Submitted by Drew Sparlin Jr.

RC156

Madam Chair and Members of the Board

Understandably these comments are directly from this 2012 BLER technical report.

I've taken liberty to underline statements and made comments throughout this report.

Drew Sparlin Jr.

US Army Corps of Engineers
Alaska District

Black Lake Ecosystem Restoration Technical Report

October 2012

Submitted by Drew Sparlin Jr. **RC156**

Executive Summary

This report investigates the physical and biological conditions at Black Lake on the Alaska Peninsula in southwestern Alaska. Black Lake provides prime rearing habitat for sockeye salmon, a critical commercial and subsistence resource to the local population. Changes observed in Black Lake over the past several decades include reduced depths and volumes. There is concern that continued reductions in depth and volume would result in harmful and unrecoverable impacts to the salmon that utilize the habitat in Black Lake. Investigations conducted as part of this study have determined that the changes observed in Black Lake are in response to geomorphic changes in the river that drains it. While Black Lake may experience further reductions in volume, the risk does not appear imminent based on recent indications that Black Lake could be approaching a new state of equilibrium. Nevertheless, continued monitoring is recommended by periodically measuring the volume of Black Lake and elevation changes in the lake's outlet and the upper reach of Black River below the lake outlet. Those measurements, coupled with an annual assessment of Chignik sockeye smolt production, would establish whether Black Lake is still degrading, and if so, the ensuing impact on system-wide sockeye production. The above measurements would also help determine whether future intervention may be warranted. Numerous structural measures were considered to alleviate the impacts of reduced depths and volumes in Black Lake to date; however, none are recommended for implementation at this time.

