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Kelly Warm Springs Historical Data Summary: Progress Report

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KELLY WARM SPRING HISTORICAL DATA SUMMARY: PROGRESS REPORT

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✦ ABSTRACT

Kelly Warm Springs is a unique geological feature located within Grand Teton National Park, Wyoming. The Kelly Warm Springs area is used extensively by park wildlife, for recreation by park visitors, and is a place of educational interest. It has also been the site of historic non-native fish releases. The current work was initiated to gather historical information and to begin systematic documentation of temperatures in and around Kelly Warm Springs. Historic information that was not published but considered valid was included. Non-native fish presence was first documented in the 1960s. Concerns about non-native fish and habitat loss for native species were discussed by researchers in the 1980s. The temperature ranges recorded at several sites October – December 2014 approached 0ºC at the lower section of the outflow channel, but remained above 20ºC in the spring pond. While these range below the preferred temperature range for goldfish, research has documented survival in near zero temperatures. All sites located below Mormon Row where temperature loggers were initially deployed were either dewatered or frozen by mid-November.

✦ INTRODUCTION

Kelly Warm Springs, located in Grand Teton National Park (43° 38’ 21.8”N, 110° 37’01.9”W), are perennial warm springs located near Kelly, Wyoming. The springs create a shallow pond, with a maximum depth of about 4 feet, and maximum width of about 350 feet (Baldwin and Franta 1960). These unique springs have been subject to multiple surveys and studies to evaluate water chemistry, temperature, toxicity, species present, and discharge. Fish surveys have shown that Kelly Warm Springs has been the recipient of non-native fish disposal/planting, which likely resulted from the disposal of aquarium specimens. Surviving non-native fish could have negative implications for native fish living in Kelly Warm Springs and could impact the stability of the food web structure and function within the springs and surrounding water outlets (Hotchkiss and Hall 2009). Along with non-native fish, non-native invertebrates (e.g., snails) have increased in population. This increased presence of non-native species can lead to competition, disease, and habitat degradation for the native species within Kelly Warm Springs (Hotchkiss and Hall 2009).

Kelly Warm Springs is easily accessed and receives frequent recreational use by park visitors. Its unique features and easy access make it a place of interest for science education and study. Though many visiting scientists, student educational groups, and others have conducted studies on Kelly Warm Springs, those data were not always published, and have not been centralized for access by park resource managers.

As park resource managers become increasingly aware of thriving non-native aquatic species in the Warm Springs, they have become concerned about their existence within a National Park, and the potential movements of these non-natives out of the springs and into surrounding waters. These concerns were realized when a goldfish was collected within 400 meters of the mainstem Snake River (Whaley 2014). Though it has long been believed that cold water temperatures in the Snake River would inhibit goldfish establishment, no studies to systematically document temperatures from Kelly Warm Springs to the Snake River have been conducted.

