TCII question Duncan Rabenstein

Question

Has the Shevlin or REALMS study site changed more in terms of Tumalo Creek's water quality (including turbidity, temperature, pH and dissolved Oxygen) from 2009 to 2015.

Variables

Independent variables: Study site, Year

Dependent variable: increases or decreases in levels of Turbidity, temperature, pH and dissolved oxygen

Constants: using a Vermier probe to take data, taking data in October and November, taking data on the left bank and taking data within a window of time every year.

Possible unwanted variables: Weather, people accidentally taking data incorrectly, taking data on different days and taking data in different steam features.

Background

The REALMS Tumalo study site is on Tumalo creek just upstream from Skyliner lodge and about 10 miles upstream from Shevlin. Unlike Shevlin the REALMS Tumalo study site was burned by the disastrous Bridge Creek fire in 1979. The fire killed the riparian vegetation, eroded the banks and destroyed the meanders. From 2002 to 2006 restoration was done at the study site including replanting the vegetation, engineering meanders into the river and making Tumalo narrower and deeper. The restoration didn't have an immediate effect; in fact the riparian vegetation has just recently grown back. To see how the health of Tumalo's water hash changed I looked at water quality because it is a good measurement of how the health of Tumalo Creek has improved. This is because Salmonids are important to the functioning of an ecosystem and they only live in healthy water.

PH is a measurement of acidity which is a measurement of hydrogen ions in moles/liter. The more hydrogen ions in a substance the more acidic it is. pH is measured on a logarithmic scale meaning every one number you go up is 10 times greater or less than the last. Most pH values range from to 1 to 14 with higher pH values being more alkaline and lower values being more acidic. Distilled water is neutral with a pH of 7. The optimal range for Salmonids is 6.5-8 the very best being 7 or a bit lower. pH is important because in extreme cases to acidic or basic water can kill Salmonids. In less extreme cases pH can decrease the egg hatching success and damage fish membranes. The pH of Tumalo is made more acidic from pine needles, snow melt and rain and made more alkaline from plants performing photosynthesis removing Carbon dioxide from the water. Pollutants can increase or decrease pH depending on the chemicals and mining can decrease pH because it exposes rocks to rain water. Overly acidic water makes heavy metals dissolve faster which makes most heavy metals toxic. pH can also change other chemicals in the water, for an example overly alkaline water makes ammonia toxic.

Dissolved Oxygen is a measurement of the amount of Oxygen dissolved in water in milligrams per liter. It is important to Salmonids because they need oxygen to breathe and get it from the water. For humans this is not an issue because 21% of the air we breath is Oxygen but creek water can range from .0001% to .002% dissolved Oxygen. This means that slight changes in dissolved oxygen greatly affect the amount of breathes fish need to take. Therefore water with low dissolved Oxygen makes fish spend more energy breathing making them more stressed. The optimal amount of dissolved oxygen providing less stress for fish is 11 milligrams

per liter or 11 parts per million which converts to .0011% or more. Riffles, water falls and bubble curtains have more dissolved Oxygen then other parts of the river. Dissolved Oxygen levels are also raised from aquatic plant photosynthesis and cold water. High elevation has the opposite effect because the air has less oxygen decreasing the amount of dissolved Oxygen in the water. Dissolved Oxygen enables the survival of aquatic plants and affects other chemicals in the water.

Turbidity is a measurement of how cloudy they water is in Nephelometric Turbidity Units or NTU. Creeks become turbid from suspended particles in the water including soil and sediment. Sediment is good for the ecosystem because it provides nutrients to the soil. Other suspended particles can also carry diseases through the river transporting them throughout the ecosystem. The optimal range of turbidity for Salmonids is 0-20 NTU. Turbidity is important because it affects dissolved Oxygen levels in the water. This is because high turbidity blocks submerged plants from photosynthesis and photosynthesis increases the amount of Oxygen in the water. Dissolved Oxygen is also lowered with high turbidity levels because high turbidity makes the sun heat the water more. This is because the suspended particles absorb extra heat, causing dissolved Oxygen to decrease. High turbidity can also clog Salmonid's gills harming them and increasing the difficulty of their breathing. Turbidity can be naturally increased from erosion that is prevented by roots holding soil in place and other riparian vegetation. Riparian vegetation can be destroyed by humans and naturally by floods fires and strong wind. Turbidity also fluctuates regularly from rain and snowmelt because they add to turbidity.

