Comparing The Streamflow of Four Connecticut Rivers Based On Their Topography And Bedrock

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ABSTRACT

Streamflow was collected for this study at the Mad River, located in Waterbury, CT. The latitude and longitude of the location is 41.54213N and -73.0096W Streamflow data was collected on November 20, 2012 at 1600, and was compared to data collected from the same location over the past twelve years. Further analysis of the Mad River streamflow was made to the topography, specifically bedrock and elevation, and to the size of the river drainage basin and then compared to data from the Shepaug River, the Salmon Creek River, and the Nonnewaug River, all in Connecticut.

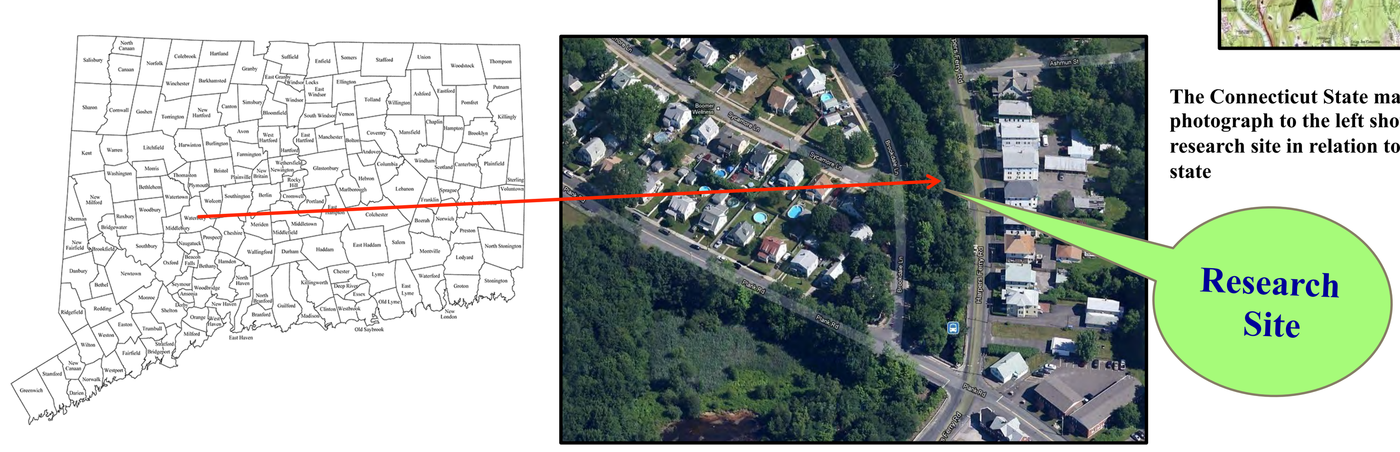
INTRODUCTION

Streamflow is the rate at which water flows in rivers or brooks. Maintaining streamflow is critical because water is essential to life. The wild life surrounding a river, including animals, fish, and plants, have all adapted to the specific amount of water flowing in the river.