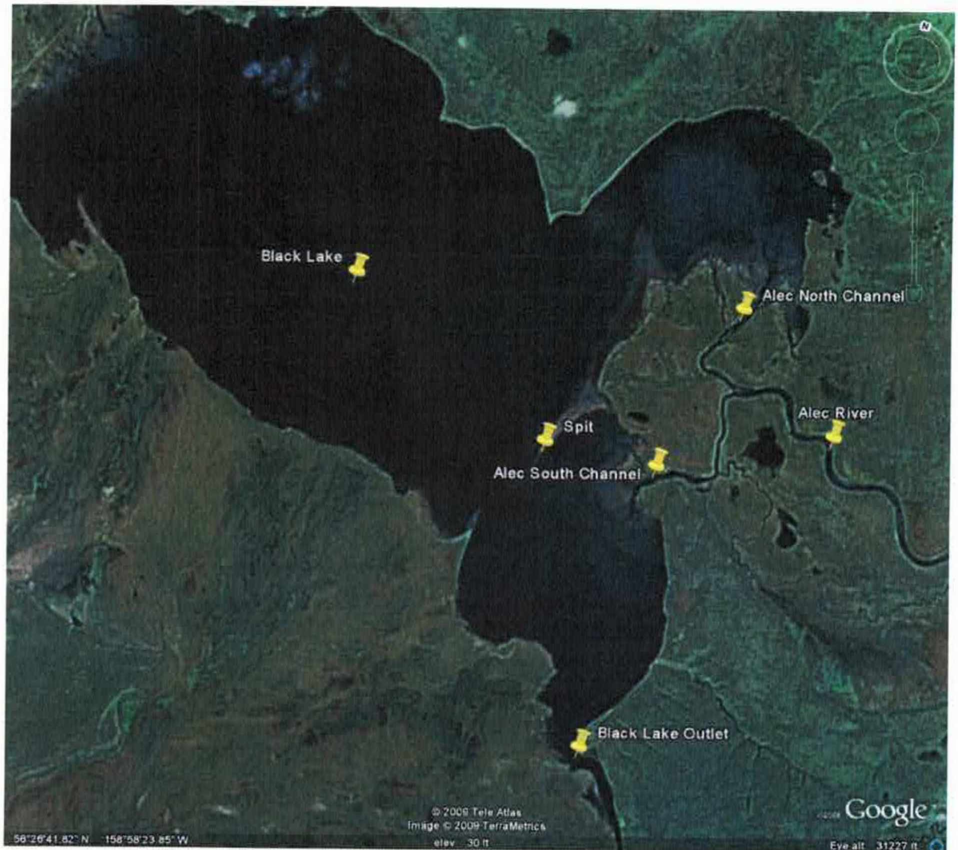

Figure 2. Overview of Alec River and Black Lake

Fishery Resources

Sockeye salmon are the principal salmon species returning to the Chignik/Black Lake drainage. Two runs, an early (May-July) and late run (June-September) enter the Chignik River. The early run spawns in Black Lake drainages, including the Alec River (Black Lake stock), and the late run spawns in Chignik Lake drainages, including the Black River between the lakes (Chignik Lake stock). Both runs are harvested commercially and the late run is harvested for local subsistence.

Juvenile sockeye salmon rearing in Black Lake appear to be responding to changing environmental conditions. There is evidence that when the lake was deeper, juvenile sockeye spent the winter in Black Lake. Today, indications are that most of the juvenile sockeye migrate to Chignik Lake by August, apparently in response to summer water temperatures that can approach 21° C. There is evidence that some juvenile sockeye find refuge in cooler water near creek mouths and migrate to Chignik Lake later in September.

Study funds were used to support a Fisheries Research Institute effort (Griffiths, et al 2012) to validate differences between the two salmon stocks. Data collected as part of this effort did not show a consistent statistical difference in body condition between the stocks. However, a subset of juveniles produced by Black Lake stocks seem to have a better body condition, though overall, fish that emigrated from Black Lake earlier were

With possible Freeze to bottom and over heat temperature in summer for salmon survival.

Migration to cooler H_2O in summer
Possible early run that do spawn Freeze out or smolt survival diminishes?

found to be in poorer condition after spending more time in Chignik Lake, a result that corroborates several previous studies.

Lower Lake Food Competition

Sockeye fry rearing in Black Lake have a growth advantage over sockeye fry of the same age rearing in Chignik Lake. Compared with the deeper and colder Chignik Lake, limnologically Black Lake can be very productive relatively early in the season. This early productivity can result in accelerated growth for sockeye salmon fry recently emerged from the spawning gravels in the Alec River. Black Lake fry benefit from the more or less ideal environmental rearing conditions in Black Lake until rising summer water temperatures apparently drive most of them to Chignik Lake where prey species are or can be more limited than in Black Lake. Black Lake fry are larger than Chignik fry of the same age when they enter Chignik Lake (Simmons et al in review 2012), and potentially can out-compete smaller Chignik Lake stock for available food resources, affect growth of the Chignik Lake stock, and potentially impair their freshwater survival.

Upper vs. Lower Competition on limited Food source?

The salmon fishery resources of the Chignik lakes system have been managed since the early 1900's. Early management was begun by the Federal Bureau of Commercial Fisheries and then subsequently by the Alaska Department of Fish and Game (ADF&G) since Alaska statehood in 1959. The University of Washington in Seattle created the Fisheries Research Institute (FRI) in 1948 and began work in the Chignik area in 1955 as part of ongoing Alaska salmon resource investigations. Currently, ADF&G and FRI are actively involved in Chignik salmon studies, and to a lesser but important extent, so too are the Chignik Regional Aquaculture Association and the U.S. Fish and Wildlife Service.

In addition to managing the Chignik commercial salmon fishery, ADF&G has been annually assessing the sockeye salmon smolt out-migration from the Chignik lakes system since 1994 and conducting limnological studies in Chignik and Black lakes annually from 2000. These studies provide data useful for improving system management toward the goal of ensuring that escapement levels are appropriately gauged for maximum sustainable yield. Integral to the smolt monitoring work is genetic analyses of the smolt. The aim is to allow run-specific forecasting by assigning smolt numbers to stock of origin by age class, advance escapement goal evaluation, and measure specific stock performance (production) and between-year survival variability, and also to evaluate long-term habitat changes.