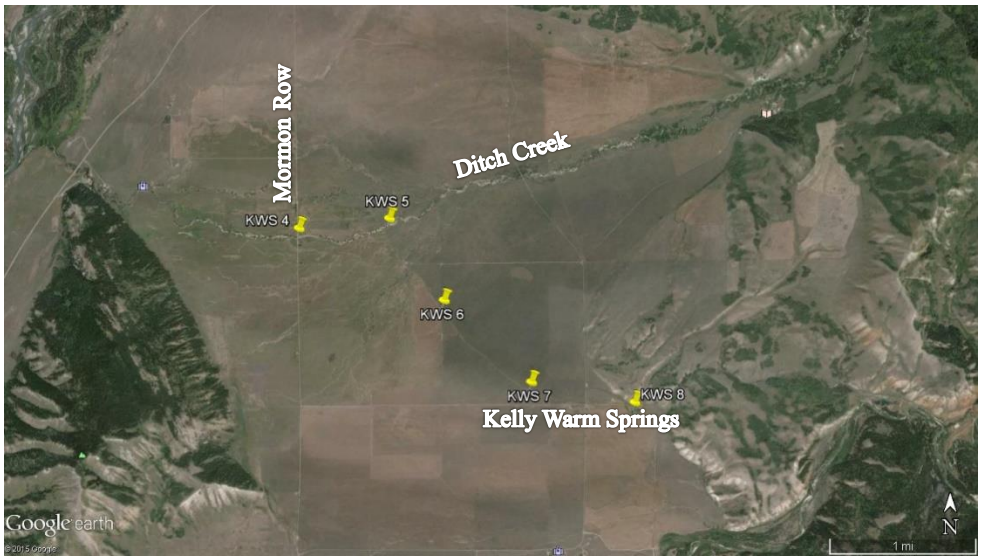

Figure 1. Map of sites where temperature loggers were deployed as of November 2014. The yellow pins represent the position where loggers were deployed to collect temperature data from the Kelly Warm Springs and within Ditch Creek.

There are two goals for the current project: 1.) Gather all pertinent aquatic resource data (1969-2013) related to Kelly Warm Springs, summarize where possible, and include the findings in this one report. 2.) Monitor water temperature in and around Kelly Warm Springs, leading to the Snake River. Meeting these goals will provide park resource managers and others one source to find historical data collected on Kelly Warm Springs and define actual temperature fluctuations in waters leading from Kelly Warm Springs to the Snake River. These data can be used for science-based management decisions about the fate of non-native fish in Kelly Warm Springs and can boost educational awareness about the potential impacts of introducing non-native species into the Warm Springs.

✦ METHODS

Historical data compilation

In order to compile historic data on the Kelly Warm Springs several resources were utilized. Data were gathered from the Grand Teton National Park Natural Resource Management records and representatives from the Wyoming Game and Fish Department (WGFD), and academic institutions were queried. Reports and information were considered valid when they had been peer-reviewed and/or published, or when the document was created by an official park service, governmental agency or academic institution. The goal of this summary was to gather all available information on Kelly Warm Springs and compile it in one place. Therefore some of the information may not generally be considered scientifically publishable but remains relevant.

Temperature monitoring

In order to conduct temperature monitoring in the Kelly Warm Springs, Hobo® Pendant® temperature/light data loggers (UA-002), were deployed in the Kelly Warm Springs and its coinciding outlet[1]. Ten temperature loggers were initially deployed into the warm springs and its outlet leading into the Snake River on July 10th 2014 (Figure 1). On July 29th three more temperature loggers were added to certain areas along the Kelly Warm Springs and its outlet. On July 31st initial data were gathered from the deployed temperature loggers still present within the Kelly Warm Springs and its outlet. On August 11th all deployed temperature loggers were pulled due to a recall from the manufacturing company. Eight temperature loggers were re-deployed on October 6th. Data from the loggers was downloaded on November 6th, and it was noted that all discharge downstream of the headgate located above the Ditch Creek crossing was directed into Ditch Creek. Consequently, 3 loggers located north of Ditch Creek near Mormon Row were pulled because all irrigation channels containing loggers were de-watered.

✦ RESULTS AND DISCUSSION

Historic data compilation

Since 1966 Kelly Warm Springs has been studied frequently. Data gathered includes temperature, water chemistry, and species collection. The following tables present the classifications and common names of native and non-native fish species captured in Kelly Warm Springs and throughout Ditch Creek.

