Implementation of an Augmentation System to Prevent the Decline of *Oncorhynchus mykiss* in Southern California Watersheds

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Abstract

This research paper investigates various environmental factors and their effects on *O. mykiss* (Steelhead Trout) in Southern California. The goal of the research is to establish a lasting solution to slow the decline of *O. mykiss* in Southern California's many watersheds that feed into the Pacific Ocean. Secondary data analysis was used to investigate possible solutions for mitigating the effects of the changing environment on watersheds that retain an *O. mykiss* population in Southern California. The main solution investigated was the use of an augmentation system with special consideration towards drought as a possible solution for slowing the decline of the *O. mykiss* population.

Introduction

O. mykiss (Steelhead Trout) is an anadromous species of fish, meaning they spawn in freshwater and mature in the ocean for two to three years (NOAA, 2016). Juvenile rainbow trout denoted by the name fry. *O. mykiss* are more commonly known as rainbow trout which are the freshwater, non-anadromous variant of *O. mykiss*. Rainbow trout go through a physical transformation called smoltification to become ocean-going fish. Smoltification is a physiological change involving changing skin color and altered body shape as well as an increased amount of Sodium, Potassium, and ATP synthase in the gills to survive in saltwater environments (Bradley et. al., 1988). There are many environmental factors that affect *O. mykiss* survival, but the most prominent factors include, overgrazing by livestock, urbanization, pollution, overfishing, negative genetic variation caused by hatchery fish, major stream blockages such as dams and bridges, and the most prominent factor, drought (Katz et al., 2012).

Research Question

The overarching research question for this paper is how can the effects of drought be mitigated to assist the reintroduction of the declining *Oncorhynchus mykiss* in Southern California watersheds?

Purpose

The purpose of this paper is to investigate the effects of the changing environment on *O. mykiss* population in Southern California watersheds and to determine whether or not an augmentation system is a suitable method of mitigating these effects. The *O. mykiss* population has suffered greatly in the past decade due to Southern California's severe drought and efforts by NOAA to create a recovery plan. However, an augmentation system as discussed in this paper has not been suggested in the attempt to reduce the impact of changing climate on *O. mykiss.*

Hypothesis

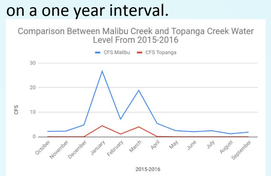
Alternative: The implementation of an augmentation system in vulnerable watersheds will create a more suitable habitat for Oncorhynchus mykiss and will correlate to an increased survival rate and population size.
Null: The implementation of an augmentation system in vulnerable watersheds has no effect on Oncorhynchus mykiss survival rates and population sizes.

Methods

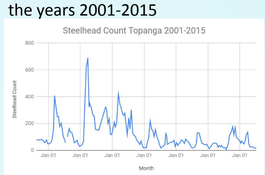
The research design was conducted using secondary data analysis. Research papers were obtained from various online databases including but not limited to EbscoHost, Google Scholar, Plos ONE, Research Gate, and ScienceDirect. Secondary data was obtained through a mentor who works for NOAA and directly from the NOAA database along with data from LVMWD's monitoring devices F-130 located in Malibu Creek and F-54C located in Topanga Creek. Other secondary data came from RCDSMM on *O. mykiss* counts for both Topanga Creek and Malibu Creek. Topanga Creek was used as a control in this theoretical study because it does not have an augmentation system in place. It is a naturally flowing creek and is only fed by rainfall and urban runoff. Topanga Creek was ideal for this study due to its close proximity and relatively similar environment to Malibu Creek. Malibu Creek was used as an experiment as a result of its augmentation system in place which is facilitated by the Tapia Water Reclamation Facility. Once data was gathered using secondary data analysis, a comparison between Malibu Creek and Topanga Creek water levels in CFS will be done in order to show the varying water levels in both creeks. The F-130 water monitoring device measures water level in cubic feet per second and transmits the data to the Tapia Water Reclamation Facility to assess whether augmentation to the stream is required. The data is transmitted to the facility from F-130 in a spreadsheet and graphical form. The F-54C water monitoring device is located in Topanga Creek. It takes water level data daily in cubic feet per second and transmits the data to LVMWD for research purposes.

Results

the Malibu Creek water level and Topanga Creek water level in CFS on a one year interval.



Graph showing O. mykiss population in Topanga Creek in the years 2001-2015



average water levels in years 2009-2016 and 1959-1966 in Topanga Creek

Month	2009-2016	1959-1966
January	2.86	6.34
February	5.71	16.52
March	4.18	1.87
April	1.25	3.39
May	1.06	0.56
June	0.51	0.23
July	0.40	0.10
August	0.30	0.07
September	0.24	0.06
October	0.44	0.06
November	0.43	7.04
December	2.91	8.19

O. mykiss population comparison between Malibu Creek and Topanga Creek in 2012

2012 Months	Topanga Creek *O. mykiss* Count	Malibu Creek *O. mykiss* Count
January	21	5
February	13	6
March	40	8
April	51	2
May	55	0
June	54	2
July	49	0
August	22	0
September	37	0
October	25	0
November	36	1
December	19	0

Discussion

when the *O. mykiss* population was compared between Malibu Creek and Topanga Creek, Topanga Creek was shown to sustain a significantly higher of *O. mykiss* than did Malibu Creek. In fact, the creek with less water without an augmentation system sustained a considerably higher number of *O. mykiss* than the creek which flowed year long and was fed by recycled water.

Conclusion

Secondary data analysis and the T-test conducted on *O. mykiss* populations between Topanga Creek and Malibu Creek strongly support the null hypothesis. The augmentation system in place for Malibu Creek is an ineffective method of conserving the Malibu Creek *O. mykiss*. However, and augmentation system may not be disregarded as a solution to conserving the *O. mykiss* population in Southern California because if an augmentation system is more directed toward *O. mykiss* survival and not just the simple discharge of water into a creek, it could be beneficial in the future when more dry seasons arrive and deprive creeks of water. Malibu Creek is also a poor example of an augmentation system as there are many variables that prevent their survival. An augmentation system could be used as an emergency solution in conserving the riparian habitat of Southern California creeks along with providing a source of recycled water for people to make it more applicable to other watersheds.

Further Work

O. mykiss is an extremely resilient fish, however they cannot fight the decreasing water levels that Southern California faces in this day and age. Further work would include researching the augmentation process and its possible benefits of implementing it into a watershed which is not as ecologically damaged as Malibu Creek.

Acknowledgments

I would like to thank Dr. Rosi Dagit, Mr. Dave Roberts, Dr. Malhotra, Mr. Russell Marlow, and Dr. Mark Capelli for their continued support throughout the research process.

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