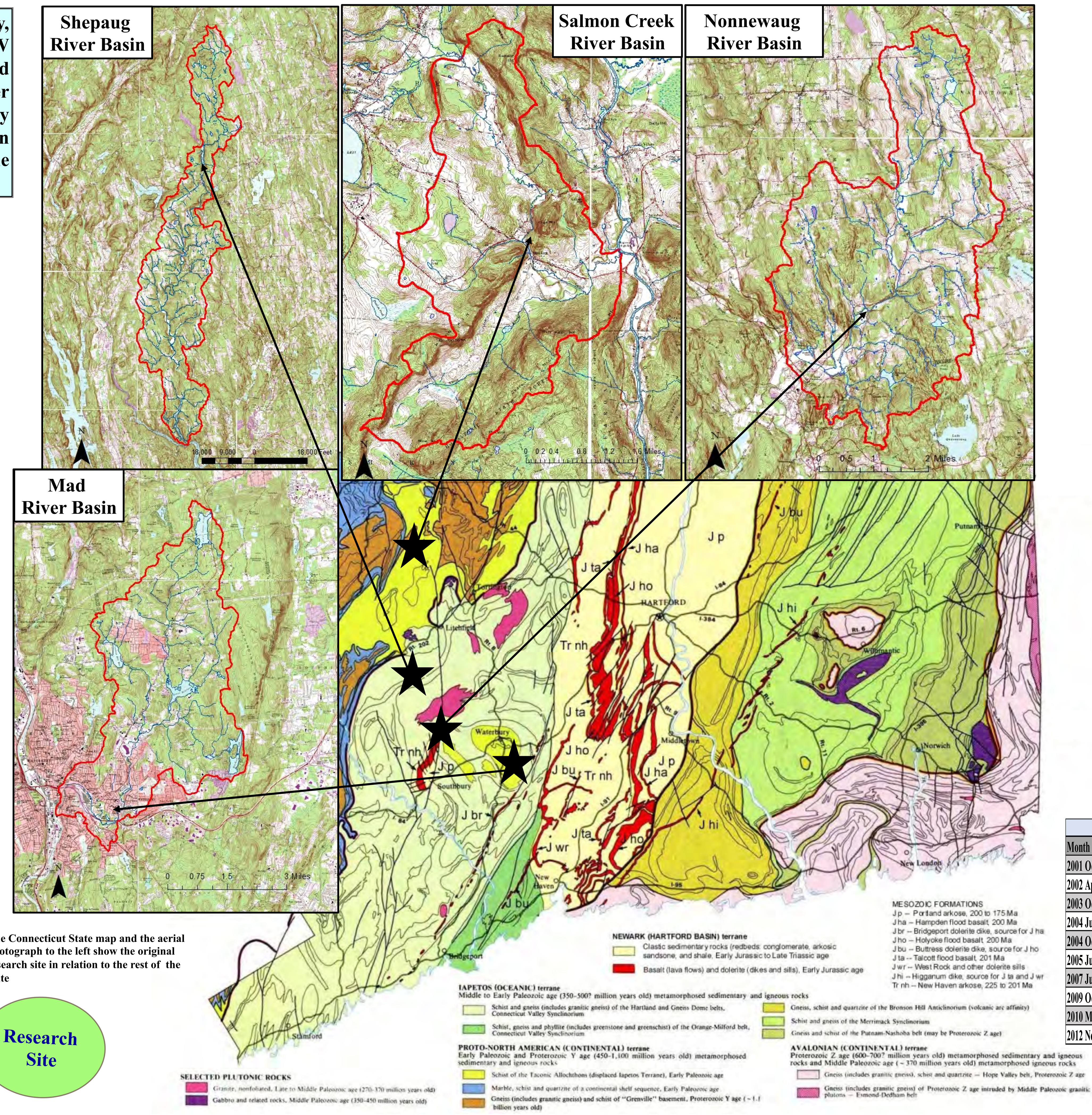
Streamflow varies by region and is affected by many circumstances, including weather, season, topography and runoff. Annual runoff is the net result of the natural influences, as well as the effect of human activities. The streamflow or discharge of a river is the amount of water passing through a given point (measured in cubic feet per second). The most significant changes in streamflow are noted from season to season. High periods of discharge may be followed by extremely low periods. Precipitation causes great changes in streamflow. Flow increases as rain directly falls into rivers or brooks and as it runs off the surrounding topography (MacBroom 1998). There is a reduction in streamflow when precipitation declines.

Topography affects streamflow, because precipitation tends to be greater in elevated areas, and depending on the soil and bedrock more runoff will flow into the river. A river basin encompasses all of the land surface drained by many gulleys, streams, and creeks that flow into that river (MacBroom 1998).

Streamflow was collected for this study at the Mad River, located in Waterbury, CT. The Mad River is surrounded by a residential and commercial area. Streamflow data was collected on November 20, 2012 at 16:00 hours, and was compared to data collected from the same location over the past twelve years. Further analysis of the Mad River streamflow was made to the topography, specifically bedrock and elevation, and to the size of the river drainage basin and then compared to data from the Shepaug River, the Salmon Creek River, and the Nonnewaug River, all in Connecticut.



The Connecticut State map and the aerial photograph to the left show the original research site in relation to the rest of the state



Connecticut Bedrock Map
The Connecticut Geological & Natural History Survey
Department Of Environmental Protection Printed 1990, 1996

MATERIALS AND METHODS

To measure streamflow, three people are needed to complete procedure.

