Economic Value of New Jersey Tributaries to the Delaware River

January 2024

Prepared by
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Institute for Public Administration
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University of Delaware

Prepared for
Environment New Jersey
Musconetcong Watershed Association

UNIVERSITY OF DELAWARE
BIDEN SCHOOL OF PUBLIC POLICY & ADMINISTRATION

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Executive Summary

The water, natural resources, and ecosystems in the New Jersey tributary watersheds to the Delaware River contribute an economic value of **$1.8 to $2.3 billion** annually to the regional economy in Mercer, Hunterdon, Morris, Warren, and Sussex Counties. This report examines that economic value in three different ways:

1. **Economic value directly related to the New Jersey tributary water resources and habitat.** The New Jersey tributary watersheds contribute over **$1.8 billion** in annual economic activity from water quality, water supply, fish and wildlife, recreation, agriculture, forests, and public parks benefits.
2. **Value of goods and services provided by the New Jersey tributary watershed ecosystems.** Using natural capital as a measure of value, habitat in the New Jersey tributary watersheds provides **$2.3 billion** annually in ecosystem goods and services in 2020 dollars, with a net present value (NPV) of **$74.9 billion** calculated over a 100-year period. The annual ecosystem services value of the New Jersey tributary watersheds is **$59 million** in Mercer County, **$354 million** in Hunterdon County, **$104 million** in Morris County, **$858 million** in Warren County, and **$920 million** in Sussex County.
3. **Employment related to the New Jersey tributary watersheds resources and habitats.** Using employment as a measure, natural resources within the New Jersey tributary watersheds directly and indirectly support over **40,000 jobs** with over **$2 billion** in annual wages.

Estimates for the three methods are based on values from the literature, applied to the New Jersey tributary watersheds using ecological economics and benefits-transfer techniques. Values are converted to 2020 dollars based on the mean annual change in the Northeast Region Consumer Price Index (CPI), which is 3% annually.

Additionally, a survey-based investigation was conducted to measure the direct monetary contribution of recreational visitors to the economy of the study area. In-person surveys were conducted at recreational locations along the Musconetcong River, focused on four types of recreational activity: fishing, general recreation (hiking, biking, picnicking, etc.), boating, and hunting. The estimated total annual spending on these recreational activities ranges from a low of more than **$133 million** to a high of nearly **$352 million.**

Finally, to assess the impact on real estate values of proximity to clean water, house values at various distances to Lake Musconetcong were analyzed. It was found that housing values increase by 6.7% (27.1% on a per-acre basis) for lakeside properties versus those at 1000 feet from the lake, and 10.0% (23.5% per acre) at 2000 feet. Overall, it is estimated that the lake adds an additional $14.7 million to residential retail value.

These estimates demonstrate that the New Jersey tributary watersheds provide significant economic benefits to the regional five county economy in northwest New Jersey and are worthy of investment to protect and preserve the valuable watershed resources.

Chapter 1. Introduction

Objectives

This report summarizes the economic value of water, natural resources, and ecosystems in northwest New Jersey tributary watersheds of the Delaware River that support significant ecological communities and drive a large water-based recreation economy in Mercer, Hunterdon, Morris, Warren, and Sussex Counties estimated as:

1. Economic activity including market and nonmarket value of water quality, water supply, fish and wildlife, recreation, agriculture, forests, and public parks benefits.
2. Ecosystem goods and services (natural capital) value provided by habitat such as wetlands, beaches, open water, forests, and farms.
3. Jobs and wages directly and indirectly associated with the New Jersey tributary watersheds and rivers.

This report also summarizes economic survey research and recreational user survey of fishing, boating, hiking, and hunting visitation conducted in the Musconetcong River watershed from April through December 2022.