In the summer of 1968 the native fish species found in the Kelly Warm Springs included the Utah Sucker *(Catstomus ardens*), Utah Chub (*Gila atrari*), Redside Shiner (*Richardsonius balteatus*), and Longnose Dace (*Rhinichthys cataractae*) (Baldwin et al. 1968). Guppies (*Poecilia reticulate*) were the only non-native aquarium species collected. By the 1970s, surveys found no Utah Suckers present in the springs. Baldwin et al. (1968) and WGFD (personal communication) suggested that the initial introduction of guppies into the Kelly Warm Springs occurred in the 1960's when this species presence was first documented. Baldwin et al. (1968) raised concerns about human presence and its potential negative influence on habitat (e.g., documented trash in the area). During sample collections in July, 1984, 37 specimens of Utah Chub and 2 Speckled Dace were caught. No Utah Suckers were observed. Non-natives captured included 65 guppy specimens and 203 Green Swordtail. Green Swordtail has not been recorded elsewhere in Wyoming (Courtenay 1984). These findings suggest that non-native fish are being deposited into Kelly Warm Springs from aquarium sources. Temperatures remained an almost constant of 25-27°C throughout the summer of 1984, however dates were not specified. Along with fish, many birds and some mammal species were also observed around the warm spring area (Courtenay 1984).

It appears that additional invasive species have been introduced since 1998 because of the increase in variety of species found in the Kelly Warm Springs since 1998 (Table 1) compared to the results found by C. Whaley and B. Hall sampled in 2009-2012 (Tables 2 and 3).

Table 1. Species collected during Kelly Warm Springs survey by Keifling in 1998 (Keifling 1999).

Common Name	Family	Genus Species
Swordtail	Poeciliidae	*Xiphophorous helleri*
Convict/Zebra	Cichildae	*Cichlasoma nigrofasciatum*
Utah Chub	Cyprinidade	*Gila ataria*
Redside Shiner	Cyprinidae	*Richardsonious balteatus*
Madtom Tadpole	Ictaluridae	*Noturus gyrinus*
Guppy	Poeciliidae	*Poecilia reticulate*

Table 2. Species collected in Kelly Warm Springs survey by Chad Whaley, June 2009 (Whaley 2012)

Common Name	Family	Genus Species	Preferred Temperature Range
Utah Chub	Cyprinidae	*Gila atraria*	N/A
Redside Shiner	Cyprinidae	*Richardsonius balteatus*	15-25°C (60-77°F) (Scharpf 2008)
Long Nose Dace	Cyprinidae	*Rhinichthys cataractae*	12.8-28°C (55 -82°F) (Edwards 1983)
Green Sword Tail	Poeciliidae	*Xiphophorus hellerii*	20-25°C (68 – 77°F)
Convict Cichlid	Cichlidae	*Amatitlania nigrofasciaa*	20 - 21°C (68-70°F) (Minckley and Marsh 2009)
Tadpole Madtom	Ictaluridae	*Noturus gyrinus*	18-24°C (65-75°F) (Alderman, 2014)
Guppy	Poeciliidae	*Poecilia reticulate*	19 - 29°C (66.2-84.2°F) (Hemdal 2003)
Bullfrog	Ranidae	*Lithobates catesbeianus*	N/A
Goldfish	Cyprinidae	*Carassius auratus*	20 - 24°C (68-75 °F) (Ford and Bellinger 2005)

Goldfish prefer water temperatures of 20 – 24ºC (68 - 75°F) (Table 2). However, Goldfish can survive in water temperatures down to 0.3°C (33ºF) and as high as 40.6°C (110ºF) (Ford and Bellinger 2005). These temperature tolerances can be highly dependent on the diet consumed. Goldfish that feed on high fat foods can more easily adapt and survive extreme temperature changes (Hoar and Cottle 1952). Tarkan et al. (2010) report that the Goldfish is a robust species able to withstand, thrive, and reproduce under environmental stress conditions including but not limited to increased turbidity, decreased dissolved oxygen, wide temperature fluctuations, and ecosystems disturbances. The upper lethal limit for Goldfish survival is 41°C, and a lower lethal limit of near 0°C has been documented (Fry et al. 1941, Ford and Bellinger 2005). Cichlid temperature tolerances are also extensive. Rantin (1986) documented Cichlid survival at a high temperature range of 32.9°C - 38.5°C and low temperatures of 7.8°C. The wide ranges of temperature tolerance for Goldfish and Cichlids suggest they have an ability to survive in some areas outside of Kelly Warm Springs.

