fork River	Weir	0.70862	0.00007	3	380	Auburn	Auburn
2018	Henrys Fork River	Weir	0.70871	0.00006	3	389	Auburn	Auburn
2018	Henrys Fork River	Weir	0.70862	0.00005	3	393	Auburn	Auburn
2018	Henrys Fork River	Weir	0.70877	0.00007	3	397	Auburn	Auburn

Appendix A. cont’d

							Classification	
Sample year	FGR region	Sample method	Natal region ^{87}Sr/^{86}Sr mean	Natal region ^{87}Sr/^{86}Sr SD	Age at capture	MEF length (mm)	DFA with Wigwam	DFA without Wigwam
2018	Henrys Fork River	Weir	0.70863	0.00008	3	396	Auburn	Auburn
2018	Henrys Fork River	Weir	0.70865	0.00005	3	402	Auburn	Auburn
2018	Henrys Fork River	Weir	0.71100	0.00012	4	402	Wild	Wild
2018	Sheep Creek	Weir	0.71016	0.00044	3	300	Under	Under
2018	Sheep Creek	Weir	0.71726	0.00019	2	305	Over	-
2018	Sheep Creek	Weir	0.70872	0.00004	3	325	Auburn	Auburn
2018	Sheep Creek	Weir	0.70979	0.00014	2	325	Under	-
2018	Sheep Creek	Weir	0.70870	0.00006	3	335	Auburn	Auburn
2018	Sheep Creek	Weir	0.70868	0.00006	3	338	Auburn	Auburn
2018	Sheep Creek	Weir	0.70864	0.00007	3	350	Auburn	Auburn
2018	Sheep Creek	Weir	0.71031	0.00011	3	355	Under	Under
2018	Sheep Creek	Weir	0.71075	0.00009	3	355	Wild	Wild
2018	Sheep Creek	Weir	0.70978	0.00012	3	365	Under	Under
2018	Sheep Creek	Weir	0.71049	0.00017	3	370	Under	Under
2018	Sheep Creek	Weir	0.71085	0.00008	3	374	Wild	Wild
2018	Sheep Creek	Weir	0.70873	0.00009	3	374	Auburn	Auburn
2018	Sheep Creek	Weir	0.70862	0.00004	3	374	Auburn	Auburn
2018	Sheep Creek	Weir	0.71057	0.00006	3	380	Under	Under
2018	Sheep Creek	Weir	0.71054	0.00006	3	380	Under	Under
2018	Sheep Creek	Weir	0.70974	0.00006	3	380	Under	Under
2018	Sheep Creek	Weir	0.70875	0.00004	3	395	Auburn	Auburn
2018	Sheep Creek	Weir	0.71040	0.00009	3	405	Under	Under
2018	Sheep Creek	Weir	0.71096	0.00011	4	405	Wild	Wild
2018	Sheep Creek	Weir	0.70878	0.00007	3	410	Auburn	Auburn
2018	Sheep Creek	Weir	0.70963	0.00008	3	413	Under	Under
2018	Sheep Creek	Weir	0.70876	0.00004	3	417	Auburn	Auburn

Appendix A. cont’d

							Classification	
Sample year	FGR region	Sample method	Natal region $^{87}Sr/^{86}Sr$ mean	Natal region $^{87}Sr/^{86}Sr$ SD	Age at capture	MEF length (mm)	DFA with Wigwam	DFA without Wigwam
2018	Sheep Creek	Weir	0.71087	0.00006	4	435	Wild	Wild
2018	Sheep Creek	Weir	0.71017	0.00013	3	437	Under	Under
2018	Sheep Creek	Weir	0.71102	0.00009	4	440	Wild	Wild
2019	Inflow	Suspended gill net	0.71122	0.00007	1	153	Wild	-
2019	Inflow	Suspended gill net	0.71110	0.00005	1	159	Wild	-
2019	Inflow	Suspended gill net	0.71120	0.00009	1	182	Wild	-
2019	Inflow	Suspended gill net	0.71113	0.00015	1	182	Wild	-
2019	Inflow	Suspended gill net	0.70986	0.00011	2	241	Under	Under
2019	Inflow	Suspended gill net	0.70887	0.00005	2	243	Under	Under
2019	Inflow	Suspended gill net	0.71859	0.00009	2	246	Over	Over
2019	Inflow	Suspended gill net	0.71984	0.00054	2	254	Over	Over
2019	Inflow	Suspended gill net	0.70944	0.00011	2	258	Under	Under
2019	Inflow	Suspended gill net	0.71122	0.00021	2	272	Wild	Wild
2019	Inflow	Suspended gill net	0.71110	0.00005	2	278	Wild	Wild
2019	Inflow	Suspended gill net	0.71121	0.00010	2	280	Wild	Wild
2019	Inflow	Suspended gill net	0.71138	0.00015	2	283	Wild	Wild
2019	Inflow	Suspended gill net	0.70953	0.00010	2	286	Under	Under
2019	Inflow	Suspended gill net	0.71683	0.00010	2	288	Over	Over
2019	Inflow	Suspended gill net	0.71087	0.00010	2	290	Wild	Wild
2019	Inflow	Suspended gill net	0.71086	0.00005	2	297	Wild	Wild
2019	Inflow	Suspended gill net	0.71084	0.00009	3	302	Wild	-
2019	Inflow	Suspended gill net	0.71084	0.00010	3	306	Wild	-
2019	Inflow	Suspended gill net	0.71095	0.00009	3	310	Wild	-
2019	Inflow	Suspended gill net	0.71108	0.00010	3	310	Wild	-
2019	Inflow	Suspended gill net	0.71076	0.00008	3	316	Wild	-
2019	Inflow	Suspended gill net	0.71434	0.00020	3	319	Over	-

Appendix A. cont'd

							Classification	
Sample year	FGR region	Sample method	Natal region $^{87}Sr/^{86}Sr$ mean	Natal region $^{87}Sr/^{86}Sr$ SD	Age at capture	MEF length (mm)	DFA with Wigwam	DFA without Wigwam
2019	Inflow	Suspended gill net	0.71087	0.00005	3	325	Wild	-
2019	Inflow	Suspended gill net	0.70855	0.00008	3	332	Auburn	-
2019	Inflow	Suspended gill net	0.70857	0.00006	3	334	Auburn	-
2019	Inflow	Suspended gill net	0.71073	0.00008	3	335	Wild	-
2019	Inflow	Suspended gill net	0.71082	0.00006	3	339	Wild	-
2019	Inflow	Suspended gill net	0.71071	0.00016	3	340	Wild	-
2019	Inflow	Suspended gill net	0.71100	0.00008	4	341	Wild	Wild
2019	Inflow	Suspended gill net	0.71084	0.00010	3	345	Wild	-
2019	Inflow	Suspended gill net	0.71086	0.00008	3	346	Wild	-
2019	Inflow	Suspended gill net	0.71099	0.00004	3	347	Wild	-
2019	Inflow	Suspended gill net	0.71095	0.00008	3	346	Wild	-
2019	Inflow	Suspended gill net	0.71109	0.00015	3	350	Wild	-
2019	Inflow	Suspended gill net	0.71111	0.00013	3	353	Wild	-
2019	Inflow	Suspended gill net	0.71106	0.00011	4	365	Wild	Wild
2019	Inflow	Suspended gill net	0.71488	0.00029	3	364	Over	-
2019	Inflow	Suspended gill net	0.71093	0.00006	3	367	Wild	-
2019	Inflow	Suspended gill net	0.71121	0.00011	4	378	Wild	Wild
2019	Inflow	Suspended gill net	0.71099	0.00012	4	380	Wild	Wild
2019	Inflow	Suspended gill net	0.70863	0.00007	3	379	Auburn	-
2019	Inflow	Suspended gill net	0.71666	0.00030	3	382	Over	-
2019	Inflow	Suspended gill net	0.70855	0.00005	3	383	Auburn	-
2019	Inflow	Suspended gill net	0.70861	0.00005	3	388	Auburn	-
2019	Inflow	Suspended gill net	0.71088	0.00007	4	395	Wild	Wild
2019	Inflow	Suspended gill net	0.70979	0.00015	3	392	Under	-
2019	Inflow	Suspended gill net	0.70793	0.00008	4	395	Over	Over
2019	Inflow	Suspended gill net	0.70963	0.00022	3	401	Under	-

Appendix A. cont’d

							Classification	
Sample year	FGR region	Sample method	Natal region ^{87}Sr/^{86}Sr mean	Natal region ^{87}Sr/^{86}Sr SD	Age at capture	MEF length (mm)	DFA with Wigwam	DFA without Wigwam
2019	Inflow	Suspended gill net	0.71119	0.00010	4	407	Wild	Wild
2019	Inflow	Suspended gill net	0.71133	0.00009	4	413	Wild	Wild
2019	Inflow	Suspended gill net	0.70846	0.00007	3	415	Auburn	-
2019	Inflow	Suspended gill net	0.70878	0.00011	3	410	Auburn	-
2019	Inflow	Suspended gill net	0.70853	0.00014	4	412	Auburn	Auburn
2019	Inflow	Suspended gill net	0.71071	0.00019	4	433	Wild	Under
2019	Inflow	Suspended gill net	0.70855	0.00009	4	440	Auburn	Auburn
2019	Inflow	Suspended gill net	0.71069	0.00044	5	450	Wild	Under
2019	Inflow	Creel	0.70821	0.00006	3	304	Over	-
2019	Inflow	Creel	0.71085	0.00012	3	328	Wild	-
2019	Inflow	Creel	0.71090	0.00009	3	345	Wild	-
2019	Inflow	Creel	0.71078	0.00007	3	352	Wild	-
2019	Inflow	Creel	0.70983	0.00011	3	353	Under	-
2019	Inflow	Creel	0.70974	0.00006	3	358	Under	-
2019	Inflow	Creel	0.70872	0.00006	3	359	Auburn	-
2019	Inflow	Creel	0.71076	0.00009	3	363	Wild	-
2019	Inflow	Creel	0.71536	0.00017	3	364	Over	-
2019	Inflow	Creel	0.71115	0.00014	4	366	Wild	Wild
2019	Inflow	Creel	0.71859	0.00016	3	370	Over	-
2019	Inflow	Creel	0.70869	0.00010	3	370	Auburn	-
2019	Inflow	Creel	0.70870	0.00007	3	370	Auburn	-
2019	Inflow	Creel	0.71088	0.00007	3	380	Wild	-
2019	Inflow	Creel	0.71662	0.00017	3	381	Over	-
2019	Inflow	Creel	0.70868	0.00005	3	383	Auburn	-
2019	Inflow	Creel	0.71036	0.00010	3	385	Under	-
2019	Inflow	Creel	0.71107	0.00008	4	390	Wild	Wild