An Economic Engine

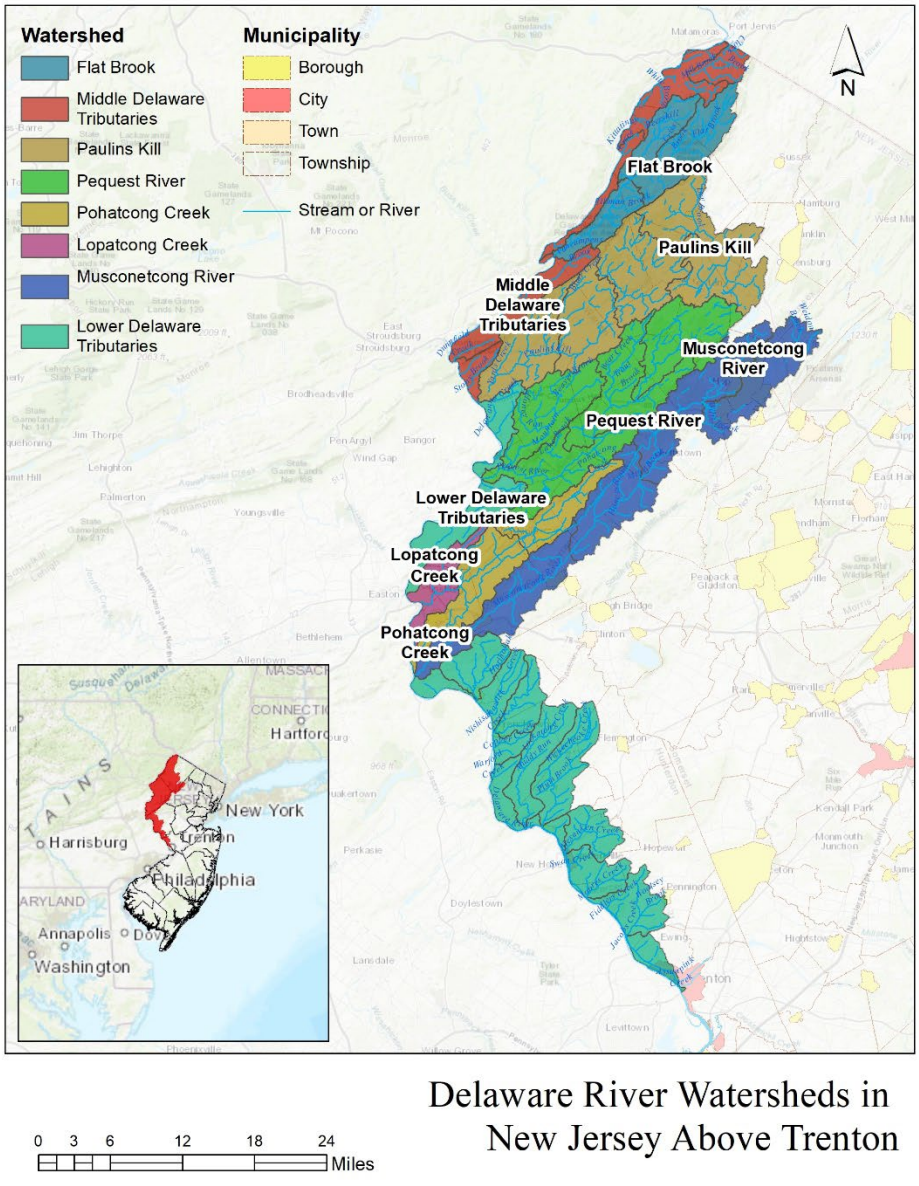
Clean water is a valuable economic and environmental resource in the northwest New Jersey tributary watersheds of the Delaware River. Previous studies of economic value in New Jersey indicate the Delaware River watershed in four states supports $21 billion in annual economic activity, the Barnegat Bay watershed provides $4 billion in annual economic value, and the State of New Jersey provides $11 billion in annual ecosystem goods and services value (Table 1.1).

Table 1.1. Estimates of economic value in New Jersey watersheds

Reference	Economic Output ($ million)	Ecosystem Services ($ million)	Jobs	Wages ($ million)
Socioeconomic Value of the Delaware River Basin in Delaware, New Jersey, New York, and Pennsylvania (Kauffman 2011)	25,000	21,000	600,000	10,000
Economic Value of the Barnegat Bay Watershed (UDWRC 2012)	4,000	2,300	60,000	2,000
Valuing New Jersey's Ecosystem Services and Natural Capital (Liu, Costanza, Troy, D'Augustino, and Mates, 2010)		11,000		

The Watershed

The northwest New Jersey tributary watersheds of the Delaware River are situated in the hilly, rocky Piedmont, Highlands, and Ridge & Valley physiographic provinces in Mercer, Hunterdon, Morris, Warren, and Sussex Counties (Figure 1.1). Approximately two-thirds of the watershed lies in Warren and Sussex Counties and one-fifth lies in Hunterdon County with the smaller balance covering Mercer and Morris Counties (Tables 1.2 and 1.3). In 2020, the 915.8 mi^2 New Jersey tributary watersheds were home to 282,673 people and hosted 93,387 jobs.