There has been an increase in the species present in Kelly Warm Springs from the early 1970's. However the increase in diversity is due to non-native species that may be harmful to the Kelly Warm Springs ecosystem. There also appears to be an increase in the abundance of non-native fish and invertebrate species in the Kelly Warm Springs and surrounding outlets (e.g., Ditch Creek) (Tables 1, 2, 3, and 4).

Table 3. Species collected by Erin Hotchkiss and Bob Hall, June 2010 (Hotchkiss 2011).

Common Name	Family	Genus Species
Utah Chub	Cyprinidae	*Gila atraria*
Redside Shiner	Cyprinidae	*Richardsonius balteatus*
Long Nose Dace	Cyprinidae	*Rhinichthys cataractae*
Green Sword Tail	Poeciliidae	*Xiphophorus hellerii*
Convict Cichlid	Cichlidae	*Amatitlania nigrofasciata*
Tadpole Madtom	Ictaluridae	*Noturus gyrinus*
Guppy	Poeciliidae	*Poecilia reticulate*
Goldfish	Cyprinidae	*Carassius auratus*
Bullfrog	Ranidae	*Lithobates catesbeianus*

Table 4. Species collected by Chad Whaley, June 2012 (Whaley 2012).

Common Name	Family	Genus Species
Speckled Dace	Cyprinidae	*Rhinichtyhs osculus*
Utah Chub	Cyprinidae	*Gila atraria*
Redside Shiner	Cyprinidae	*Richardsonius balteatus*
Green Swordtail	Poeciliidae	*Xiphophorus hellerii*
Convict Cichlid	Cichlidae	*Amatitlania nigrofasciata*
Guppy	Poeciliidae	*Poecilia reticulate*
Tadpole Madtom	Ictaluridae	*Noturus gyrinus*

Table 5. Temperature data from Kelly Warm Springs and the outlet Ditch Creek, collected by the U. S. Geological Survey (Cox 1972).

Warm Springs Date	Temp.(°C)	Ditch Creek Date	Temp. (°C)
5/13/69	26	5/13/69	7
7/22/69	27	7/22/69	22
9/26/69	25.5	9/26/69	5
11/11/69	25.5	11/12/69	2.5
5/3/70	27.5	8/5/70	18.5
10/16/70	27	10/16/70	0
9/17/71	26	6/7/71	4

Table 6. Temperature data collected from Kelly Warm Springs by the National Park Service (Grand Teton National Park 1972)

Date	Temperature(°C)	Discharge (CFS)
5/13/69	26°	16
7/22/69	27	12.8
9/26/69	25.5	9.76
11/11/69	25.5	7.86
5/3/70	27.5	5.96
10/16/70	27	27
9/17/71	26	11.03

There was less than a 3°C temperature range over three years of spring, summer, and fall monitoring (Tables 5 and 6). The mean temperature of these measurements is 26°C. However, it should be

noted that these measurements were in the Kelly Warm Springs proper, and that winter sampling data was not collected. Also, there was no continuous monitoring, these were one-time measurements.

Discussions about eradicating non-native species in the Kelly Warm Springs were held in the 1980's. Courtenay (1984) observed that "there should be no non-native pets within the boundaries of a National Park," however he also stated that the "tropical fish" were/are no harm to the indigenous species residing within the springs. However, the disappearance of Utah Sucker concurrent with the increase in non-native fish may suggest non-native fish have had an impact. The comments by Courtenay (1984) represent the thought that Kelly Warm Springs be left in its current status until further study was conducted to determine whether it was plausible to take action. Necessary actions to remove non-native species may be quite extensive and expensive, especially if the goal was to rid the Warm Springs and its outlets of non-native species.