Appendix A. cont'd

							Classification	
Sample year	FGR region	Sample method	Natal region ^{87}Sr/^{86}Sr mean	Natal region ^{87}Sr/^{86}Sr SD	Age at capture	MEF length (mm)	DFA with Wigwam	DFA without Wigwam
2019	Inflow	Creel	0.71100	0.00007	4	390	Wild	Wild
2019	Inflow	Creel	0.70962	0.00012	3	390	Under	-
2019	Inflow	Creel	0.71881	0.00040	4	400	Over	Over
2019	Inflow	Creel	0.70865	0.00006	3	400	Auburn	-
2019	Inflow	Creel	0.71112	0.00015	4	401	Wild	Wild
2019	Inflow	Creel	0.71094	0.00007	4	405	Wild	Wild
2019	Inflow	Creel	0.71100	0.00008	4	410	Wild	Wild
2019	Inflow	Creel	0.70867	0.00007	3	410	Auburn	-
2019	Inflow	Creel	0.70860	0.00005	3	410	Auburn	-
2019	Inflow	Creel	0.71096	0.00005	4	410	Wild	Wild
2019	Inflow	Creel	0.71091	0.00009	4	415	Wild	Wild
2019	Inflow	Creel	0.70863	0.00008	3	420	Auburn	-
2019	Inflow	Creel	0.71094	0.00005	3	421	Wild	-
2019	Inflow	Creel	0.71090	0.00006	5	431	Wild	Wild
2019	Inflow	Creel	0.70863	0.00008	3	437	Auburn	-
2019	Inflow	Creel	0.70869	0.00004	3	438	Auburn	-
2019	Inflow	Creel	0.70869	0.00006	4	439	Auburn	Auburn
2019	Inflow	Creel	0.71104	0.00015	4	446	Wild	Wild
2019	Inflow	Creel	0.70876	0.00005	3	450	Auburn	-
2019	Inflow	Sinking gill net	0.71094	0.00005	3	331	Wild	-
2019	Inflow	Sinking gill net	0.71084	0.00014	3	336	Wild	-
2019	Inflow	Sinking gill net	0.70862	0.00005	3	341	Auburn	-
2019	Inflow	Sinking gill net	0.70861	0.00007	3	345	Auburn	-
2019	Inflow	Sinking gill net	0.70860	0.00010	3	345	Auburn	-
2019	Inflow	Sinking gill net	0.70862	0.00005	3	350	Auburn	-
2019	Inflow	Sinking gill net	0.70867	0.00008	3	352	Auburn	-

Appendix A. cont'd

Sample year	FGR region	Sample method	Natal region $^{87}Sr/^{86}Sr$ mean	Natal region $^{87}Sr/^{86}Sr$ SD	Age at capture	MEF length (mm)	Classification DFA with Wigwam	 DFA without Wigwam
2019	Inflow	Sinking gill net	0.71086	0.00008	3	355	Wild	-
2019	Inflow	Sinking gill net	0.71083	0.00009	4	356	Wild	Wild
2019	Inflow	Sinking gill net	0.71086	0.00014	3	356	Wild	-
2019	Inflow	Sinking gill net	0.71104	0.00012	4	362	Wild	Wild
2019	Inflow	Sinking gill net	0.71105	0.00011	4	362	Wild	Wild
2019	Inflow	Sinking gill net	0.71565	0.00011	3	362	Over	-
2019	Inflow	Sinking gill net	0.71101	0.00009	4	363	Wild	Wild
2019	Inflow	Sinking gill net	0.71079	0.00010	3	370	Wild	-
2019	Inflow	Sinking gill net	0.70954	0.00014	3	370	Under	-
2019	Inflow	Sinking gill net	0.70867	0.00008	4	370	Auburn	Auburn
2019	Inflow	Sinking gill net	0.71102	0.00008	3	371	Wild	-
2019	Inflow	Sinking gill net	0.70974	0.00009	3	382	Under	-
2019	Inflow	Sinking gill net	0.70864	0.00011	3	382	Auburn	-
2019	Inflow	Sinking gill net	0.70966	0.00009	3	385	Under	-
2019	Inflow	Sinking gill net	0.71097	0.00016	3	386	Wild	-
2019	Inflow	Sinking gill net	0.70892	0.00022	3	392	Under	-
2019	Inflow	Sinking gill net	0.70871	0.00006	3	393	Auburn	-
2019	Inflow	Sinking gill net	0.70965	0.00009	3	397	Under	-
2019	Inflow	Sinking gill net	0.71120	0.00008	4	402	Wild	Wild
2019	Inflow	Sinking gill net	0.70963	0.00023	3	402	Under	-
2019	Inflow	Sinking gill net	0.71613	0.00020	3	404	Over	-
2019	Inflow	Sinking gill net	0.71124	0.00011	4	388	Wild	Wild
2019	Inflow	Sinking gill net	0.71100	0.00013	4	406	Wild	Wild
2019	Inflow	Sinking gill net	0.71088	0.00013	4	410	Wild	Wild
2019	Inflow	Sinking gill net	0.71098	0.00005	4	410	Wild	Wild
2019	Inflow	Sinking gill net	0.71121	0.00023	4	414	Wild	Wild

Appendix A. cont’d

							Classification	
Sample year	FGR region	Sample method	Natal region $^{87}Sr/^{86}Sr$ mean	Natal region $^{87}Sr/^{86}Sr$ SD	Age at capture	MEF length (mm)	DFA with Wigwam	DFA without Wigwam
2019	Inflow	Sinking gill net	0.71104	0.00014	4	420	Wild	Wild
2019	Inflow	Sinking gill net	0.71108	0.00015	4	424	Wild	Wild
2019	Inflow	Sinking gill net	0.70864	0.00007	4	425	Auburn	Auburn
2019	Inflow	Sinking gill net	0.71115	0.00019	4	430	Wild	Wild
2019	Inflow	Sinking gill net	0.71098	0.00008	4	431	Wild	Wild
2019	Inflow	Sinking gill net	0.71111	0.00013	4	431	Wild	Wild
2019	Inflow	Sinking gill net	0.71089	0.00005	4	437	Wild	Wild
2019	Inflow	Sinking gill net	0.71117	0.00007	4	440	Wild	Wild
2019	Inflow	Sinking gill net	0.71101	0.00007	4	444	Wild	Wild
2019	Inflow	Sinking gill net	0.71076	0.00009	4	446	Wild	Wild
2019	Inflow	Sinking gill net	0.71105	0.00013	4	455	Wild	Wild
2019	Inflow	Sinking gill net	0.71087	0.00012	4	457	Wild	Wild
2019	Open Hills	Suspended gill net	0.70971	0.00024	2	248	Under	Under
2019	Open Hills	Suspended gill net	0.70864	0.00014	2	252	Auburn	Auburn
2019	Open Hills	Suspended gill net	0.70844	0.00017	2	265	Auburn	Auburn
2019	Open Hills	Suspended gill net	0.71081	0.00006	2	265	Wild	Wild
2019	Open Hills	Suspended gill net	0.71092	0.00008	2	271	Wild	Wild
2019	Open Hills	Suspended gill net	0.71087	0.00004	2	271	Wild	Wild
2019	Open Hills	Suspended gill net	0.71080	0.00007	2	275	Wild	Wild
2019	Open Hills	Suspended gill net	0.70868	0.00004	2	280	Auburn	Auburn
2019	Open Hills	Suspended gill net	0.71086	0.00010	2	282	Wild	Wild
2019	Open Hills	Suspended gill net	0.71086	0.00007	2	282	Wild	Wild
2019	Open Hills	Suspended gill net	0.70974	0.00008	3	312	Under	-
2019	Open Hills	Suspended gill net	0.70859	0.00007	3	332	Auburn	-
2019	Open Hills	Suspended gill net	0.70972	0.00009	3	335	Under	-
2019	Open Hills	Suspended gill net	0.71522	0.00020	3	340	Over	-

Appendix A. cont'd

Sample year	FGR region	Sample method	Natal region $^{87}Sr/^{86}Sr$ mean	Natal region $^{87}Sr/^{86}Sr$ SD	Age at capture	MEF length (mm)	Classification DFA with Wigwam	 DFA without Wigwam
2019	Open Hills	Suspended gill net	0.70864	0.00006	3	341	Auburn	-
2019	Open Hills	Suspended gill net	0.72165	0.00036	3	345	Over	-
2019	Open Hills	Suspended gill net	0.70964	0.00007	3	349	Under	-
2019	Open Hills	Suspended gill net	0.71491	0.00025	3	355	Over	-
2019	Open Hills	Suspended gill net	0.70974	0.00006	3	358	Under	-
2019	Open Hills	Suspended gill net	0.70964	0.00007	3	360	Under	-
2019	Open Hills	Suspended gill net	0.71086	0.00008	3	360	Wild	-
2019	Open Hills	Suspended gill net	0.70864	0.00006	3	365	Auburn	-
2019	Open Hills	Suspended gill net	0.70864	0.00009	3	374	Auburn	-
2019	Open Hills	Suspended gill net	0.70883	0.00021	3	375	Auburn	-
2019	Open Hills	Suspended gill net	0.71097	0.00008	3	380	Wild	-
2019	Open Hills	Suspended gill net	0.71766	0.00033	3	380	Over	-
2019	Open Hills	Suspended gill net	0.70974	0.00010	3	382	Under	-
2019	Open Hills	Suspended gill net	0.71627	0.00024	3	383	Over	-
2019	Open Hills	Suspended gill net	0.71078	0.00006	3	391	Wild	-
2019	Open Hills	Suspended gill net	0.70866	0.00011	3	396	Auburn	-
2019	Open Hills	Suspended gill net	0.71100	0.00011	3	400	Wild	-
2019	Open Hills	Suspended gill net	0.71098	0.00011	4	404	Wild	Wild
2019	Open Hills	Suspended gill net	0.71095	0.00015	4	414	Wild	Wild
2019	Open Hills	Suspended gill net	0.71091	0.00013	4	414	Wild	Wild
2019	Open Hills	Suspended gill net	0.71097	0.00012	4	419	Wild	Wild
2019	Open Hills	Suspended gill net	0.71093	0.00008	4	422	Wild	Wild
2019	Open Hills	Suspended gill net	0.71091	0.00009	4	427	Wild	Wild
2019	Open Hills	Suspended gill net	0.70870	0.00006	4	430	Auburn	Auburn
2019	Open Hills	Suspended gill net	0.71105	0.00010	4	430	Wild	Wild
2019	Open Hills	Suspended gill net	0.71785	0.00036	3	433	Over	-

Appendix A. cont'd

Sample year	FGR region	Sample method	Natal region $^{87}Sr/^{86}Sr$ mean	Natal region $^{87}Sr/^{86}Sr$ SD	Age at capture	MEF length (mm)	Classification	
							DFA with Wigwam	DFA without Wigwam
2019	Open Hills	Creel	0.71097	0.00013	2	267	Wild	Wild
2019	Open Hills	Creel	0.71009	0.00019	2	287	Under	Under
2019	Open Hills	Creel	0.71827	0.00033	2	300	Over	Over
2019	Open Hills	Creel	0.70866	0.00007	2	305	Auburn	Auburn
2019	Open Hills	Creel	0.71080	0.00010	3	309	Wild	-
2019	Open Hills	Creel	0.70867	0.00008	3	311	Auburn	-
2019	Open Hills	Creel	0.71091	0.00006	3	326	Wild	-
2019	Open Hills	Creel	0.71086	0.00006	3	327	Wild	-
2019	Open Hills	Creel	0.70867	0.00003	3	340	Auburn	-
2019	Open Hills	Creel	0.71086	0.00004	4	397	Wild	Wild
2019	Open Hills	Creel	0.70972	0.00007	3	348	Under	-
2019	Open Hills	Creel	0.70870	0.00006	3	353	Auburn	-
2019	Open Hills	Creel	0.71092	0.00006	3	355	Wild	-
2019	Open Hills	Creel	0.71088	0.00006	3	356	Wild	-
2019	Open Hills	Creel	0.70985	0.00006	3	361	Under	-
2019	Open Hills	Creel	0.71097	0.00007	3	365	Wild	-
2019	Open Hills	Creel	0.70867	0.00008	3	365	Auburn	-
2019	Open Hills	Creel	0.71100	0.00008	3	370	Wild	-
2019	Open Hills	Creel	0.70872	0.00005	3	375	Auburn	-
2019	Open Hills	Creel	0.71094	0.00006	3	375	Wild	-
2019	Open Hills	Creel	0.70881	0.00007	3	381	Auburn	-
2019	Open Hills	Creel	0.70956	0.00010	3	385	Under	-
2019	Open Hills	Creel	0.71088	0.00009	3	386	Wild	-
2019	Open Hills	Creel	0.70860	0.00007	3	397	Auburn	-
2019	Open Hills	Creel	0.71091	0.00012	4	403	Wild	Wild
2019	Open Hills	Creel	0.71104	0.00009	4	405	Wild	Wild