Delaware River Watersheds in New Jersey Above Trenton

Figure 1.1. Northern New Jersey tributary watersheds along the Delaware River

Table 1.2. Area, population, and jobs in New Jersey tributary watersheds of the Delaware River

County	Area (mi^2)	Area (%)	Population (2020)	Jobs (2020)
Hunterdon	169.0	18%	32,718	17,082
Mercer	32.3	4%	32,659	11,477
Morris	43.8	5%	32,282	19,259
Sussex	311.2	34%	109,667	28,921
Warren	359.6	39%	75,345	16,648
Total	**915.8**	**100%**	**282,673**	**93,387**

Table 1.3. Population by watershed and county in the New Jersey tributary watersheds of the Delaware River

County and Watershed	Population (2020)	Area (ac)	Area (mi^2)
Hunterdon	32,659	108,145	169.0
Lower Delaware Tributaries	26,718	91,658	143.2
Musconetcong River	5,941	16,487	25.8
Mercer	32,718	20,660	32.3
Lower Delaware Tributaries	32,718	20,660	32.3
Morris	32,284	28,049	43.8
Musconetcong River	32,284	28,049	43.8
Sussex	75,345	199,140	311.2
Flat Brook	2,408	42,094	65.8
Middle Delaware Tributaries	3,364	28,208	44.1
Musconetcong River	26,497	23,924	37.4
Paulins Kill	30,220	75,202	117.5
Pequest River	12,858	29,712	46.4
Warren	109,667	230,113	359.6
Lopatcong Creek	24,045	12,415	19.4
Lower Delaware Tributaries	12,210	25,274	39.5
Middle Delaware Tributaries	643	16,072	25.1
Musconetcong River	23,693	30,714	48.0
Paulins Kill	7,943	38,061	59.5
Pequest River	21,077	70,402	110.0
Pohatcong Creek	20,055	37,175	58.1
Total	**282,673**	**586,107**	**915.8**

The New Jersey tributary watersheds of the Delaware River include 10 streams between Trenton and High Point State Park ranging from the 174 square miles Paulins Kill to the 19 square miles Lopatcong Creek watershed. These streams provide drinking water and recreation for residents of

cities and towns such as Trenton, Lambertville, Stockton, Frenchtown, Riegelsville, Phillipsburg, Hackettstown, Netcong, Blairstown, and Newton, New Jersey. Popular recreational areas in the watersheds are the Delaware and Raritan State Park, Lake Hopatcong, Merrill Creek Reservoir, Allamuchy Mountain State Park, Swartswood Lake State Park, Stokes State Forest, High Point State Park, and Delaware Water Gap National Recreation Area.

Mercer County: The Assunpink, Jacobs, and Fiddlers creek tributaries drain 32 square miles from the towns of Trenton, Washington Crossing, and Lambertville with three-fourths of the land undeveloped in agriculture and forest and wetlands.

Hunterdon County: The Musconetcong River and Alexauken Creek, Lockatong Creek, and Wichehoke Creek watersheds drain 169 square miles from Stockton, Seargentsville, and Milford with nearly 90% of the land undeveloped in agriculture and forest and wetlands.

Morris County: About 44 square miles of the upper Muscontecong River watershed flows from Lake Hopatcong and Hackettstown with 85% of the land undeveloped in agriculture, forest, wetlands, and open water.

Warren County: The watersheds drain 360 square miles from Lopatcong Creek, Musconetcong River, Paulins Kill, Pequest River, and Pohatcong Creek and the towns of Phillipsburg, Belvidere, Oxford, and Netcong. Over 90% of the land is undeveloped in agriculture, forest, wetlands, and open water.

Sussex County: The watersheds drain 311 square miles from Flat Brook, Musconetcong River, Paulins Kill, and Pequest River; the towns of Blairstown and Newton; and Delaware Water Gap National Recreation Area, Worthington State Park, and High Point State Park. Over 95% of the land is undeveloped in agriculture, forest, wetlands, and open water.

Land Use

The New Jersey tributary watersheds of the Delaware River drain approximately 915.8 square miles, and according to the National Oceanic and Atmospheric Administration (NOAA) Coastal Services Center (CSC) (2016), comprises 8% urban land, 22% farmland, 55% forest, 10% wetlands, 2% open water, and 2% other land cover types (Tables 1.4 and 1.5).