Along with concern about non-native species in the Kelly Warm Springs, there have been efforts to rehabilitate the springs itself. These included cooperative efforts by private landowners and the National Park Service to modify the shape of the springs along with the outflows and inflows. These efforts were initiated due to private landowner concerns related to irrigation issues. The National Park Service views this project favorably because of concerns related to non-native species competition with native species and disease introduction.

Current temperature monitoring

Table 7. Preliminary temperature data gathered from October 6-December 14, 2014.

Hobo Name	Mean Temp (°C)	Maximum Temp (°C)	Minimum Temp (°C)
KWS 4	*8.6*	19.7	0.12
KWS 5	*12.8*	23.9	1.2
KWS 6	*15.4*	26.4	2.6
KWS 7	*20.4*	28.3	10.8
KWS 8	*23.9*	30.9	16.1

By mid-November, 3 of 4 sites downstream of Kelly Warm Springs proper experienced minimum water temperatures approaching 0°C (Table 7). All sites located below Mormon Row, where temperature loggers were initially deployed, were either dewatered or frozen by mid-November.

The Kelly Warm Springs is a popular area for recreational visitation. Visitors frequent the Warm Springs to observe terrestrial and aquatic life, boat, picnic, swim, etc. It appears that some visitors started depositing non-native fish into the springs as early as the 1960s, which has been a cause for concern (Baldwin and Franta 1968). The National Park Service is currently gathering visitor count data but suggest visitor numbers in the thousands each year (K. Melander, NPS personal communication). Heavy visitor use is linked to erosion around the Kelly Warm Springs (Figure 2). Footpaths have been have been created by the traffic around almost the entirety of the springs. This traffic appears to have caused damage to vegetation with land erosion at the surface of the springs (Figure 2). The human and animal traffic in the warm springs may have also elevated the presence of algae and sediment in the area (Figure 3). In addition to land traffic from humans and animals around the springs, there is also high traffic in the water from swimmers, waders, kayakers, etc. (Figures 3 and 4). The National Park Service has begun an educational program to teach the public about potential issues related to Kelly Warm Springs (Summer 2014). During educational events, the public was invited to participate in citizen science (Figure 5) where they worked with park personnel to identify fish caught in minnow traps. Bullfrog tadpoles and Swordtails were identified and the data were recorded to follow fish species and amphibian presence within the warm springs (Figures 6, 7, and 8). This capture helps the National Park Service compile data as well as provides an opportunity for the public to learn proper sampling and observation techniques while they catalog and record the information. To further educate the public, the National Park Service recently posted signs (Figure 9) that request the public refrain from releasing aquarium fish and other specimens into Kelly Warm Springs.

Figure 2. Human traffic path to and from the warm springs. Photographer unknown.

Figure 3. Image of the Kelly Warm Springs with swimers. This is a frequent occurrence year around creating heavy traffic not only around but in the springs. Photographer unknown.

Figure 4. Image displaying algae growth.

Figure 5. Image of a minnow trap placed in the north end of the Warm Springs and used for an educational program to identify and sample species in the springs. Photo by Paige Anderson.

In summary, research and monitoring has occurred in the Kelly Warm Springs since the 1960s and concern about non-native species and potential ecological damages have continued to grow since their initial discovery. The abundance and diversity of non-native species present within the springs, along with high human traffic threatens to erode, contaminate, and potentially introduce disease. Studies and observations pertaining to these potential threats are ongoing and in continuous review by the National Park Service and the U.S. Geological Survey.

Figure 6. Image of sample of native and non-native species taken from the warm springs. Photo by Paige Anderson.

Figure 7. An image of species being sampled and observed from the Kelly Warm Springs. Photo by Paige Anderson.

Figure 8. Specimens placed in ziploc bag for identification. Photo by Paige Anderson.

Figure 9. Image of sign at the entrance to the Kelly warm Springs asking vistors to refrain from dumping unwanted non-native fish. Photo by Paige Anderson.

[1]Any use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

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