Appendix A. cont'd

							Classification	
Sample year	FGR region	Sample method	Natal region $^{87}Sr/^{86}Sr$ mean	Natal region $^{87}Sr/^{86}Sr$ SD	Age at capture	MEF length (mm)	DFA with Wigwam	DFA without Wigwam
2019	Open Hills	Sinking gill net	0.70885	0.00009	4	395	Auburn	Auburn
2019	Open Hills	Sinking gill net	0.70882	0.00011	4	396	Auburn	Auburn
2019	Open Hills	Sinking gill net	0.71632	0.00017	3	403	Over	-
2019	Open Hills	Sinking gill net	0.70869	0.00005	3	410	Auburn	-
2019	Open Hills	Sinking gill net	0.71097	0.00006	4	413	Wild	Wild
2019	Open Hills	Sinking gill net	0.70890	0.00006	4	418	Under	Under
2019	Open Hills	Sinking gill net	0.71097	0.00004	4	421	Wild	Wild
2019	Open Hills	Sinking gill net	0.70885	0.00003	3	425	Auburn	-
2019	Open Hills	Sinking gill net	0.70878	0.00008	4	466	Auburn	Auburn
2019	Open Hills	Sinking gill net	0.71092	0.00008	3	316	Wild	-
2019	Open Hills	Sinking gill net	0.70865	0.00003	3	317	Auburn	-
2019	Open Hills	Sinking gill net	0.70960	0.00008	3	324	Under	-
2019	Open Hills	Sinking gill net	0.71087	0.00007	3	325	Wild	-
2019	Open Hills	Sinking gill net	0.70812	0.00005	3	331	Over	-
2019	Open Hills	Sinking gill net	0.71081	0.00006	3	336	Wild	-
2019	Open Hills	Sinking gill net	0.71709	0.00033	3	340	Over	-
2019	Open Hills	Sinking gill net	0.70870	0.00006	3	353	Auburn	-
2019	Open Hills	Sinking gill net	0.70963	0.00008	4	354	Under	Under
2019	Open Hills	Sinking gill net	0.71597	0.00006	3	356	Over	-
2019	Open Hills	Sinking gill net	0.70868	0.00005	3	363	Auburn	-
2019	Open Hills	Sinking gill net	0.71535	0.00025	3	366	Over	-
2019	Open Hills	Sinking gill net	0.70866	0.00009	4	367	Auburn	Auburn
2019	Open Hills	Sinking gill net	0.71561	0.00023	3	369	Over	-
2019	Open Hills	Sinking gill net	0.70975	0.00007	3	370	Under	-
2019	Open Hills	Sinking gill net	0.71609	0.00026	3	370	Over	-
2019	Open Hills	Sinking gill net	0.71483	0.00016	4	372	Over	Over

Appendix A. cont’d

Sample year	FGR region	Sample method	Natal region ^{87}Sr/^{86}Sr mean	Natal region ^{87}Sr/^{86}Sr SD	Age at capture	MEF length (mm)	Classification	
							DFA with Wigwam	DFA without Wigwam
2019	Open Hills	Sinking gill net	0.70863	0.00005	3	372	Auburn	-
2019	Open Hills	Sinking gill net	0.70968	0.00005	3	380	Under	-
2019	Open Hills	Sinking gill net	0.71464	0.00017	3	383	Over	-
2019	Open Hills	Sinking gill net	0.70867	0.00007	3	384	Auburn	-
2019	Open Hills	Sinking gill net	0.70958	0.00008	4	390	Under	Under
2019	Open Hills	Sinking gill net	0.70946	0.00014	4	393	Under	Under
2019	Open Hills	Sinking gill net	0.70868	0.00004	3	394	Auburn	-
2019	Canyon	Suspended gill net	0.70859	0.00009	2	247	Auburn	Auburn
2019	Canyon	Suspended gill net	0.71773	0.00035	2	248	Over	Over
2019	Canyon	Suspended gill net	0.71014	0.00011	2	257	Under	Under
2019	Canyon	Suspended gill net	0.70872	0.00009	2	266	Auburn	Auburn
2019	Canyon	Suspended gill net	0.71087	0.00007	3	270	Wild	-
2019	Canyon	Suspended gill net	0.71099	0.00008	2	274	Wild	Wild
2019	Canyon	Suspended gill net	0.71080	0.00005	3	280	Wild	-
2019	Canyon	Suspended gill net	0.71091	0.00007	3	285	Wild	-
2019	Canyon	Suspended gill net	0.70868	0.00006	3	300	Auburn	-
2019	Canyon	Suspended gill net	0.70863	0.00005	3	300	Auburn	-
2019	Canyon	Suspended gill net	0.71008	0.00029	3	305	Under	-
2019	Canyon	Suspended gill net	0.70864	0.00005	3	314	Auburn	-
2019	Canyon	Suspended gill net	0.71077	0.00006	3	320	Wild	-
2019	Canyon	Suspended gill net	0.70969	0.00011	3	323	Under	-
2019	Canyon	Suspended gill net	0.71786	0.00021	3	328	Over	-
2019	Canyon	Suspended gill net	0.71096	0.00008	3	329	Wild	-
2019	Canyon	Suspended gill net	0.71073	0.00012	3	333	Wild	-
2019	Canyon	Suspended gill net	0.70952	0.00023	3	335	Under	-
2019	Canyon	Suspended gill net	0.71091	0.00012	3	337	Wild	-

Appendix A. cont'd

Sample year	FGR region	Sample method	Natal region $^{87}Sr/^{86}Sr$ mean	Natal region $^{87}Sr/^{86}Sr$ SD	Age at capture	MEF length (mm)	Classification	
							DFA with Wigwam	DFA without Wigwam
2019	Canyon	Suspended gill net	0.71092	0.00012	3	338	Wild	-
2019	Canyon	Suspended gill net	0.70867	0.00007	3	340	Auburn	-
2019	Canyon	Suspended gill net	0.71087	0.00008	3	345	Wild	-
2019	Canyon	Suspended gill net	0.70860	0.00010	3	347	Auburn	-
2019	Canyon	Suspended gill net	0.71104	0.00015	3	349	Wild	-
2019	Canyon	Suspended gill net	0.70879	0.00004	4	356	Auburn	Auburn
2019	Canyon	Suspended gill net	0.71027	0.00010	3	356	Under	-
2019	Canyon	Suspended gill net	0.70963	0.00007	3	358	Under	-
2019	Canyon	Suspended gill net	0.71091	0.00006	3	359	Wild	-
2019	Canyon	Suspended gill net	0.71084	0.00006	3	364	Wild	-
2019	Canyon	Suspended gill net	0.71083	0.00004	2	295	Wild	Wild
2019	Canyon	Suspended gill net	0.70866	0.00007	4	369	Auburn	Auburn
2019	Canyon	Suspended gill net	0.70870	0.00004	4	371	Auburn	Auburn
2019	Canyon	Suspended gill net	0.71711	0.00058	3	372	Over	-
2019	Canyon	Suspended gill net	0.70867	0.00006	4	374	Auburn	Auburn
2019	Canyon	Suspended gill net	0.70948	0.00005	3	377	Under	-
2019	Canyon	Suspended gill net	0.71092	0.00007	4	401	Wild	Wild
2019	Canyon	Suspended gill net	0.70875	0.00005	3	357	Auburn	-
2019	Canyon	Creel	0.70978	0.00009	2	255	Under	Under
2019	Canyon	Creel	0.70971	0.00008	2	270	Under	Under
2019	Canyon	Creel	0.71093	0.00009	2	275	Wild	Wild
2019	Canyon	Creel	0.71087	0.00009	3	340	Wild	-
2019	Canyon	Creel	0.70996	0.00007	2	285	Under	Under
2019	Canyon	Creel	0.70972	0.00006	2	290	Under	Under
2019	Canyon	Creel	0.70982	0.00010	3	300	Under	-
2019	Canyon	Creel	0.70962	0.00007	3	305	Under	-

Appendix A. cont’d

							Classification	
Sample year	FGR region	Sample method	Natal region $^{87}Sr/^{86}Sr$ mean	Natal region $^{87}Sr/^{86}Sr$ SD	Age at capture	MEF length (mm)	DFA with Wigwam	DFA without Wigwam
2019	Canyon	Creel	0.70871	0.00007	3	305	Auburn	-
2019	Canyon	Creel	0.70870	0.00008	3	310	Auburn	-
2019	Canyon	Creel	0.70866	0.00007	3	310	Auburn	-
2019	Canyon	Creel	0.70871	0.00006	3	310	Auburn	-
2019	Canyon	Creel	0.71037	0.00006	3	314	Under	-
2019	Canyon	Creel	0.70867	0.00005	4	325	Auburn	Auburn
2019	Canyon	Creel	0.70993	0.00017	3	325	Under	-
2019	Canyon	Creel	0.71092	0.00015	3	328	Wild	-
2019	Canyon	Creel	0.70874	0.00006	3	330	Auburn	-
2019	Canyon	Creel	0.70966	0.00006	3	330	Under	-
2019	Canyon	Creel	0.70949	0.00006	3	355	Under	-
2019	Canyon	Creel	0.71101	0.00007	4	370	Wild	Wild
2019	Canyon	Creel	0.71104	0.00028	4	370	Wild	Wild
2019	Canyon	Creel	0.71101	0.00015	4	375	Wild	Wild
2019	Canyon	Creel	0.70966	0.00008	3	395	Under	-
2019	Canyon	Creel	0.70871	0.00006	4	397	Auburn	Auburn
2019	Canyon	Creel	0.71085	0.00005	4	402	Wild	Wild
2019	Canyon	Creel	0.70870	0.00006	4	406	Auburn	Auburn
2019	Henrys Fork River	Weir	0.70861	0.00004	3	313	Auburn	-
2019	Henrys Fork River	Weir	0.70851	0.00008	2	334	Auburn	Auburn
2019	Henrys Fork River	Weir	0.70860	0.00004	3	335	Auburn	-
2019	Henrys Fork River	Weir	0.70861	0.00007	3	340	Auburn	-
2019	Henrys Fork River	Weir	0.70993	0.00026	3	350	Under	-
2019	Henrys Fork River	Weir	0.71662	0.00019	3	353	Over	-
2019	Henrys Fork River	Weir	0.70884	0.00017	4	354	Auburn	Auburn
2019	Henrys Fork River	Weir	0.70871	0.00007	4	360	Auburn	Auburn