Temperature is a measurement of the amount of heat energy in the water measured in Fahrenheit and Celsius. The optimal Temperature for Salmonids is from 40-66 degrees Fahrenheit. Because Salmonids are warm-blooded their temperature is completely dependent on the temperature of the water they live in and they have adapted to certain temperatures. This is important because the temperature of Salmonids decides the rate of there metabolism. When water temperatures fluctuate to drastically it may slow down or speed up Salmonid metabolism. Cold water also contains more dissolved Oxygen than warm water. However eggs hatch faster in warm water giving them a better chance of not getting eaten before they have hatched. Temperature is decreased from the shade provided by riparian vegetation. Temperature is also affected by the speed of the water flow because faster water has less chance to be heated by the sun. Dams can also increase or decrease the temperature of water depending on what layer of the water is released. If the top layer of water is released the temperature increases because that water is heated more from the sun. The opposite is true when the bottom layer of water is released.

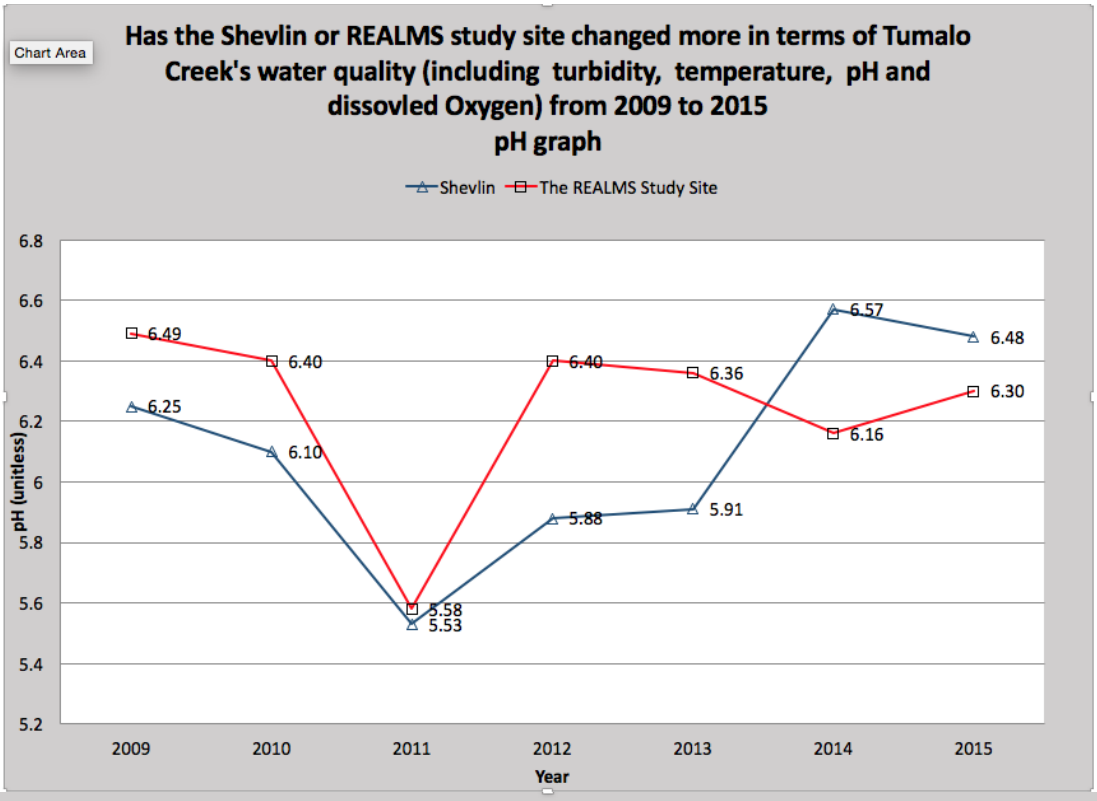
Hypothesis

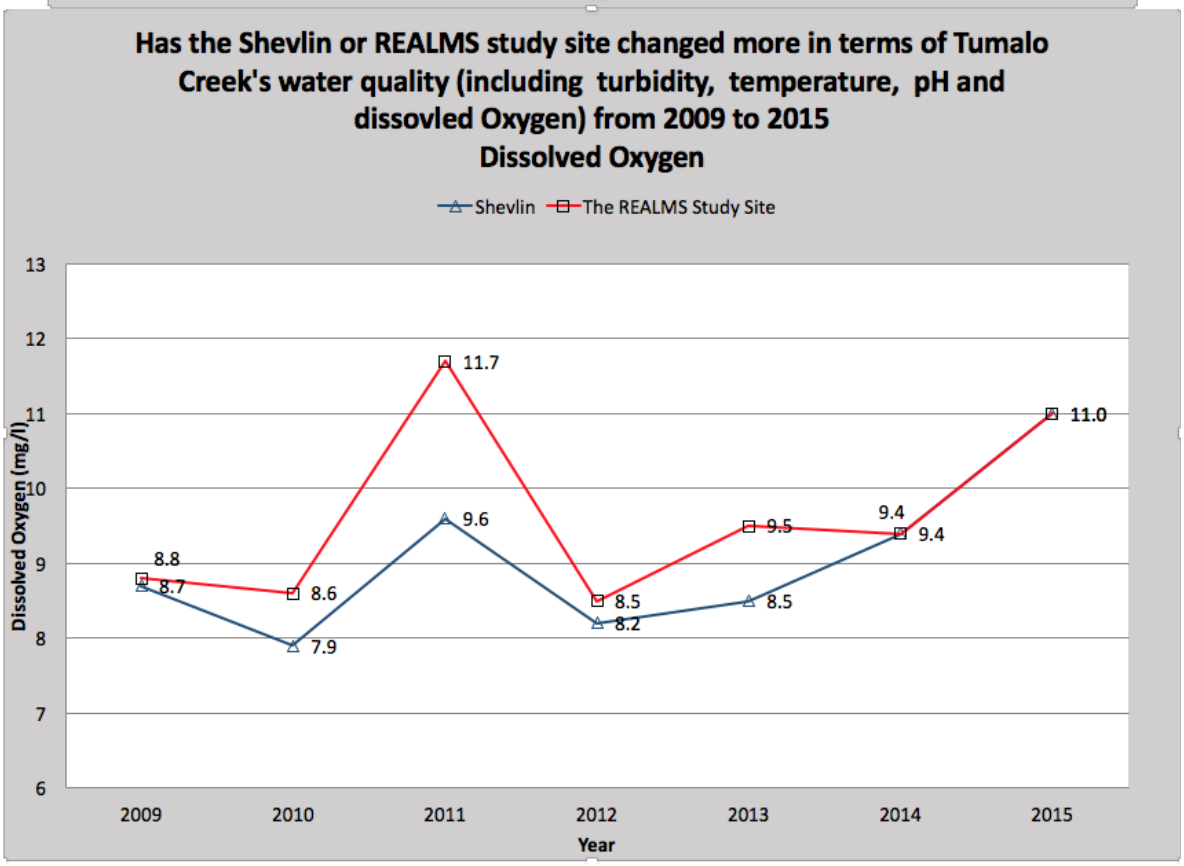
Hypothesis: I think that the REALMS study site has changed more in terms of Tumalo creeks water quality from 2009 to 2015. This is because Shevlin was not burned by the Bridge Creek fire but the REALMS Tumalo study site was. Therefore in 2009 the REALMS study side would not have fully grown back from the Bridge Creek fire. In 2015 restoration has taken effect at the REALMS study site leading to a definite improvement in its water quality. On the contrary in 2009 the Shevlin study site was not burned in the bridge creek fire. This means the river was still fairly healthy in 2009 and would not be as different in 2015. Although this may not be so clear cut because the water quality at is certain spot in the river is mainly effected by the conditions upstream from it. The 10 mile stretch above Shevlin was been in a decent condition since 2009. However The 2 mile stretch directly above the Realms Tumalo study site was not fully recovered in 2009 and has now significantly improved. Above that stretch it was not burned by the fire therefore would not have improved as much.