Table 1.4. Land use by county in the New Jersey tributary watersheds of the Delaware River (NOAA CSC 2016)

County	Urban (mi^2)	Farmland (mi^2)	Forest (mi^2)	Wetland (mi^2)	Water (mi^2)	Other (mi^2)	Total (mi^2)
Hunterdon	8.5	64.4	78.9	9.1	0.4	7.7	169.0
Mercer	9.7	7.2	12.2	1.6	0.1	1.6	32.3
Morris	7.1	2.1	24.9	5.0	3.2	1.4	43.8
Sussex	17.4	34.4	197.8	47.7	9.4	4.4	311.2
Warren	30.6	92.4	194.2	32.7	4.5	5.2	359.6
Total	**73.4**	**200.5**	**508.1**	**96.1**	**17.5**	**20.2**	**915.8**

County	Urban (%)	Farmland (%)	Forest (%)	Wetland (%)	Water (%)	Other (%)	Total (%)
Hunterdon	5%	38%	47%	5%	0%	5%	100%
Mercer	30%	22%	38%	5%	0%	5%	100%
Morris	16%	5%	57%	12%	7%	3%	100%
Sussex	6%	11%	64%	15%	3%	1%	100%
Warren	9%	26%	54%	9%	1%	1%	100%
Total	**8%**	**22%**	**55%**	**10%**	**2%**	**2%**	**100%**

Table 1.5. Land use by watershed in the New Jersey tributary watersheds of the Delaware River (NOAA CSC 2016)

County	Urban (mi^2)	Farmland (mi^2)	Forest (mi^2)	Wetland (mi^2)	Water (mi^2)	Other (mi2)	Total (mi^2)
Flat Brook	0.4	3.1	52.4	8.8	0.5	0.5	65.8
Lopatcong Creek	6.7	6.5	5.4	0.3	0.0	0.5	19.4
Lower Delaware Tributaries	20.2	80.4	93.9	11.3	0.7	8.5	215.0
Middle Delaware Tributaries	1.3	4.3	55.6	6.4	1.2	0.4	69.2
Musconetcong River	19.3	26.3	84.2	13.7	6.2	5.2	155.0
Paulins Kill	11.0	28.6	103.5	26.1	5.5	2.3	177.0
Pequest River	7.7	32.9	85.9	26.2	2.1	1.7	156.4
Pohatcong Creek	6.6	18.6	27.2	3.4	1.1	1.1	58.1
Total	**73.4**	**200.5**	**508.1**	**96.1**	**17.5**	**20.2**	**915.8**

County	Urban (%)	Farmland (%)	Forest (%)	Wetland (%)	Water (%)	Other (%)	Total (%)
Flat Brook	1%	5%	80%	13%	1%	1%	100%
Lopatcong Creek	35%	33%	28%	1%	0%	2%	100%
Lower Delaware Tributaries	9%	37%	44%	5%	0%	4%	100%
Middle Delaware Tributaries	2%	6%	80%	9%	2%	1%	100%
Musconetcong River	12%	17%	54%	9%	4%	3%	100%
Paulins Kill	6%	16%	58%	15%	3%	1%	100%
Pequest River	5%	21%	55%	17%	1%	1%	100%
Pohatcong Creek	11%	32%	47%	6%	2%	2%	100%
Total	**8%**	**22%**	**55%**	**10%**	**2%**	**2%**	**100%**

Summary of characteristics of the New Jersey tributary watersheds of the Delaware River:

- Watershed area 915.8 square miles
- Population (2020) 282,673
- Streams 1,127 miles
- Wetlands 61,518 acres
- Forests 325,163 acres

Chapter 2. Methods

Valuation Techniques

The University of Delaware derived the economic value of the New Jersey tributary watersheds of the Delaware River from published studies that employed the following valuation techniques:

- **Avoided Cost:** Society sustains costs if certain ecosystems were not present or are lost. For instance, the loss of wetlands may increase economic costs from flood damage.
- **Replacement Cost:** Natural services are lost and replaced by more expensive human systems. For instance, forests provide water filtration benefits that would be replaced by costly water filtration plants.
- **Net Factor Income by Enhancement of Income:** Improved water quality is known to enhance fishing productivity and boost fishing jobs and wages.
- **Travel Cost:** Visitors are willing to pay to travel and purchase food and lodging to visit ecosystems and natural resources for tourism, boating, hunting, fishing, and birding.
- **Hedonic Pricing:** Residents may be willing to pay more for higher property values along scenic bay and river coastlines with improved water quality.
- **Contingent Valuation:** Valuation by survey of individual preferences to preserve ecosystems. People may be willing to pay more in fees or water rates to preserve river and bay water quality.