Appendix A. cont’d

							Classification	
Sample year	FGR region	Sample method	Natal region $^{87}Sr/^{86}Sr$ mean	Natal region $^{87}Sr/^{86}Sr$ SD	Age at capture	MEF length (mm)	DFA with Wigwam	DFA without Wigwam
2019	Henrys Fork River	Weir	0.70865	0.00009	3	360	Auburn	-
2019	Henrys Fork River	Weir	0.70953	0.00009	3	361	Under	-
2019	Henrys Fork River	Weir	0.70874	0.00010	4	362	Auburn	Auburn
2019	Henrys Fork River	Weir	0.70869	0.00015	4	370	Auburn	Auburn
2019	Henrys Fork River	Weir	0.70868	0.00015	3	370	Auburn	-
2019	Henrys Fork River	Weir	0.70869	0.00013	3	372	Auburn	-
2019	Henrys Fork River	Weir	0.71072	0.00009	4	376	Wild	Wild
2019	Henrys Fork River	Weir	0.71080	0.00009	4	380	Wild	Wild
2019	Henrys Fork River	Weir	0.71737	0.00025	3	380	Over	-
2019	Henrys Fork River	Weir	0.71543	0.00047	3	380	Over	-
2019	Henrys Fork River	Weir	0.70864	0.00008	4	382	Auburn	Auburn
2019	Henrys Fork River	Weir	0.71706	0.00027	3	382	Over	-
2019	Henrys Fork River	Weir	0.71487	0.00007	3	393	Over	-
2019	Henrys Fork River	Weir	0.71648	0.00020	3	395	Over	-
2019	Henrys Fork River	Weir	0.71623	0.00056	3	396	Over	-
2019	Henrys Fork River	Weir	0.70961	0.00007	3	397	Under	-
2019	Henrys Fork River	Weir	0.70974	0.00006	3	397	Under	-
2019	Henrys Fork River	Weir	0.70882	0.00004	4	400	Auburn	Auburn
2019	Henrys Fork River	Weir	0.71784	0.00067	3	402	Over	-
2019	Henrys Fork River	Weir	0.70875	0.00012	4	404	Auburn	Auburn
2019	Henrys Fork River	Weir	0.70872	0.00011	4	404	Auburn	Auburn
2019	Henrys Fork River	Weir	0.70873	0.00006	4	410	Auburn	Auburn
2019	Henrys Fork River	Weir	0.70873	0.00006	4	412	Auburn	Auburn
2019	Henrys Fork River	Weir	0.70883	0.00010	4	414	Auburn	Auburn
2019	Henrys Fork River	Weir	0.70879	0.00010	4	420	Auburn	Auburn
2019	Henrys Fork River	Weir	0.71596	0.00008	3	421	Over	-

Appendix A. cont’d

							Classification	
Sample year	FGR region	Sample method	Natal region $^{87}Sr/^{86}Sr$ mean	Natal region $^{87}Sr/^{86}Sr$ SD	Age at capture	MEF length (mm)	DFA with Wigwam	DFA without Wigwam
2019	Henrys Fork River	Weir	0.70866	0.00006	4	422	Auburn	Auburn
2019	Henrys Fork River	Weir	0.70872	0.00004	4	428	Auburn	Auburn
2019	Henrys Fork River	Weir	0.70888	0.00005	4	431	Under	Under
2019	Henrys Fork River	Weir	0.70873	0.00003	4	437	Auburn	Auburn
2019	Henrys Fork River	Weir	0.70974	0.00012	4	440	Under	Under
2019	Henrys Fork River	Weir	0.70871	0.00007	4	442	Auburn	Auburn
2019	Henrys Fork River	Weir	0.70878	0.00007	4	447	Auburn	Auburn
2019	Sheep Creek	Weir	0.70980	0.00005	3	283	Under	-
2019	Sheep Creek	Weir	0.70858	0.00004	3	296	Auburn	-
2019	Sheep Creek	Weir	0.71090	0.00006	3	313	Wild	-
2019	Sheep Creek	Weir	0.70866	0.00004	3	313	Auburn	-
2019	Sheep Creek	Weir	0.71095	0.00006	3	316	Wild	-
2019	Sheep Creek	Weir	0.70867	0.00012	3	320	Auburn	-
2019	Sheep Creek	Weir	0.70865	0.00009	3	322	Auburn	-
2019	Sheep Creek	Weir	0.70861	0.00003	3	324	Auburn	-
2019	Sheep Creek	Weir	0.70869	0.00008	3	327	Auburn	-
2019	Sheep Creek	Weir	0.71093	0.00004	4	330	Wild	Wild
2019	Sheep Creek	Weir	0.70864	0.00006	3	330	Auburn	-
2019	Sheep Creek	Weir	0.70968	0.00009	3	340	Under	-
2019	Sheep Creek	Weir	0.71671	0.00025	3	343	Over	-
2019	Sheep Creek	Weir	0.70868	0.00003	3	343	Auburn	-
2019	Sheep Creek	Weir	0.70947	0.00009	3	344	Under	-
2019	Sheep Creek	Weir	0.70977	0.00008	3	352	Under	-
2019	Sheep Creek	Weir	0.70965	0.00009	3	353	Under	-
2019	Sheep Creek	Weir	0.70870	0.00007	3	353	Auburn	-
2019	Sheep Creek	Weir	0.70873	0.00005	3	361	Auburn	-

Appendix A. cont'd

Sample year	FGR region	Sample method	Natal region ^{87}Sr/^{86}Sr mean	Natal region ^{87}Sr/^{86}Sr SD	Age at capture	MEF length (mm)	Classification	
							DFA with Wigwam	DFA without Wigwam
2019	Sheep Creek	Weir	0.71090	0.00007	3	362	Wild	-
2019	Sheep Creek	Weir	0.70958	0.00005	3	357	Under	-
2019	Sheep Creek	Weir	0.70960	0.00008	3	364	Under	-
2019	Sheep Creek	Weir	0.71073	0.00005	4	372	Wild	Wild
2019	Sheep Creek	Weir	0.70970	0.00008	3	372	Under	-
2019	Sheep Creek	Weir	0.71614	0.00039	3	373	Over	-
2019	Sheep Creek	Weir	0.70971	0.00008	3	373	Under	-
2019	Sheep Creek	Weir	0.70979	0.00013	3	380	Under	-
2019	Sheep Creek	Weir	0.70976	0.00009	3	380	Under	-
2019	Sheep Creek	Weir	0.70869	0.00014	3	382	Auburn	-
2019	Sheep Creek	Weir	0.70955	0.00010	3	384	Under	-
2019	Sheep Creek	Weir	0.71509	0.00025	3	384	Over	-
2019	Sheep Creek	Weir	0.71570	0.00052	3	391	Over	-
2019	Sheep Creek	Weir	0.70869	0.00003	4	393	Auburn	Auburn
2019	Sheep Creek	Weir	0.71076	0.00005	4	394	Wild	Wild
2019	Sheep Creek	Weir	0.70870	0.00003	4	394	Auburn	Auburn
2019	Sheep Creek	Weir	0.71564	0.00057	3	400	Over	-
2019	Sheep Creek	Weir	0.71089	0.00010	4	400	Wild	Wild
2019	Sheep Creek	Weir	0.70871	0.00003	3	402	Auburn	-
2019	Sheep Creek	Weir	0.70962	0.00007	3	406	Under	-
2019	Sheep Creek	Weir	0.70965	0.00005	4	412	Under	Under
2019	Sheep Creek	Weir	0.70974	0.00008	3	412	Under	-
2019	Sheep Creek	Weir	0.71556	0.00021	3	415	Over	-
2019	Sheep Creek	Weir	0.70961	0.00012	3	415	Under	-
2019	Sheep Creek	Weir	0.70884	0.00013	3	420	Auburn	-
2019	Sheep Creek	Weir	0.70858	0.00007	4	422	Auburn	Auburn

Appendix A. cont’d

							Classification	
Sample year	FGR region	Sample method	Natal region ^{87}Sr/^{86}Sr mean	Natal region ^{87}Sr/^{86}Sr SD	Age at capture	MEF length (mm)	DFA with Wigwam	DFA without Wigwam
2019	Sheep Creek	Weir	0.71657	0.00038	3	422	Over	-
2019	Sheep Creek	Weir	0.71560	0.00012	3	425	Over	-
2019	Sheep Creek	Weir	0.70867	0.00007	3	437	Auburn	-
2020	Inflow	Suspended gill net	0.71109	0.00010	1	146	Wild	Wild
2020	Inflow	Suspended gill net	0.71120	0.00007	1	148	Wild	Wild
2020	Inflow	Suspended gill net	0.71107	0.00009	1	153	Wild	Wild
2020	Inflow	Suspended gill net	0.71123	0.00009	1	157	Wild	Wild
2020	Inflow	Suspended gill net	0.71128	0.00011	1	161	Wild	Wild
2020	Inflow	Suspended gill net	0.71112	0.00011	1	163	Wild	Wild
2020	Inflow	Suspended gill net	0.71099	0.00010	1	163	Wild	Wild
2020	Inflow	Suspended gill net	0.71114	0.00007	1	172	Wild	Wild
2020	Inflow	Suspended gill net	0.71101	0.00007	2	273	Wild	-
2020	Inflow	Suspended gill net	0.71108	0.00005	2	277	Wild	-
2020	Inflow	Suspended gill net	0.71102	0.00015	2	278	Wild	-
2020	Inflow	Suspended gill net	0.70982	0.00012	2	284	Under	-
2020	Inflow	Suspended gill net	0.71129	0.00005	2	293	Wild	-
2020	Inflow	Suspended gill net	0.71135	0.00020	2	293	Wild	-
2020	Inflow	Suspended gill net	0.71119	0.00005	3	312	Wild	Wild
2020	Inflow	Suspended gill net	0.71120	0.00006	3	313	Wild	Wild
2020	Inflow	Suspended gill net	0.71114	0.00013	3	337	Wild	Wild
2020	Inflow	Suspended gill net	0.71105	0.00007	3	320	Wild	Wild
2020	Inflow	Suspended gill net	0.71078	0.00006	3	333	Wild	Wild
2020	Inflow	Suspended gill net	0.71117	0.00013	3	343	Wild	Wild
2020	Inflow	Suspended gill net	0.71132	0.00010	3	343	Wild	Wild
2020	Inflow	Suspended gill net	0.71113	0.00004	4	438	Wild	-
2020	Inflow	Suspended gill net	0.71124	0.00020	3	352	Wild	Wild

Appendix A. cont’d

							Classification	
Sample year	FGR region	Sample method	Natal region $^{87}Sr/^{86}Sr$ mean	Natal region $^{87}Sr/^{86}Sr$ SD	Age at capture	MEF length (mm)	DFA with Wigwam	DFA without Wigwam
2020	Inflow	Suspended gill net	0.71118	0.00005	3	353	Wild	Wild
2020	Inflow	Suspended gill net	0.71147	0.00004	3	354	Wild	Wild
2020	Inflow	Suspended gill net	0.70869	0.00012	3	364	Auburn	Auburn
2020	Inflow	Suspended gill net	0.71102	0.00008	3	367	Wild	Wild
2020	Inflow	Suspended gill net	0.71101	0.00010	4	379	Wild	-
2020	Inflow	Suspended gill net	0.71100	0.00007	3	381	Wild	Wild
2020	Inflow	Suspended gill net	0.71080	0.00025	4	395	Wild	-
2020	Inflow	Suspended gill net	0.71078	0.00010	3	400	Wild	Wild
2020	Inflow	Suspended gill net	0.71094	0.00010	4	402	Wild	-
2020	Inflow	Suspended gill net	0.71111	0.00020	4	403	Wild	-
2020	Inflow	Suspended gill net	0.71070	0.00012	4	415	Wild	-
2020	Inflow	Suspended gill net	0.71078	0.00006	4	423	Wild	-
2020	Inflow	Suspended gill net	0.71063	0.00007	4	425	Under	-
2020	Inflow	Suspended gill net	0.70981	0.00019	3	431	Under	Under
2020	Inflow	Suspended gill net	0.71081	0.00010	4	434	Wild	-
2020	Inflow	Suspended gill net	0.71087	0.00020	4	445	Wild	-
2020	Inflow	Suspended gill net	0.71086	0.00020	4	446	Wild	-
2020	Inflow	Suspended gill net	0.71062	0.00016	4	447	Under	-
2020	Inflow	Suspended gill net	0.71097	0.00018	4	457	Wild	-
2020	Inflow	Suspended gill net	0.71095	0.00009	4	459	Wild	-
2020	Inflow	Suspended gill net	0.71090	0.00017	4	463	Wild	-
2020	Inflow	Suspended gill net	0.71074	0.00015	4	463	Wild	-
2020	Inflow	Suspended gill net	0.71083	0.00014	4	468	Wild	-
2020	Inflow	Suspended gill net	0.71322	0.00049	4	474	Over	-
2020	Inflow	Suspended gill net	0.71065	0.00012	4	475	Under	-
2020	Inflow	Suspended gill net	0.71093	0.00012	6	505	Wild	Wild