Chignik sockeye smolt abundance varies annually and has averaged about 13 million for the last 18 years (Figure 3). The between-year fluctuations in smolt numbers indicate wide changeability in environmental (habitat) conditions within the Chignik drainage, which affects sockeye smolt survival and production. This level of smolt abundance indicates that the Chignik lakes system as a whole is very productive, and there is no downward trend evident at this time.

God blessed good news as of 2012

unfortunatly climate change has exasperated the affects of this study in last 5 years. 2017 – 2022

A bathymetric survey of Black Lake was performed in 2011. The survey provided the absolute elevation of the lake bottom, as opposed to determining depths based upon the WSE at the time of the survey. A bathymetric contour map and stage (WSE) versus volume and stage versus surface area curves were generated from the data collected. This showed that at a WSE elevation of 26 feet, the average depth of the lake is 6.3 feet with a maximum depth of 13.6 feet.

What is extent of degredation since 2012 to prior 2006 ITHR report?

To examine trends in WSE, changes in vegetation around the perimeter of the lake were used as a proxy for changes in the average WSE. To relate changes in vegetation to changes in average lake stage, two key assumptions are made: that vegetation around the lake responds to changes in average lake WSE and that the bathymetry of the lake remains relatively constant. The results of this analysis indicate that over the past 50 years, the average lake water surface elevation has decreased by approximately 1 to 2 feet. This corresponds to an average volume decrease of between 17 and 30 percent. These depth and volume reductions are less than all but one of the previous estimates documented in this report. Though the average volume appears to be declining, based on recent lake stage measurements, the water surface elevation during significant runoff events can still reach historic levels.

One of the concerns of reduced WSEs in Black Lake is an increase in water temperature due to reduced volume and depth. Sufficient increases in water temperatures could cause salmon and other species to seek refuge in cooler water such as that provided by the deeper Chignik Lake. During the course of this study, a hydrodynamic model (Griffiths, et al. 2011) was used to refine the impacts changes in lake depth and volume would have upon water temperature. The hydrodynamic model was used to simulate various future scenarios. It showed that air temperature, not depth, is the driving force determining water temperatures in large, shallow lakes subject to high wind mixing, such as Black Lake. The model predicted that small increases in WSE would actually raise water temperatures, likely due to the increase of residence time of water in the lake. With recent warming trends experienced in the region and expected to continue into the near future, it is likely that Black Lake will experience further increases in water temperature in spite of changes in WSE.

Warming trends increased drastically since report 2012

Can't ignore this!

What is the mechanism by which Black Lake is becoming shallower?

While all previous investigations attributed long-term reductions in Black Lake depth and volume to reduced WSEs, it is also possible for a lake to experience reductions in depth and volume due to sedimentation. The contribution of sedimentation to the reductions experienced at Black Lake was not previously measured. Identifying the relative contributions of lowered WSE and sedimentation to the overall reductions in depth and volume documented at Black Lake is important when considering suitable management measures for implementation. To address this, sedimentations rates occurring in Black Lake for the past 50 years were estimated using lake bed coring data techniques.

Have heard reports that the West Fork has migrated off channel below black lake tributary reducing water levels in Black Lake /

possible that the Black River may be approaching a new equilibrium following a stream channel shift in the West Fork, a tributary to the Black River. It is to be expected that as the West Fork continues to migrate across its alluvial fan over decades and centuries, the water levels in Black Lake will fluctuate in response to the changing bed of the Black River. The West Fork currently appears to have migrated as far south as possible with a hardpoint preventing further migration. While no estimates have been made on when the river will migrate back towards Black Lake, if and when this does occur, we can expect to see aggradation in portions of the Black River and a subsequent response of higher WSE in Black Lake. While further reductions in Black Lake WSE are possible, major reductions and impacts to rearing habitat are not anticipated.

Water entering Black Lake's main basin, on the opposite side of the spit from the lake outlet, will be sufficient to ensure that the spit remains open for the foreseeable future, even if all flows in the Alec River switched to its southern delta channel. Major impacts to habitat access and water circulation from further extension of the spit are not anticipated.