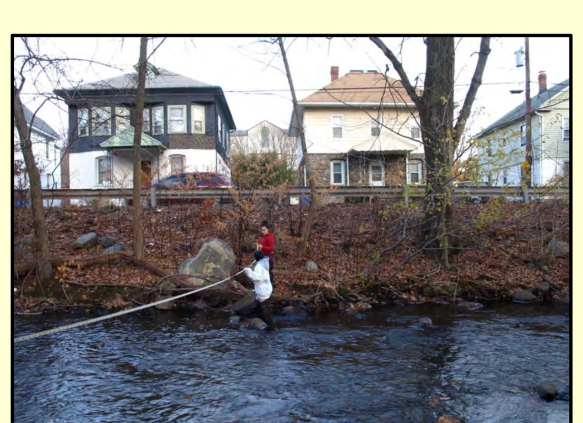
1. Select an area of the river with laminar flow.
2. Measure a 10 foot length of river and mark the spot with tape.
3. Measure the width of the river. Record this data on the Stream Flow data sheet.
4. Using the yardstick, move across the river measuring the depth (in feet) at a minimum of six locations. Record these measurements on the Stream Flow data sheet.
5. At the locations where depth was measured, release the tennis ball and record how long it takes to travel the 10 foot length of the river. The time keeper records the time it takes the tennis ball to travel the 10 feet of the river.
6. Do calculations to find overall discharge (streamflow)

Calculations:

Find the mean stream depth (in feet).
Find the mean time (in seconds).
The formula for finding discharge (streamflow) is :

$D = wdal/t$

D= discharge in cubic feet per second
W= width of river is feet
d- mean depth in feet
l= distance in feet
t= time in seconds
a= A friction coefficient based on the stream bed
0.8 for a rocky substrate or 0.9 for a smooth substrate
t- Mean time



Infante and Bhageloo Measuring the Mad River Width

The topographic maps of the four river basins were compared to the Connecticut Geologic Bedrock Map in order to determine the bedrock the rivers are flowing over and through. The river acreage was determined through research using CLEAR.

RESULTS

RIVER BASIN	ACRES	HIGHEST ELEVATION in FEET	RIVERBED ELEVATION in FEET	LATITUDE & LONGITUDE	MAIN BEDROCK
Mad River	2,394	~650 Feet	~400 Feet	41.5421N & -73.0096W	Waterbury Gneiss
Nonnewaug River	784	~800 Feet	~380 Feet	41.3433N & -73.1042W	Schist
Salmon Creek River	740	~1240 Feet	~750 Feet	41.7234N & -73.2945W	Gneiss
Shepaug River	45,400	~1050 Feet	~530 Feet	41.5632N & -73.2329W	Ratlum Mountain Schist

As can be seen in the chart above, the Salmon Creek River Basin and the Nonnewaug River Basin are very similar in size. The Nonnewaug River Basin covers 784 acres while the Salmon Creek Basin covers 740 acres. The river with the largest change in elevation is the Salmon Creek River, with a difference of 520 feet from the highest point to the river bed, versus the Nonnewaug River which has a 420 feet change from the highest point to the river bed.

Both of the river's bedrock is metamorphic. The Salmon Creek basin consists of Ratlum Mountain schist and the Nonnewaug River basin consists of schist.

The Shepaug has the largest river basin at 45,000 acres, with a change in elevation of 490 feet. The Shepaug River has large variations in streamflow, especially in April 2002. The bedrock of this river basin consists of metamorphic rock, specifically Manhattan Schist.

The Mad River Basin is intermediate of the other three river basins at 2,934 acres. It has a 250 feet change in elevation and consists of Waterbury Gneiss bedrock.

CONCLUSIONS

When analyzing the streamflow from the Mad River Basin over the past eleven years, the results show a variation of 36.8 Ft^3/Sec. The data collected and discussed from the Mad River Basin as well as the other river basins was collected at different times of the year; which may reflect seasonal variations in precipitation.

Another variable that can impact streamflow is that all four rivers have dams. Streamflow is impacted when water is released or withheld. For example, the Shepaug River runs through the towns of Washington, Roxbury, Watertown, and Middlebury, as well as others. However, the City of Waterbury controls the amount of water released from the Peters Dam (on the Shepaug River) in Woodville, Connecticut since 1921; as it provides water for the city of Waterbury. In the late 1990's, a law suit against the City of Waterbury requested it release more water into the river basin as the lack of sufficient water was affecting the riparian environments of the basin. The City of Waterbury was ordered to increase specific flow rates by May 1, 2002 (Hodgson 2000). This may account for the large streamflow on the Shepaug River in April 2002 (see graph below).