Appendix A. cont'd

Sample year	FGR region	Sample method	Natal region ^{87}Sr/^{86}Sr mean	Natal region ^{87}Sr/^{86}Sr SD	Age at capture	MEF length (mm)	Classification	
							DFA with Wigwam	DFA without Wigwam
2020	Inflow	Suspended gill net	0.71104	0.00022	6	510	Wild	Wild
2020	Inflow	Creel	0.71555	0.00050	2	260	Over	-
2020	Inflow	Creel	0.71106	0.00009	2	276	Wild	-
2020	Inflow	Creel	0.71104	0.00007	2	294	Wild	-
2020	Inflow	Creel	0.71124	0.00019	2	295	Wild	-
2020	Inflow	Creel	0.71109	0.00006	3	305	Wild	Wild
2020	Inflow	Creel	0.71091	0.00009	3	310	Wild	Wild
2020	Inflow	Creel	0.70873	0.00005	3	316	Auburn	Auburn
2020	Inflow	Creel	0.71104	0.00013	3	317	Wild	Wild
2020	Inflow	Creel	0.71124	0.00007	3	322	Wild	Wild
2020	Inflow	Creel	0.71082	0.00009	3	324	Wild	Wild
2020	Inflow	Creel	0.71064	0.00023	3	330	Under	Under
2020	Inflow	Creel	0.71115	0.00007	3	330	Wild	Wild
2020	Inflow	Creel	0.71112	0.00008	3	332	Wild	Wild
2020	Inflow	Creel	0.71121	0.00010	3	342	Wild	Wild
2020	Inflow	Creel	0.71098	0.00014	3	345	Wild	Wild
2020	Inflow	Creel	0.71107	0.00013	3	350	Wild	Wild
2020	Inflow	Creel	0.71122	0.00022	3	350	Wild	Wild
2020	Inflow	Creel	0.71114	0.00006	3	354	Wild	Wild
2020	Inflow	Creel	0.71081	0.00010	4	360	Wild	-
2020	Inflow	Creel	0.71111	0.00008	3	372	Wild	Wild
2020	Inflow	Creel	0.71091	0.00008	3	373	Wild	Wild
2020	Inflow	Creel	0.71095	0.00007	3	382	Wild	Wild
2020	Inflow	Creel	0.71114	0.00009	4	386	Wild	-
2020	Inflow	Creel	0.71141	0.00011	3	387	Wild	Wild
2020	Inflow	Creel	0.71063	0.00009	3	390	Under	Under

Appendix A. cont'd

							Classification	
Sample year	FGR region	Sample method	Natal region ^{87}Sr/^{86}Sr mean	Natal region ^{87}Sr/^{86}Sr SD	Age at capture	MEF length (mm)	DFA with Wigwam	DFA without Wigwam
2020	Inflow	Creel	0.71105	0.00024	4	395	Wild	-
2020	Inflow	Creel	0.71109	0.00018	4	400	Wild	-
2020	Inflow	Creel	0.70877	0.00005	3	404	Auburn	Auburn
2020	Inflow	Creel	0.71136	0.00016	4	412	Wild	-
2020	Inflow	Creel	0.71109	0.00011	4	412	Wild	-
2020	Inflow	Creel	0.71093	0.00018	4	415	Wild	-
2020	Inflow	Creel	0.71112	0.00010	4	423	Wild	-
2020	Inflow	Creel	0.71120	0.00011	4	425	Wild	-
2020	Inflow	Creel	0.71153	0.00039	5	428	Wild	Wild
2020	Inflow	Creel	0.71093	0.00006	4	430	Wild	-
2020	Inflow	Creel	0.71107	0.00029	4	430	Wild	-
2020	Inflow	Creel	0.71088	0.00019	4	435	Wild	-
2020	Inflow	Creel	0.71103	0.00020	4	440	Wild	-
2020	Inflow	Creel	0.71090	0.00010	4	445	Wild	-
2020	Inflow	Creel	0.71070	0.00011	4	455	Wild	-
2020	Inflow	Sinking gill net	0.71083	0.00053	3	328	Wild	Wild
2020	Inflow	Sinking gill net	0.71087	0.00018	3	342	Wild	Wild
2020	Inflow	Sinking gill net	0.71063	0.00016	4	347	Under	-
2020	Inflow	Sinking gill net	0.71556	0.00008	4	358	Over	-
2020	Inflow	Sinking gill net	0.71100	0.00017	4	361	Wild	-
2020	Inflow	Sinking gill net	0.71079	0.00008	3	363	Wild	Wild
2020	Inflow	Sinking gill net	0.70871	0.00008	3	364	Auburn	Auburn
2020	Inflow	Sinking gill net	0.71089	0.00012	4	370	Wild	-
2020	Inflow	Sinking gill net	0.70859	0.00008	4	370	Auburn	-
2020	Inflow	Sinking gill net	0.71096	0.00026	3	381	Wild	Wild
2020	Inflow	Sinking gill net	0.71663	0.00027	4	382	Over	-

Appendix A. cont'd

Sample year	FGR region	Sample method	Natal region ^{87}Sr/^{86}Sr mean	Natal region ^{87}Sr/^{86}Sr SD	Age at capture	MEF length (mm)	Classification	
							DFA with Wigwam	DFA without Wigwam
2020	Inflow	Sinking gill net	0.71069	0.00038	4	394	Wild	-
2020	Inflow	Sinking gill net	0.71075	0.00011	4	394	Wild	-
2020	Inflow	Sinking gill net	0.70865	0.00012	4	400	Auburn	-
2020	Inflow	Sinking gill net	0.71651	0.00036	4	402	Over	-
2020	Inflow	Sinking gill net	0.70867	0.00005	4	403	Auburn	-
2020	Inflow	Sinking gill net	0.71078	0.00010	4	412	Wild	-
2020	Inflow	Sinking gill net	0.71082	0.00019	4	425	Wild	-
2020	Inflow	Sinking gill net	0.71077	0.00015	4	426	Wild	-
2020	Inflow	Sinking gill net	0.71100	0.00012	4	430	Wild	-
2020	Inflow	Sinking gill net	0.71077	0.00017	4	433	Wild	-
2020	Inflow	Sinking gill net	0.70850	0.00015	4	433	Auburn	-
2020	Inflow	Sinking gill net	0.71060	0.00011	4	441	Under	-
2020	Inflow	Sinking gill net	0.71119	0.00015	4	444	Wild	-
2020	Inflow	Sinking gill net	0.70842	0.00014	4	445	Auburn	-
2020	Inflow	Sinking gill net	0.71091	0.00010	4	450	Wild	-
2020	Inflow	Sinking gill net	0.71097	0.00013	5	452	Wild	Wild
2020	Inflow	Sinking gill net	0.71091	0.00013	5	461	Wild	Wild
2020	Inflow	Sinking gill net	0.71085	0.00013	6	492	Wild	Wild
2020	Open Hills	Suspended gill net	0.71066	0.00013	1	195	Wild	Under
2020	Open Hills	Suspended gill net	0.71721	0.00028	2	243	Over	-
2020	Open Hills	Suspended gill net	0.71081	0.00008	2	244	Wild	-
2020	Open Hills	Suspended gill net	0.70870	0.00008	2	250	Auburn	-
2020	Open Hills	Suspended gill net	0.70861	0.00006	2	256	Auburn	-
2020	Open Hills	Suspended gill net	0.71061	0.00010	2	265	Under	-
2020	Open Hills	Suspended gill net	0.71132	0.00009	2	284	Wild	-
2020	Open Hills	Suspended gill net	0.71094	0.00014	3	292	Wild	Wild

Appendix A. cont’d

							Classification	
Sample year	FGR region	Sample method	Natal region ^{87}Sr/^{86}Sr mean	Natal region ^{87}Sr/^{86}Sr SD	Age at capture	MEF length (mm)	DFA with Wigwam	DFA without Wigwam
2020	Open Hills	Suspended gill net	0.71094	0.00011	4	396	Wild	-
2020	Open Hills	Suspended gill net	0.71116	0.00009	3	353	Wild	Wild
2020	Open Hills	Suspended gill net	0.71089	0.00013	4	354	Wild	-
2020	Open Hills	Suspended gill net	0.71074	0.00015	3	369	Wild	Wild
2020	Open Hills	Suspended gill net	0.70889	0.00011	3	367	Under	Under
2020	Open Hills	Suspended gill net	0.71086	0.00019	4	382	Wild	-
2020	Open Hills	Suspended gill net	0.71078	0.00020	4	398	Wild	-
2020	Open Hills	Suspended gill net	0.71071	0.00012	4	408	Wild	-
2020	Open Hills	Suspended gill net	0.71075	0.00008	4	408	Wild	-
2020	Open Hills	Suspended gill net	0.71061	0.00009	4	410	Under	-
2020	Open Hills	Suspended gill net	0.70852	0.00008	4	415	Auburn	-
2020	Open Hills	Suspended gill net	0.71070	0.00019	4	415	Wild	-
2020	Open Hills	Suspended gill net	0.71073	0.00011	4	420	Wild	-
2020	Open Hills	Suspended gill net	0.71115	0.00010	4	425	Wild	-
2020	Open Hills	Suspended gill net	0.71078	0.00007	4	432	Wild	-
2020	Open Hills	Suspended gill net	0.71095	0.00005	4	442	Wild	-
2020	Open Hills	Suspended gill net	0.70877	0.00003	4	448	Auburn	-
2020	Open Hills	Suspended gill net	0.71076	0.00009	4	452	Wild	-
2020	Open Hills	Suspended gill net	0.71084	0.00009	4	458	Wild	-
2020	Open Hills	Suspended gill net	0.70986	0.00009	4	467	Under	-
2020	Open Hills	Suspended gill net	0.71096	0.00008	4	474	Wild	-
2020	Open Hills	Suspended gill net	0.71089	0.00008	4	475	Wild	-
2020	Open Hills	Suspended gill net	0.70878	0.00007	4	488	Auburn	-
2020	Open Hills	Creel	0.71115	0.00015	2	258	Wild	-
2020	Open Hills	Creel	0.70989	0.00015	2	282	Under	-
2020	Open Hills	Creel	0.71100	0.00015	3	305	Wild	Wild