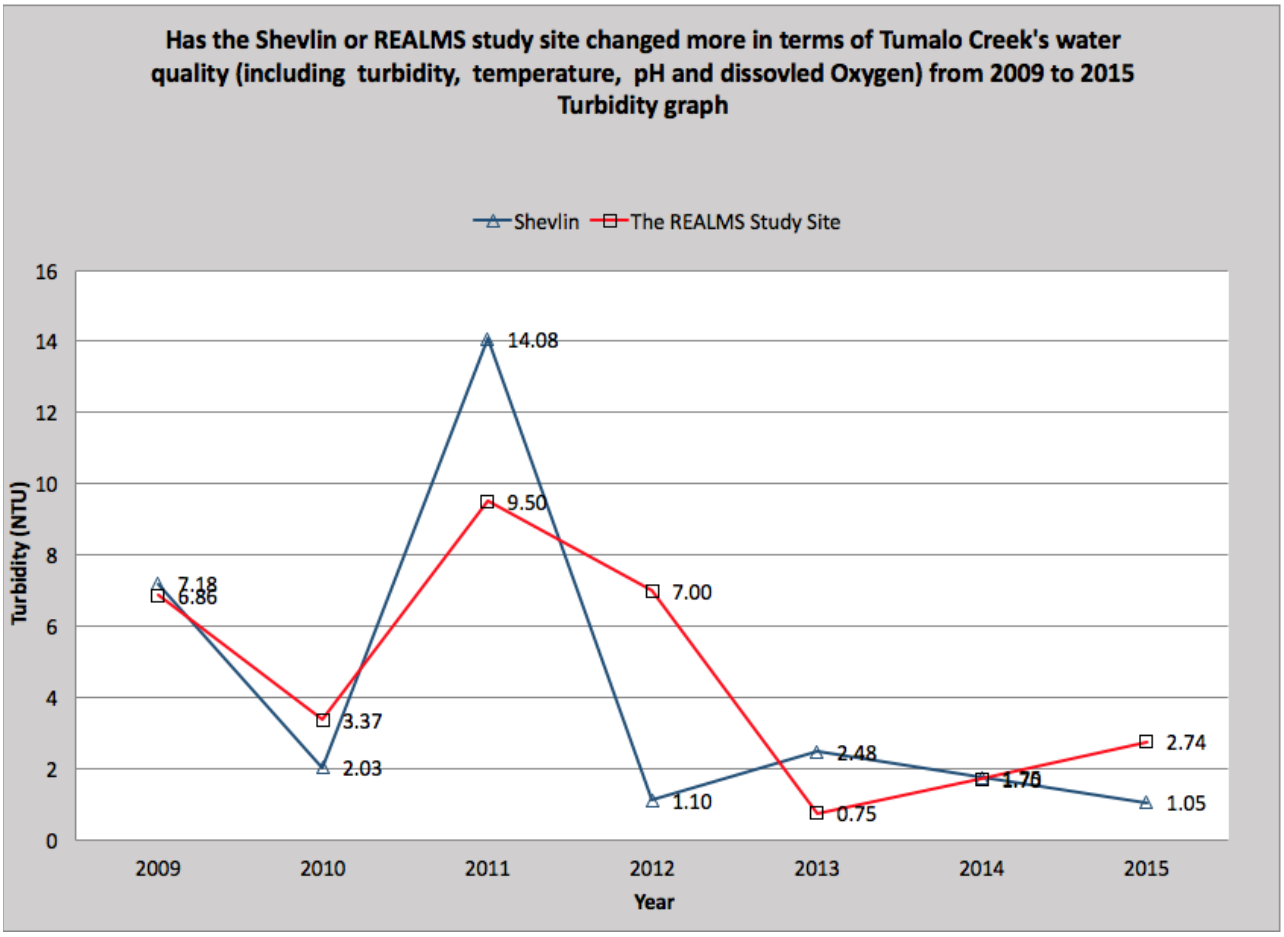
Procedure

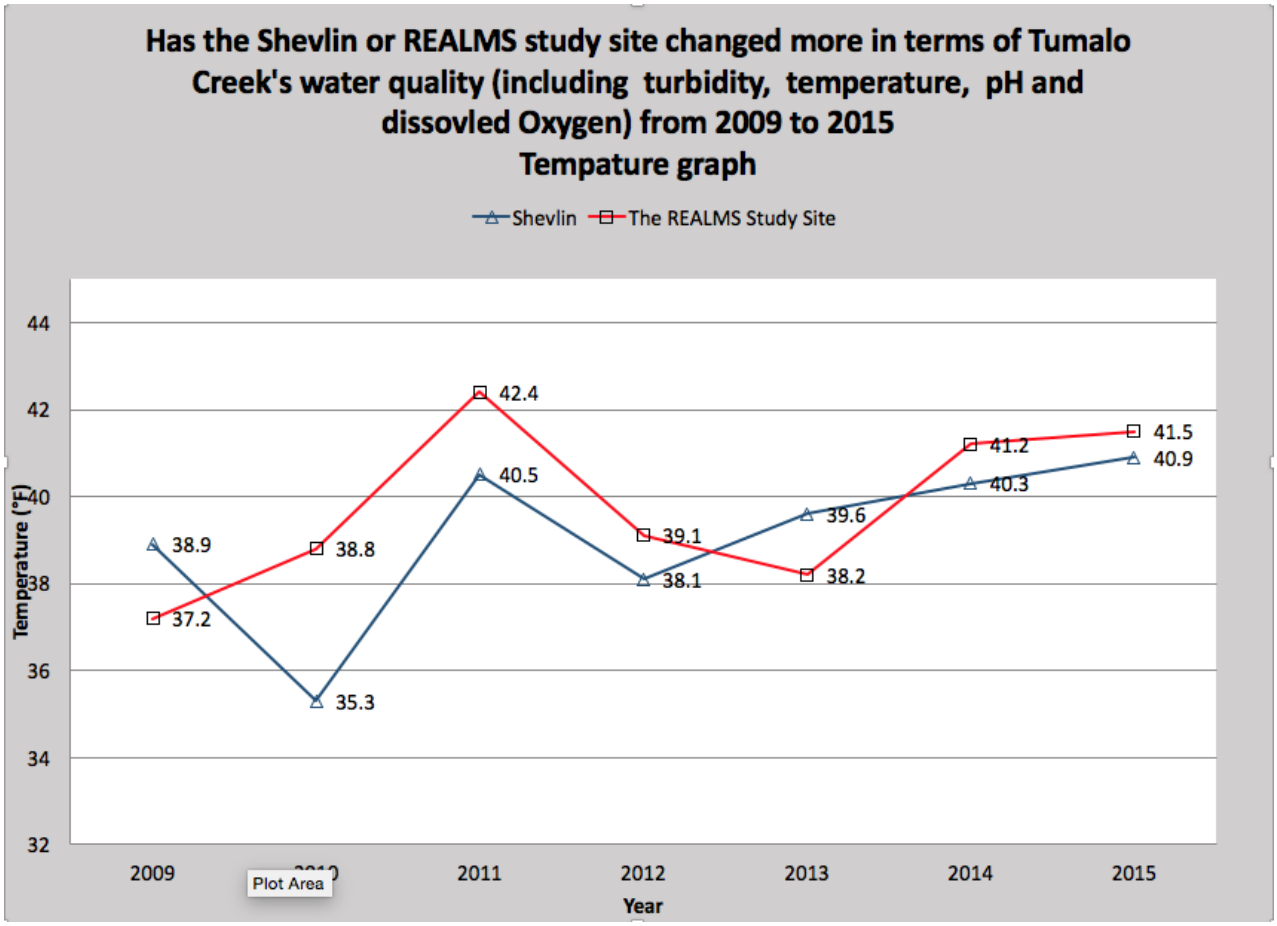
Data was collected at Shevlin park and the REALMS study site. It was collected with electronic Vernier probes according to the protocol corresponding with the device. REALMS middle school students collected the data on the left bank in November and October of 2009 and 2015.