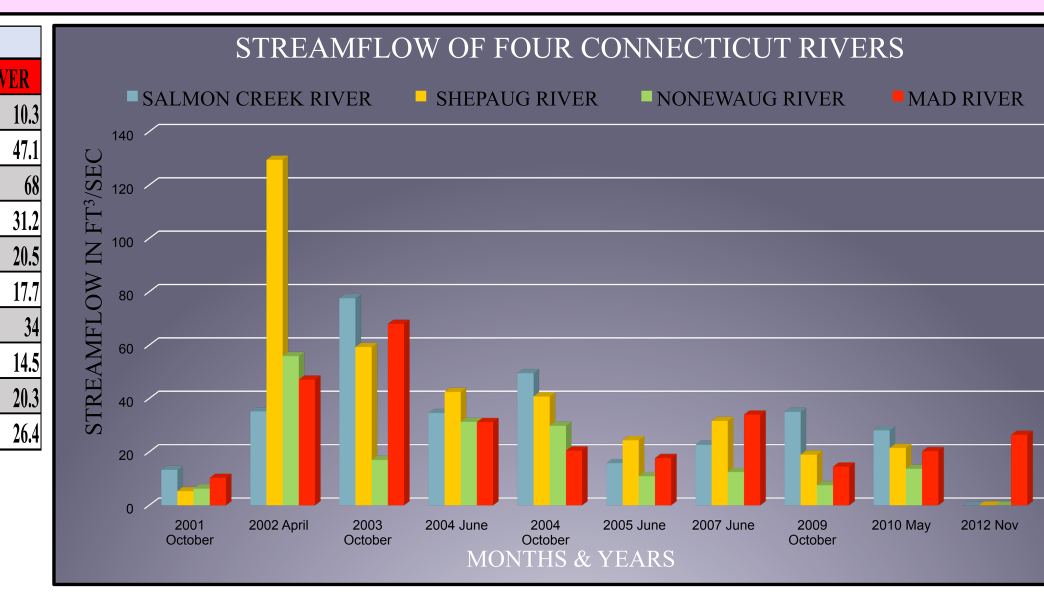
The two river basins that are the most similar are the Salmon Creek River and the Nonnewaug River. The Nonnewaug has less discharge, on average; which may be due to the fact that a small portion of the bedrock that the river flows through is clastic sedimentary rock, a more porous and permeable rock than the mostly metamorphic rock of the river basin. The Salmon Creek River basin has a greater difference in elevation, approximately 70 feet, than that of the Nonnewaug River Basin. While the Salmon Creek River has a smaller drainage basin than the Nonnewaug River, according to the data (see graph below), the Salmon Creek River has a greater streamflow than the Nonnewaug every year compared, except one.

This difference in streamflow may be due to a combination of precipitation flowing over metamorphic rock and the gravitational pull due to the extra height. Metamorphic rocks are formed by the recrystallization of previous sedimentary, igneous, or metamorphic rocks; due to a chemical reaction caused by increased heat and pressure. This process makes metamorphic rocks less porous than the sedimentary rocks, discussed in the Nonnewaug River basin, that formed due to the compaction of sediments. The difference between the metamorphic rocks, gneiss and schist, that are part of the river basins discussed in this research is due to the grade of metamorphism each type of rock experiences. Gneiss is the result of a higher grade (more heat and pressure) of metamorphism than schist. Metamorphic rocks are permeable at fractures.

We are unable to draw a direct relationship between one specific variable and the data collected because there are many factors that control streamflow. Topography, the type of bedrock, the use of dams for controlling water use, and precipitation. More research must be conducted looking at these variables individually and across time.

STREAMFLOW IN FT3/SEC				
Month & Year	SALMON CREEK RIVER	SHEPAUG RIVER	NONEWAUG RIVER	MAD RIVER
2001 October	13.3	5.31	6.25	10.3
2002 April	35.2	129.5	55.9	47.1
2003 October	77.6	59.3	17	68
2004 June	34.6	42.5	31.3	31.2
2004 October	49.5	40.8	29.8	20.5
2005 June	15.8	24.4	10.9	17.7
2007 June	22.7	31.6	12.5	34
2009 October	35	19	7.52	14.5
2010 May	28.1	21.5	13.7	20.3
2012 Nov	NO DATA AVAILABLE	NO DATA AVAILAB	NO DATA AVAILABL	26.4

Data Table for Streamflow of Four CT Rivers



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