Appendix A. cont'd

							Classification	
Sample year	FGR region	Sample method	Natal region $^{87}Sr/^{86}Sr$ mean	Natal region $^{87}Sr/^{86}Sr$ SD	Age at capture	MEF length (mm)	DFA with Wigwam	DFA without Wigwam
2020	Open Hills	Creel	0.71094	0.00019	3	310	Wild	Wild
2020	Open Hills	Creel	0.71109	0.00016	3	319	Wild	Wild
2020	Open Hills	Creel	0.71121	0.00018	4	326	Wild	-
2020	Open Hills	Creel	0.71117	0.00004	3	329	Wild	Wild
2020	Open Hills	Creel	0.71110	0.00017	3	330	Wild	Wild
2020	Open Hills	Creel	0.71111	0.00018	3	333	Wild	Wild
2020	Open Hills	Creel	0.71099	0.00016	3	340	Wild	Wild
2020	Open Hills	Creel	0.71081	0.00007	3	343	Wild	Wild
2020	Open Hills	Creel	0.70870	0.00007	4	350	Auburn	-
2020	Open Hills	Creel	0.70879	0.00007	4	405	Auburn	-
2020	Open Hills	Creel	0.71679	0.00030	4	370	Over	-
2020	Open Hills	Creel	0.71095	0.00011	4	375	Wild	-
2020	Open Hills	Creel	0.71061	0.00006	4	380	Under	-
2020	Open Hills	Creel	0.71062	0.00008	4	382	Under	-
2020	Open Hills	Creel	0.71091	0.00011	4	385	Wild	-
2020	Open Hills	Creel	0.71101	0.00008	4	452	Wild	-
2020	Open Hills	Creel	0.71086	0.00010	4	390	Wild	-
2020	Open Hills	Creel	0.71113	0.00006	4	403	Wild	-
2020	Open Hills	Creel	0.71111	0.00020	4	404	Wild	-
2020	Open Hills	Creel	0.70876	0.00006	4	405	Auburn	-
2020	Open Hills	Creel	0.70864	0.00013	4	414	Auburn	-
2020	Open Hills	Creel	0.70855	0.00012	4	416	Auburn	-
2020	Open Hills	Creel	0.71059	0.00019	4	422	Under	-
2020	Open Hills	Creel	0.71075	0.00012	4	415	Wild	-
2020	Open Hills	Creel	0.71096	0.00008	4	430	Wild	-
2020	Open Hills	Creel	0.71112	0.00009	4	438	Wild	-

Appendix A. cont'd

							Classification	
Sample year	FGR region	Sample method	Natal region $^{87}Sr/^{86}Sr$ mean	Natal region $^{87}Sr/^{86}Sr$ SD	Age at capture	MEF length (mm)	DFA with Wigwam	DFA without Wigwam
2020	Open Hills	Creel	0.70905	0.00009	4	455	Under	-
2020	Open Hills	Sinking gill net	0.71094	0.00022	3	314	Wild	Wild
2020	Open Hills	Sinking gill net	0.71089	0.00027	3	335	Wild	Wild
2020	Open Hills	Sinking gill net	0.71096	0.00010	2	336	Wild	-
2020	Open Hills	Sinking gill net	0.71091	0.00011	4	347	Wild	-
2020	Open Hills	Sinking gill net	0.71095	0.00019	4	347	Wild	-
2020	Open Hills	Sinking gill net	0.71071	0.00011	3	350	Wild	Under
2020	Open Hills	Sinking gill net	0.71114	0.00013	4	365	Wild	-
2020	Open Hills	Sinking gill net	0.71096	0.00011	4	373	Wild	-
2020	Open Hills	Sinking gill net	0.71062	0.00006	4	380	Under	-
2020	Open Hills	Sinking gill net	0.70972	0.00010	4	385	Under	-
2020	Open Hills	Sinking gill net	0.71072	0.00005	4	386	Wild	-
2020	Open Hills	Sinking gill net	0.71097	0.00008	4	390	Wild	-
2020	Open Hills	Sinking gill net	0.70864	0.00016	4	391	Auburn	-
2020	Open Hills	Sinking gill net	0.70852	0.00009	4	401	Auburn	-
2020	Open Hills	Sinking gill net	0.71094	0.00016	4	406	Wild	-
2020	Open Hills	Sinking gill net	0.71090	0.00009	4	407	Wild	-
2020	Open Hills	Sinking gill net	0.71080	0.00013	4	410	Wild	-
2020	Open Hills	Sinking gill net	0.71081	0.00010	4	411	Wild	-
2020	Open Hills	Sinking gill net	0.70852	0.00013	4	420	Auburn	-
2020	Open Hills	Sinking gill net	0.70855	0.00009	4	421	Auburn	-
2020	Open Hills	Sinking gill net	0.71601	0.00018	4	421	Over	-
2020	Open Hills	Sinking gill net	0.71088	0.00012	4	432	Wild	-
2020	Open Hills	Sinking gill net	0.71110	0.00009	4	440	Wild	-
2020	Open Hills	Sinking gill net	0.70855	0.00008	4	442	Auburn	-
2020	Open Hills	Sinking gill net	0.71095	0.00020	4	443	Wild	-

Appendix A. cont'd

							Classification	
Sample year	FGR region	Sample method	Natal region $^{87}Sr/^{86}Sr$ mean	Natal region $^{87}Sr/^{86}Sr$ SD	Age at capture	MEF length (mm)	DFA with Wigwam	DFA without Wigwam
2020	Open Hills	Sinking gill net	0.71064	0.00016	4	451	Under	-
2020	Open Hills	Sinking gill net	0.71076	0.00006	5	455	Wild	Wild
2020	Open Hills	Sinking gill net	0.71076	0.00013	4	461	Wild	-
2020	Open Hills	Sinking gill net	0.70865	0.00008	4	463	Auburn	-
2020	Open Hills	Sinking gill net	0.71079	0.00015	4	469	Wild	-
2020	Canyon	Suspended gill net	0.71090	0.00017	1	149	Wild	-
2020	Canyon	Suspended gill net	0.71071	0.00022	1	166	Wild	Under
2020	Canyon	Suspended gill net	0.71078	0.00005	1	203	Wild	Wild
2020	Canyon	Suspended gill net	0.70854	0.00010	2	230	Auburn	-
2020	Canyon	Suspended gill net	0.70863	0.00016	2	242	Auburn	-
2020	Canyon	Suspended gill net	0.71089	0.00010	2	243	Wild	-
2020	Canyon	Suspended gill net	0.71082	0.00016	2	245	Wild	-
2020	Canyon	Suspended gill net	0.71064	0.00013	2	258	Under	-
2020	Canyon	Suspended gill net	0.71103	0.00016	3	395	Wild	Wild
2020	Canyon	Suspended gill net	0.70849	0.00013	2	279	Auburn	-
2020	Canyon	Suspended gill net	0.71027	0.00031	2	280	Under	-
2020	Canyon	Suspended gill net	0.71066	0.00008	2	284	Wild	-
2020	Canyon	Suspended gill net	0.70869	0.00008	2	286	Auburn	-
2020	Canyon	Suspended gill net	0.71055	0.00030	2	297	Under	-
2020	Canyon	Suspended gill net	0.71091	0.00013	2	300	Wild	-
2020	Canyon	Suspended gill net	0.71092	0.00013	3	300	Wild	Wild
2020	Canyon	Suspended gill net	0.71086	0.00007	3	308	Wild	Wild
2020	Canyon	Suspended gill net	0.71095	0.00009	2	313	Wild	-
2020	Canyon	Suspended gill net	0.71064	0.00013	2	313	Under	-
2020	Canyon	Suspended gill net	0.70859	0.00007	3	322	Auburn	Auburn
2020	Canyon	Suspended gill net	0.71085	0.00017	3	324	Wild	Wild

Appendix A. cont'd

							Classification	
Sample year	FGR region	Sample method	Natal region $^{87}Sr/^{86}Sr$ mean	Natal region $^{87}Sr/^{86}Sr$ SD	Age at capture	MEF length (mm)	DFA with Wigwam	DFA without Wigwam
2020	Canyon	Suspended gill net	0.71075	0.00007	3	325	Wild	Wild
2020	Canyon	Suspended gill net	0.70843	0.00004	3	341	Auburn	Auburn
2020	Canyon	Suspended gill net	0.71063	0.00008	3	341	Under	Under
2020	Canyon	Suspended gill net	0.71065	0.00005	4	352	Wild	-
2020	Canyon	Suspended gill net	0.71103	0.00010	3	357	Wild	Wild
2020	Canyon	Suspended gill net	0.71083	0.00015	4	357	Wild	-
2020	Canyon	Suspended gill net	0.71111	0.00018	3	360	Wild	Wild
2020	Canyon	Suspended gill net	0.71103	0.00011	4	362	Wild	-
2020	Canyon	Suspended gill net	0.71101	0.00028	4	373	Wild	-
2020	Canyon	Suspended gill net	0.71091	0.00007	3	373	Wild	Wild
2020	Canyon	Suspended gill net	0.70980	0.00025	3	374	Under	Under
2020	Canyon	Suspended gill net	0.70884	0.00005	3	391	Auburn	Auburn
2020	Canyon	Suspended gill net	0.71068	0.00014	4	400	Wild	-
2020	Canyon	Suspended gill net	0.71091	0.00009	4	404	Wild	-
2020	Canyon	Suspended gill net	0.71646	0.00028	4	405	Over	-
2020	Canyon	Suspended gill net	0.70867	0.00005	3	426	Auburn	Auburn
2020	Canyon	Creel	0.70952	0.00009	2	260	Under	-
2020	Canyon	Creel	0.70976	0.00008	2	273	Under	-
2020	Canyon	Creel	0.71122	0.00006	3	296	Wild	Wild
2020	Canyon	Creel	0.71076	0.00014	3	300	Wild	Wild
2020	Canyon	Creel	0.71104	0.00006	3	307	Wild	Wild
2020	Canyon	Creel	0.70880	0.00006	3	310	Auburn	Auburn
2020	Canyon	Creel	0.71104	0.00008	3	312	Wild	Wild
2020	Canyon	Creel	0.71107	0.00004	3	313	Wild	Wild
2020	Canyon	Creel	0.71106	0.00008	3	320	Wild	Wild
2020	Canyon	Creel	0.71111	0.00011	4	325	Wild	-

Appendix A. cont'd

							Classification	
Sample year	FGR region	Sample method	Natal region $^{87}Sr/^{86}Sr$ mean	Natal region $^{87}Sr/^{86}Sr$ SD	Age at capture	MEF length (mm)	DFA with Wigwam	DFA without Wigwam
2020	Canyon	Creel	0.71074	0.00011	4	330	Wild	-
2020	Canyon	Creel	0.71093	0.00007	4	330	Wild	-
2020	Canyon	Creel	0.70887	0.00008	4	332	Under	-
2020	Canyon	Creel	0.71100	0.00009	3	340	Wild	Wild
2020	Canyon	Creel	0.71105	0.00005	4	340	Wild	-
2020	Canyon	Creel	0.71089	0.00011	3	341	Wild	Wild
2020	Canyon	Creel	0.71074	0.00012	3	350	Wild	Wild
2020	Canyon	Creel	0.71108	0.00011	4	350	Wild	-
2020	Canyon	Creel	0.70992	0.00013	3	351	Under	Under
2020	Canyon	Creel	0.71088	0.00016	4	360	Wild	-
2020	Canyon	Creel	0.71083	0.00005	4	360	Wild	-
2020	Canyon	Creel	0.71082	0.00012	4	367	Wild	-
2020	Canyon	Creel	0.70861	0.00004	4	370	Auburn	-
2020	Canyon	Creel	0.71087	0.00013	4	370	Wild	-
2020	Canyon	Creel	0.71112	0.00024	4	372	Wild	-
2020	Canyon	Creel	0.71094	0.00009	4	380	Wild	-
2020	Canyon	Creel	0.71083	0.00007	4	380	Wild	-
2020	Canyon	Creel	0.71088	0.00011	4	382	Wild	-
2020	Canyon	Creel	0.71094	0.00012	3	390	Wild	Wild
2020	Canyon	Creel	0.71084	0.00005	4	394	Wild	-
2020	Canyon	Creel	0.71093	0.00008	4	398	Wild	-
2020	Canyon	Creel	0.70857	0.00003	3	402	Auburn	Auburn
2020	Canyon	Creel	0.71102	0.00006	4	403	Wild	-
2020	Canyon	Creel	0.70880	0.00008	4	414	Auburn	-
2020	Canyon	Creel	0.71087	0.00003	4	442	Wild	-
2020	Canyon	Sinking gill net	0.71072	0.00006	4	331	Wild	-