Control Structure at the Outlet of Black Lake

Maybe time to Consider alternatives to mitigate degradation of water sources migrating tributaries

One method to raise the WSE in Black Lake is to construct a broad-crested weir extending across the river in Reach 3 of the Black River. The weir could have a lowered section in the middle to allow passage of boats and fish. The effect of this type of structure is that at low flows the center portion functions as a weir, raising the upstream WSE. At high flows, the weir flow area expands with a decreasing influence upstream. Calculations show that such a weir would increase the WSE in Black Lake by approximately 1.3 to 1.5 feet at lower flows, and 0.1 to 0.25 foot at higher bank full flows. Such a structure would only have appreciable impacts upon WSE during low flow periods, which generally occur during the winter. Since there are few juvenile sockeye salmon present in Black Lake during the winter, presumably due to high summer water temperatures in Black Lake triggering migration to cooler waters downstream, this alternative would have minimal biological benefits. In addition, hydrodynamic modeling (Griffiths 2011) showed that increases in lake depth by as much as 6.5 feet would have no appreciable impact upon water temperatures in Black Lake. Due to the remote location and difficult access to the site, construction would be expensive and challenging. Additionally, if the system did not react optimally with the weir in place, opportunities for timely and effective adaptive management would be severely limited. Further consideration of this alternative is not suggested at this time.

In-stream Control Structures in the Black River

As an alternate to placing a single structure at the mouth of Black Lake, several smaller grade control structures could be placed in the Black River to control the WSE of Black Lake. Multiple erosion resistant structures such as cross-vanes or check dams consisting of imported materials (rocks and/or logs) could be placed in the stream channel. Each structure would provide a grade control structure and would prevent downcutting of the Black River. A number of these structures placed strategically throughout the Black River could return the Black River, and subsequently Black Lake, to historical water

Monitoring Plan

Considering the documented gradual changes in the physical habitat of Black Lake, it would be beneficial to monitor some of the trends identified in this study to confirm the direction and rates of change in the future. The primary objective of such a monitoring plan should be to detect any accelerated degradation within Reach 3 of the Black River that could lead to further volume losses in Black Lake. This is the only alternative plan recommended at this time.

Preliminary Evaluation of Alternatives

Numerous structural measures were considered to alleviate the impacts of reduced depths and volumes in Black Lake. Implementation of any of these measures is not warranted at this time due to several factors;

- It appears that the Black Lake/Black River system may be approaching a point of geomorphic equilibrium following a channel shift of a tributary to the Black River. While further reductions in Black Lake WSE are possible, major reductions and impacts to rearing habitat are not anticipated.
- There is no clear correlation between the changes documented at Black Lake and the fisheries resources of the Black Lake/Chignik fishery. To what extent that these changes have reduced sockeye salmon production of Black Lake is unknown. No sustained downward trend in the fishery attributable to the reduction in depth and volume has been documented.
- Structural measures are predicted to have a minimal impact upon the thermal regime of Black Lake and hence are not expected to increase the utilization of Black Lake habitat. Future anticipated increases in air temperature are likely to have a larger impact.

Conclusion

Lower WSE in Black Lake are attributable to the shift in location where the West Fork River enters the Black River. While the trend in lower average lake WSE may continue, the rate of change appears to be decreasing, and it is possible that the Black River may be approaching a new equilibrium. It is to be expected that the water levels in Black Lake will fluctuate in response to the changing bed of the Black River. While further reductions in Black Lake WSE are possible, major reductions and impacts to rearing habitat are not anticipated. Water entering Black Lake in its main basin on the opposite side of the spit from the lake outlet will be sufficient to ensure that the spit remains open for the foreseeable future, even if all flows in the Alec River were to switch to its southern delta channel. Major impacts to habitat access and water circulation from further extension of the spit are not anticipated.