Graphs






Has the Shevlin or REALMS study site changed more in terms of Tumalo Creek's water quality (including turbidity, temperature, pH and dissovled Oxygen) from 2009 to 2015
Turbidity graph
Shevlin
The REALMS Study Site
Turbidity (NTU)
16
14
12
10
8
6
4
2
0
14.08
9.50
7.18
6.86
7.00
3.37
2.03
2.48
1.10
0.75
1.75
2.74
1.05
2009
2010
2011
2012
2013
2014
2015
Year


Has the Shevlin or REALMS study site changed more in terms of Tumalo Creek's water quality (including turbidity, temperature, pH and dissovled Oxygen) from 2009 to 2015
Tempature graph
Shevlin
The REALMS Study Site
Temperature (°F)
44
42
40
38
36
34
32
42.4
41.2
41.5
40.9
40.5
40.3
39.6
39.1
38.9
38.8
38.2
38.1
37.2
35.3
2009
2011
2012
2013
2014
2015
Plot Area
Year

Analysis

PH at the REALMS study site went from 6.49 in 2009 to 6.3 in 2015. At Shevlin pH went from 6.25 to 6.48. This means that the REALMS study site increased 0.04 more then Shevlin decreased. Although the REALMS study site changed more supporting the hypothesis it also dropped farther from the habitable zone of 6.5-8. Both study sites are slightly under the standard habitable zone in 2015 but Salminids in the Tumalo watershed have adapted to acidic waters. Tumalo creeks acidity comes from the soil type and pine needles.

Dissolved Oxygen at the REALMS study site went from 8.8 mg/l in 2009 to 11 mg/l in 2015. At Shevlin dissolved oxygen went from 8.7 to 11 mg/l. This means that Shevlin increased 0.1 mg/l more than the REALMS study site which is within the margin of error. This shows that the 2 study sites changed practically equally from 2009 to 2015 in terms of dissolved Oxygen. In 2009 both study sites' dissolved Oxygen levels were sufficient for supporting only adult Salmonids. Now in 2015 both study sites are in the habitable range of dissolved oxygen for all Salmonids of 11 mg/l or more. Dissolve oxygen probably increased from 2009 to 2015 because during restoration more aquatic vegetation was planted. Aquatic plants add to dissolved Oxygen when they perform photosynthesis.

Turbidity at the REALMS study site went from 6.86 NTU in 2009 to 2.74 NTU in 2015. At Shevlin Turbidity went from 7.18 to 1.05 NTU. This means that Shevlin's turbidity decreased 2.1 more NTU then the REALMS study site from 2009 to 2015. 2.1 NTU is within the margin of error. However it is significant enough prove that the opposite of the hypothesis is true if other variables followed the same trend. Both study sites have gotten significantly healthier but have always stayed in the habitable range for of 0-20 NTU. Turbitity probably decreased from 2009 to 2015 because restoration decreased the amount of sediment and therefore Turbidity.

Water temperature at the REALMS Tumalo study went from 37.2 degrees Fahrenheit in 2009 to 41.5 in 2015. At Shevlin the water temperature went from 38.9 to 40.9 degrees Fahrenheit. This means that the REALMS study site increased 2.3 degrees more than Shevlin. 2.3 degrease Fahrenheit is within the margin of error. However it would still be enough to prove the hypothesis is true if other variables followed the same trend. In 2009 both study sites were cold enough to delay egg hatching time. Now in 2015 at both study sites the water temperature is in the habitable range of 40-60 degrees Fahrenheit. Water temperature probably increased from 2009 to 2015 because air temperature increased as well.

PH didn't show enough of a trend or difference to be conclusive. The difference of increase in dissolved oxygen levels between the two study sites was 0.1 which is also not significant enough to be conclusive. Turbidity almost decreased a significant amount more at Shevlin. However this is canceled out because temperature also almost increased a significant amount more at the REALMS study site. Because of neither study site changed more than the other the hypothesis that the REALMS study site would change more is incorrect. Although this study does not show that either study site changed more it does show an overall trend of both study sites improving in terms of water quality. Both study sites probably improved equally because Bridge Creek fire affected both study sites. If this is true it can be inferred that the water quality of a certain spot in a creek is directly effected by the conditions 10-12 miles above it. Further studies could be conducted to find out if pH actually decreased at the REALMS study site from 2009 to 2015. Along with looking into why all of the water quality variables in this study significantly changed in 2011. This study would have been more conclusive with more data from a larger diversity of study sites. To better analyze the results this study could included more history of the study sites to provide more possible explanations.