Appendix A. cont'd

							Classification	
Sample year	FGR region	Sample method	Natal region $^{87}Sr/^{86}Sr$ mean	Natal region $^{87}Sr/^{86}Sr$ SD	Age at capture	MEF length (mm)	DFA with Wigwam	DFA without Wigwam
2020	Canyon	Sinking gill net	0.70893	0.00008	3	331	Under	Under
2020	Canyon	Sinking gill net	0.71082	0.00007	4	333	Wild	-
2020	Canyon	Sinking gill net	0.70853	0.00004	4	346	Auburn	-
2020	Canyon	Sinking gill net	0.71089	0.00009	3	347	Wild	Wild
2020	Canyon	Sinking gill net	0.71093	0.00005	3	347	Wild	Wild
2020	Canyon	Sinking gill net	0.71090	0.00007	3	352	Wild	Wild
2020	Canyon	Sinking gill net	0.71118	0.00011	3	353	Wild	Wild
2020	Canyon	Sinking gill net	0.71066	0.00026	4	354	Wild	-
2020	Canyon	Sinking gill net	0.71081	0.00005	4	361	Wild	-
2020	Canyon	Sinking gill net	0.71103	0.00009	3	362	Wild	Wild
2020	Canyon	Sinking gill net	0.71096	0.00009	3	370	Wild	Wild
2020	Canyon	Sinking gill net	0.70855	0.00006	4	371	Auburn	-
2020	Canyon	Sinking gill net	0.71033	0.00005	3	372	Under	Under
2020	Canyon	Sinking gill net	0.71067	0.00004	4	374	Wild	-
2020	Canyon	Sinking gill net	0.71076	0.00006	3	384	Wild	Wild
2020	Canyon	Sinking gill net	0.71091	0.00008	4	386	Wild	-
2020	Canyon	Sinking gill net	0.71088	0.00008	4	391	Wild	-
2020	Canyon	Sinking gill net	0.71095	0.00008	4	393	Wild	-
2020	Canyon	Sinking gill net	0.70849	0.00003	4	395	Auburn	-
2020	Canyon	Sinking gill net	0.71087	0.00007	4	404	Wild	-
2020	Canyon	Sinking gill net	0.71076	0.00017	4	405	Wild	-
2020	Canyon	Sinking gill net	0.71079	0.00010	4	412	Wild	-
2020	Canyon	Sinking gill net	0.71073	0.00004	4	417	Wild	-
2020	Canyon	Sinking gill net	0.70869	0.00003	3	417	Auburn	Auburn
2020	Canyon	Sinking gill net	0.71084	0.00006	4	424	Wild	-
2020	Canyon	Sinking gill net	0.71075	0.00005	4	427	Wild	-

Appendix A. cont'd

Sample year	FGR region	Sample method	Natal region $^{87}Sr/^{86}Sr$ mean	Natal region $^{87}Sr/^{86}Sr$ SD	Age at capture	MEF length (mm)	Classification DFA with Wigwam	DFA without Wigwam
2020	Canyon	Sinking gill net	0.71089	0.00005	4	429	Wild	-
2020	Canyon	Sinking gill net	0.70869	0.00006	4	431	Auburn	-
2020	Canyon	Sinking gill net	0.71085	0.00014	4	431	Wild	-
2020	Canyon	Sinking gill net	0.71079	0.00010	4	432	Wild	-
2020	Canyon	Sinking gill net	0.71458	0.00018	4	444	Over	-
2020	Canyon	Sinking gill net	0.71091	0.00012	5	447	Wild	Wild
2020	Canyon	Sinking gill net	0.70847	0.00010	4	451	Auburn	-
2020	Canyon	Sinking gill net	0.71084	0.00016	4	482	Wild	-
2020	Sheep Creek	Weir	0.71073	0.00013	3	298	Wild	Wild
2020	Sheep Creek	Weir	0.71082	0.00006	3	314	Wild	Wild
2020	Sheep Creek	Weir	0.70975	0.00007	2	315	Under	-
2020	Sheep Creek	Weir	0.70976	0.00008	2	317	Under	-
2020	Sheep Creek	Weir	0.70998	0.00008	2	320	Under	-
2020	Sheep Creek	Weir	0.71088	0.00016	3	321	Wild	Wild
2020	Sheep Creek	Weir	0.71091	0.00027	2	321	Wild	-
2020	Sheep Creek	Weir	0.71101	0.00005	3	331	Wild	Wild
2020	Sheep Creek	Weir	0.71098	0.00011	3	348	Wild	Wild
2020	Sheep Creek	Weir	0.71098	0.00011	3	349	Wild	Wild
2020	Sheep Creek	Weir	0.71078	0.00006	3	355	Wild	Wild
2020	Sheep Creek	Weir	0.71093	0.00008	4	355	Wild	-
2020	Sheep Creek	Weir	0.71103	0.00027	3	356	Wild	Wild
2020	Sheep Creek	Weir	0.71063	0.00010	3	360	Under	Under
2020	Sheep Creek	Weir	0.70861	0.00006	3	361	Auburn	Auburn
2020	Sheep Creek	Weir	0.70853	0.00013	4	362	Auburn	-
2020	Sheep Creek	Weir	0.71096	0.00013	4	374	Wild	-
2020	Sheep Creek	Weir	0.71075	0.00008	4	376	Wild	-

Appendix A. cont’d

							Classification	
Sample year	FGR region	Sample method	Natal region ^{87}Sr/^{86}Sr mean	Natal region ^{87}Sr/^{86}Sr SD	Age at capture	MEF length (mm)	DFA with Wigwam	DFA without Wigwam
2020	Sheep Creek	Weir	0.70850	0.00010	4	378	Auburn	-
2020	Sheep Creek	Weir	0.70843	0.00008	3	381	Auburn	Auburn
2020	Sheep Creek	Weir	0.71084	0.00011	3	381	Wild	Wild
2020	Sheep Creek	Weir	0.70997	0.00021	4	392	Under	-
2020	Sheep Creek	Weir	0.71067	0.00010	4	395	Wild	-
2020	Sheep Creek	Weir	0.70829	0.00007	4	401	Auburn	-
2020	Sheep Creek	Weir	0.71086	0.00036	3	406	Wild	Wild
2020	Sheep Creek	Weir	0.71085	0.00035	4	410	Wild	-
2020	Sheep Creek	Weir	0.70987	0.00032	4	410	Under	-
2020	Sheep Creek	Weir	0.70874	0.00011	4	411	Auburn	-
2020	Sheep Creek	Weir	0.71078	0.00017	4	424	Wild	-
2020	Sheep Creek	Weir	0.71098	0.00009	4	430	Wild	-
2020	Sheep Creek	Weir	0.70860	0.00004	4	430	Auburn	-
2020	Sheep Creek	Weir	0.71101	0.00015	4	430	Wild	-
2020	Sheep Creek	Weir	0.71099	0.00030	4	442	Wild	-
2020	Sheep Creek	Weir	0.71067	0.00010	4	446	Wild	-
2020	Sheep Creek	Weir	0.70863	0.00006	4	482	Auburn	-

Appendix B. Sample year, hatchery sampled, along with mean and standard deviation of the $^{87}Sr/^{86}Sr$ of otolith from hatchery sampled kokanee. Agencies include Wyoming Game and Fish Department (WGFD), Utah Division of Wildlife Resources (UDWR), U.S. Fish and Wildlife Service (USFWS). Hatchery samples that used Rainbow Trout as surrogates are represented by astrisk (*).

Sample Year	Hatchery	Agency	Natal region $^{87}Sr/^{86}Sr$ mean	Natal region $^{87}Sr/^{86}Sr$ SD
		Auburn		
2020	Auburn	WGFD	0.70855	0.00006
2020	Auburn	WGFD	0.70857	0.00003
2020	Auburn	WGFD	0.70867	0.00009
2020	Auburn	WGFD	0.70852	0.00005
2020	Auburn	WGFD	0.70867	0.00004
		Over		
2020	*Boulder	WGFD	0.71757	0.00017
2020	*Boulder	WGFD	0.71884	0.00043
2020	*Boulder	WGFD	0.71813	0.00025
2020	*Boulder	WGFD	0.71862	0.00019
2020	*Boulder	WGFD	0.71739	0.00040
2020	*Clark Fork	WGFD	0.71629	0.00085
2020	*Clark Fork	WGFD	0.71462	0.00074
2020	*Clark Fork	WGFD	0.71427	0.00112
2020	*Clark Fork	WGFD	0.71375	0.00050
2020	*Clark Fork	WGFD	0.71603	0.00060
2020	Dan Speas	WGFD	0.71478	0.00028
2020	Dan Speas	WGFD	0.71532	0.00015
2020	Dan Speas	WGFD	0.71510	0.00054
2020	Dan Speas	WGFD	0.71490	0.00023
2020	Dan Speas	WGFD	0.71500	0.00041
		Under		
2020	Daniel	WGFD	0.71019	0.00035
2020	Daniel	WGFD	0.70999	0.00050
2020	Daniel	WGFD	0.71046	0.00018
2020	Daniel	WGFD	0.71051	0.00013
2020	Daniel	WGFD	0.71045	0.00013
2020	Dubois	WGFD	0.71049	0.00013
2020	Dubois	WGFD	0.71057	0.00012
2020	Dubois	WGFD	0.71070	0.00009
2020	Dubois	WGFD	0.71036	0.00007
2020	Dubois	WGFD	0.71067	0.00008
2020	Jones Hole	USFWS	0.70958	0.00009
2020	Jones Hole	USFWS	0.70970	0.00009

Appendix B. cont'd

Sample Year	Hatchery	Agency	Natal region $^{87}Sr/^{86}Sr$ mean	Natal region $^{87}Sr/^{86}Sr$ SD
2020	Jones Hole	USFWS	0.70952	0.00011
2020	Jones Hole	USFWS	0.70956	0.00014
2020	Jones Hole	USFWS	0.70940	0.00006
2020	Midway	UDWR	0.71051	0.00009
2020	Midway	UDWR	0.71055	0.00009
2020	Midway	UDWR	0.71050	0.00009
2020	Midway	UDWR	0.71048	0.00010
2020	Midway	UDWR	0.71050	0.00008
2020	*Saratoga	USFWS	0.71047	0.00035
2020	*Saratoga	USFWS	0.71046	0.00009
2020	*Saratoga	USFWS	0.71075	0.00024
2020	*Saratoga	USFWS	0.71048	0.00025
2020	*Saratoga	USFWS	0.71055	0.00023
2020	Tillet	WGFD	0.71048	0.00014
2020	Tillet	WGFD	0.71031	0.00012
2020	Tillet	WGFD	0.71018	0.00010
2020	Tillet	WGFD	0.71042	0.00006
2020	Tillet	WGFD	0.71045	0.00012
2020	Whiterocks	UDWR	0.71018	0.00006
2020	Whiterocks	UDWR	0.71006	0.00021
2020	Whiterocks	UDWR	0.71036	0.00010
2020	Whiterocks	UDWR	0.71013	0.00009
2020	Whiterocks	UDWR	0.71026	0.00004
			"Natural"	
2020	*Wigwam	WGFD	0.71103	0.00020
2020	*Wigwam	WGFD	0.71066	0.00040
2020	*Wigwam	WGFD	0.71086	0.00036
2020	*Wigwam	WGFD	0.71002	0.00016
2020	*Wigwam	WGFD	0.71114	0.00048

Appendix C. Location of water samples including the region (hatchery, Flaming Gorge Reservoir region, and tributary), locality within a region, Universal Transverse Mercator (UTM) coordinate, along with the $^{87}Sr/^{86}Sr$ value.