The Chignik River salmon fishery continues to be a robust salmon fishery. The Chignik River watershed began as the result of dynamic natural processes and will likely continue to be shaped by those same processes. The fishery will likely continue to shift life history strategies to account for the habitat changes accordingly. Competition between Black Lake emigrants and Chignik Lake smolt will likely continue in years when conditions increase temperatures in Black Lake. Continued monitoring of smolt outmigration and limnology in the system will provide the best way to detect changes in the early life history strategies that may be deleterious to this vital fishery.

Recommendations

Continued monitoring of smolt outmigration and limnology in the Chignik system is the best way to detect changes in the early life history strategies that may detrimentally impact the overall resources of the watershed. Such data are not confounded by variable ocean conditions and therefore are essential for linking changes in freshwater life stages and the overall health of sockeye salmon stocks. Annual collection of Black Lake water surface elevation data, combined with periodic collection of cross section data from the Black River, and satellite imagery of the region will allow early identification of any geomorphic forcings that could result in a deleterious loss of rearing habitat in Black Lake. A monitoring plan, as described in Supplemental Information, is recommended to ensure the system is approaching a state of renewed equilibrium and to identify any stressors to the system before they have irreversible impacts upon Black Lake and its fishery resources.

Continued study under Section 206 of the Water Resources Development Act of 1996 is not warranted at this time because the Authority does not facilitate monitoring efforts prior to project implementation. Thus, there is no Federal interest under the Continuing Authorities Program.

Views of the Sponsor

The sponsor, the Lake and Peninsula Borough (Borough), has worked closely with the Chignik Regional Aquaculture Association (CRAA), which has played the primary role in coordinating Black Lake research since its founding in 1991. The Borough and CRAA believe that the unusually rapid changes in the watershed that led to the significant reductions in the volume of Black Lake over the last 30 years continue to present a significant potential danger to the future salmon productivity of Black Lake. Due to the large natural variation in run size, the impacts of very different management regimes over time (e.g. Federal versus State management and Japanese high seas drift net fishing near shore versus the institution of the 200-mile limit); climate change (e.g. Pacific Decadal Oscillation and global warming); and the complex life history of salmon, it is impossible to statistically correlate declining lake volume with reductions in Black Lake salmon productivity. While the extent of any reduction in Black Lake salmon productivity over the last 30 years is unknown, it is obvious and universally acknowledged that if Black Lake volume continues to decline, even at a reduced rate, eventually Black Lake will suffer a substantial negative impact on average future salmon production.

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Please don't ignore in-river issues?

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In addition to changes in the longitudinal profile, a river can respond with changes in pattern, roughness, and shape in response to base level changes.

Black Lake Water Level Controls — amount of viable spawning!

As with any reservoir or lake the water surface elevation is controlled by:

- Volume of water flowing into the lake
- Direct water losses and gains (precipitation, infiltration, and evaporation)
- Relationship between water storage and the lake water surface elevation
- Relationship between lake water surface elevation and water flowing out of the lake (outlet rating curve)

The volume of water flowing into the lake will vary over time due to changes in many direct factors such as precipitation, temperature, and reduction in glacier runoff. Long-term changes, such as changes in vegetation, in the watersheds can also affect the volume of water that flows into Black Lake.

Previous studies have characterized the outlet of Black Lake as a weir to estimate the relationship between outflow and the lake water surface elevation. Generally, flow out of Black Lake is tranquil with no obvious sill or weir at the outlet or within the upper reach of the Black River. The stage versus discharge relationship of Black Lake is controlled by the channel hydraulics of the upper Black River rather than a typical lake outlet sill.

The confluence of the West Fork River used to enter the Black River farther upstream than at the present moment. Knappen (1929) described how the high sediment load of the West Fork River created the alluvial fan that dams the outlet of Black Lake and establishes the water level of the lake. Figure 16 shows a present day braid of the West Fork flowing into the Black River and depositing sediment in the Black River channel. It is to be expected that as the West Fork River migrates across this alluvial fan, over decades and centuries, that the water levels in Black Lake will fluctuate in response to the changing bed of the Black River.

These are enough reasons to consider the true "optimum" spawning number of Chignik system as a whole.

Is it possible to be over escaping the system with adverse affects?

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