	Location				
Region	Locality	UTM zone	Easting	Northing	$^{87}Sr/^{86}Sr$
Auburn Hatchery	Intake	12	491727	4734579	0.708443
Auburn Hatchery	Holding	12	491727	4734579	0.708421
Boulder Hatchery	Intake	12	607238	4730165	0.722774
Boulder Hatchery	Holding	12	607238	4730165	0.724280
Clark Fork Hatchery	Intake	12	646914	4977719	0.727034
Clark Fork Hatchery	Holding	12	646914	4977719	0.725192
Dan Speas Hatchery	Intake	13	374749	4734486	0.717138
Dan Speas Hatchery	Holding	13	374749	4734486	0.716940
Daniel Hatchery	Intake	12	571176	4753237	0.711572
Daniel Hatchery	Holding	12	571176	4753237	0.711567
Dubois Hatchery	Intake	12	614375	4817342	0.712731
Dubois Hatchery	Holding	12	614375	4817342	0.712694
Jones Hole Hatchery	Intake	12	664328	4494867	0.710089
Jones Hole Hatchery	Holding	12	664328	4494867	0.710064
Midway Hatchery	Intake	12	460279	4483003	0.710687
Midway Hatchery	Holding	12	460279	4483003	0.710701
Saratoga Hatchery	Intake	13	350676	4596331	0.712401
Saratoga Hatchery	Holding	13	350676	4596331	0.712391
Tillet Hatchery	Intake	12	714292	4984904	0.707763
Tillet Hatchery	Holding	12	714292	4984904	0.707767
Whiterocks Hatchery	Intake	12	588516	4481948	0.711697
Whiterocks Hatchery	Holding	12	588516	4481948	0.711590
Wigwam Hatchery	Intake	13	309221	4881843	0.715076
Wigwam Hatchery	Holding	13	309221	4881843	0.714602
Inflow Region	Surface	12	621099	4562662	0.710906
Inflow Region	Depth	12	621099	4562662	0.710920
Inflow Region	Surface	12	619639	4567195	0.710925
Inflow Region	Depth	12	619639	4567195	0.710897
Inflow Region	Surface	12	619631	4566709	0.710962
Inflow Region	Depth	12	619631	4566709	0.710906
Inflow Region	Surface	12	627120	4575753	0.711016
Inflow Region	Depth	12	627120	4575753	0.711010
Inflow Region	Surface	12	620095	4564666	0.710935
Inflow Region	Depth	12	620095	4564666	0.710941

Appendix C. cont’d

	Location				
Region	Locality	UTM zone	Easting	Northing	$^{87}Sr/^{86}Sr$
Open Hills Region	Surface	12	621979	4555821	0.710938
Open Hills Region	Depth	12	621979	4555821	0.710921
Open Hills Region	Surface	12	623086	4559221	0.710925
Open Hills Region	Depth	12	623086	4559221	0.710958
Open Hills Region	Surface	12	621529	4544761	0.710938
Open Hills Region	Depth	12	621529	4544761	0.710942
Open Hills Region	Surface	12	621589	4556190	0.710965
Open Hills Region	Depth	12	621589	4556190	0.710983
Open Hills Region	Surface	12	620791	4549368	0.710963
Open Hills Region	Depth	12	620791	4549368	0.711001
Canyon Region	Surface	12	617064	4528697	0.710889
Canyon Region	Depth	12	617064	4528697	0.710879
Canyon Region	Surface	12	614076	4533274	0.710907
Canyon Region	Depth	12	614076	4533274	0.710861
Canyon Region	Surface	12	622533	4527729	0.710898
Canyon Region	Depth	12	622533	4527729	0.710874
Canyon Region	Surface	12	621113	4528729	0.710897
Canyon Region	Depth	12	621113	4528729	0.710872
Canyon Region	Surface	12	627165	4530648	0.710879
Canyon Region	Depth	12	627165	4530648	0.710878
Confluence	Surface	12	622804	4572472	0.711010
Confluence	Depth	12	622804	4572472	0.710848
Dam	Surface	12	632709	4530851	0.710881
Dam	Depth	12	632709	4530851	0.710834
Linwood Bay	Surface	12	615176	4538569	0.710870
Linwood Bay	Depth	12	615176	4538569	0.710833
Sheep Creek Bay	Surface	12	612240	4531691	0.710895
Sheep Creek Bay	Depth	12	612240	4531691	0.710804
Blacks Fork River	Surface	12	616085	4581754	0.710520
Blacks Fork River	Surface	12	613335	4585575	0.710537
Blacks Fork River	Surface	12	608981	4600209	0.710526
Green River	Surface	12	627432	4597995	0.710954
Green River	Surface	12	605071	4624362	0.710928
Green River	Surface	12	578410	4652442	0.710843
Henrys Fork River	Surface	12	612089	4539925	0.710337
Henrys Fork River	Surface	12	606256	4544301	0.710205
Sheep Creek	Surface	12	610109	4530743	0.708806

Appendix C. cont'd

	Location				
Region	Locality	UTM zone	Easting	Northing	$^{87}Sr/^{86}Sr$
Sheep Creek	Surface	12	607544	4531643	0.708805
Sheep Creek	Surface	12	602944	4531481	0.709235

Appendix D. Sample year, sample location, sample method, and number of kokanee that were assigned a hatchery origin from both model-based discriminant function analysis separated by hatchery origins.

			Count	
Sample Year	Sample location	Sample method	DFA with Wigwam	DFA without Wigwam
		Auburn		
2018	Inflow	Suspended gill net	8	4
2018	Inflow	Creel	5	5
2018	Inflow	Sinking gill net	1	1
2018	Open Hills	Suspended gill net	8	3
2018	Open Hills	Creel	1	1
2018	Open Hills	Sinking gill net	3	3
2018	Canyon	Suspended gill net	5	5
2018	Canyon	Creel	3	3
2018	Canyon	Sinking gill net	0	0
2018	Henrys Fork River	Weir	21	21
2018	Sheep Creek	Weir	9	9
2019	Inflow	Suspended gill net	9	2
2019	Inflow	Creel	12	1
2019	Inflow	Sinking gill net	9	2
2019	Open Hills	Suspended gill net	10	4
2019	Open Hills	Creel	8	1
2019	Open Hills	Sinking gill net	12	4
2019	Canyon	Suspended gill net	12	6
2019	Canyon	Creel	8	3
2019	Canyon	Sinking gill net	0	0
2019	Henrys Fork River	Weir	24	18
2019	Sheep Creek	Weir	17	3
2020	Inflow	Suspended gill net	1	1
2020	Inflow	Creel	2	2
2020	Inflow	Sinking gill net	6	1
2020	Open Hills	Suspended gill net	5	0
2020	Open Hills	Creel	5	0
2020	Open Hills	Sinking gill net	6	0
2020	Canyon	Suspended gill net	8	4
2020	Canyon	Creel	4	2
2020	Canyon	Sinking gill net	6	1
2020	Henrys Fork River	Weir	0	0
2020	Sheep Creek	Weir	8	2
		Over		
2018	Inflow	Suspended gill net	1	1

Appendix D. cont'd

			Count	
Sample Year	Sample location	Sample method	DFA with Wigwam	DFA without Wigwam
		Over		
2018	Inflow	Creel	0	0
2018	Inflow	Sinking gill net	0	0
2018	Open Hills	Suspended gill net	1	1
2018	Open Hills	Creel	0	0
2018	Open Hills	Sinking gill net	1	0
2018	Canyon	Suspended gill net	2	0
2018	Canyon	Creel	0	0
2018	Canyon	Sinking gill net	0	0
2018	Henrys Fork River	Weir	0	0
2018	Sheep Creek	Weir	1	0
2019	Inflow	Suspended gill net	7	4
2019	Inflow	Creel	5	1
2019	Inflow	Sinking gill net	2	0
2019	Open Hills	Suspended gill net	6	0
2019	Open Hills	Creel	1	1
2019	Open Hills	Sinking gill net	9	1
2019	Canyon	Suspended gill net	3	1
2019	Canyon	Creel	0	0
2019	Canyon	Sinking gill net	0	0
2019	Henrys Fork River	Weir	9	0
2019	Sheep Creek	Weir	8	0
2020	Inflow	Suspended gill net	1	0
2020	Inflow	Creel	1	0
2020	Inflow	Sinking gill net	3	0
2020	Open Hills	Suspended gill net	1	0
2020	Open Hills	Creel	1	0
2020	Open Hills	Sinking gill net	1	0
2020	Canyon	Suspended gill net	1	0
2020	Canyon	Creel	0	0
2020	Canyon	Sinking gill net	1	0
2020	Henrys Fork River	Weir	0	0
2020	Sheep Creek	Weir	0	0
		Under		
2018	Inflow	Suspended gill net	4	2
2018	Inflow	Creel	2	2
2018	Inflow	Sinking gill net	3	1
2018	Open Hills	Suspended gill net	4	1
2018	Open Hills	Creel	12	12

Appendix D. cont'd

			Count	
Sample year	Sample location	Sample method	DFA with Wigwam	DFA without Wigwam
		Under		
2018	Open Hills	Sinking gill net	5	5
2018	Canyon	Suspended gill net	6	4
2018	Canyon	Creel	2	2
2018	Canyon	Sinking gill net	0	0
2018	Henrys Fork River	Weir	0	0
2018	Sheep Creek	Weir	11	10
2019	Inflow	Suspended gill net	6	4
2019	Inflow	Creel	4	0
2019	Inflow	Sinking gill net	6	0
2019	Open Hills	Suspended gill net	7	1
2019	Open Hills	Creel	4	1
2019	Open Hills	Sinking gill net	7	4
2019	Canyon	Suspended gill net	7	1
2019	Canyon	Creel	11	4
2019	Canyon	Sinking gill net	0	0
2019	Henrys Fork River	Weir	6	2
2019	Sheep Creek	Weir	16	1
2020	Inflow	Suspended gill net	5	1
2020	Inflow	Creel	2	2
2020	Inflow	Sinking gill net	2	0
2020	Open Hills	Suspended gill net	4	1
2020	Open Hills	Creel	5	0
2020	Open Hills	Sinking gill net	3	0
2020	Canyon	Suspended gill net	6	2
2020	Canyon	Creel	4	1
2020	Canyon	Sinking gill net	2	2
2020	Henrys Fork River	Weir	0	0
2020	Sheep Creek	Weir	6	1