Background

The University of Delaware Water Resources Center worked with the Musconetcong Watershed Association (MWA) and Environment New Jersey to quantify the economic value of the Delaware River Tributaries in northwest New Jersey above Trenton. We utilized data from the U.S. Census Bureau, U.S. Department of Labor, NOAA, U.S. Department of Agriculture (USDA), National Park Service, U.S. Fish and Wildlife Service, Outdoor Industry Association, and Delaware Tributaries Explorer v1.0 together with material from emerging fields in ecological economics and ecosystem services. We employed methods such as hedonic pricing and willingness to pay (WTP) in the economic analysis. Hedonic pricing looks at existing market values in housing and compares values in places with varying levels or quality of natural amenities. This approach is most common with housing markets and has a well-established literature and methods. WTP includes survey-based methodology to assess the economic value of a change in the provision of a natural resource.

Scope of Work

1. **Area of Interest:** Define and map area of interest as the Delaware River tributaries watersheds (915.8 mi^2) with a population of 282,600 in New Jersey above Trenton (LC1) and NJ Highlands (UC2) in the Piedmont and Ridge and Valley physiographic provinces in Mercer County (Fiddlers Creek and Alexauken Creek), Hunterdon County (Lockatong Creek

and Harihokake Creek), Warren County (Musconetcong River, Merrill Creek, and Lopatcong Creek), and Sussex County (Paulins Kill and Flatbrook).

2. **Field Reconnaissance**: Conduct field reconnaissance to the New Jersey watersheds to familiarize with geography, gather economic and recreational survey data for the watershed, and review progress with MWA and Environment New Jersey.
3. **Literature Review:** Review published literature and internet-based resources and gather socioeconomic data relevant to the New Jersey tributaries. Access databases, studies, and reports from the U.S. Census, U.S. Department of Labor, USDA, NOAA, MWA (Delaware Tributaries Explorer v1.0), Environment New Jersey, and labor, natural resources, and economic development departments for the State of New Jersey. Utilize recreation data from Delaware Tributaries Explorer v1.0 and MWA Great Waters website.
4. **Economic Value:** Estimate the 2020 market and nonmarket values (the socioeconomic framework) of goods and services provided by the New Jersey watersheds using indicators such as population, housing units, employment, industrial activity (water-based and other), and land use value.
5. **Ecosystem Services:** Tabulate 2020 natural capital value of environmental resources (ecosystem goods and services value) in the watershed provided by habitat as wetlands, forests, open water, beaches, and agriculture. Access data from the 2004 NJDEP study of ecosystem goods and services and New Jersey Water Supply Plan for drinking water and irrigation.
6. **Jobs and Wages:** Summarize the Delaware River tributaries in the New Jersey watershed-related direct and indirect jobs and employment organized by North Atlantic Industrial Classification System codes (NAICS) such as water supply, fisheries, recreation, agriculture, and others. Access MWA map of recreational outfitters and recreation businesses.
7. **Recreational User Survey:** Survey recreational users at trail heads, canoe and kayak access, and hunting/fishing/wildlife areas to tabulate frequency and length of visits, estimated expenditures, services consumed, and often a question about a shift in those amenities and potential change in expenditure. This involves in-person surveying at fishing, hunting, hiking, and boating access areas and targeted outreach to hunting and fishing clubs.

8. **Housing hedonics case study—Lake Musconetcong:** Using Lake Musconetcong as a case study, test the effects of distance to water features. Using the commercial internet reality tool Zillow.com, determine per acre of property and per square footage of housing, and assess whether there is a significant effect on these values based on distance. Calculate the total fiscal impact of Lake Musconetcong by estimating total property values given the effect of the lake compared to total values without the lake's effect.
9. **Report:** Prepare a report and GIS mapping summarizing the total and indirect market value of goods and services provided by the New Jersey tributary watersheds as measured by (a) annual economic value, (b) ecosystem good and services, (c) direct and indirect jobs, together with the results of the recreational user survey.

Chapter 3. Economic Value

Hodge and Dunn (1992) illustrated the total economic value of water resources based on use and nonuse values (Figure 3.1). Use values include direct values, such as market goods from sales of crops, fish, and timber and unpriced benefits from recreation and aesthetic view, and ecological function values (ecosystem services) from flood control, water storage, and waste assimilation services of wetland and forest habitat. Nonuse values include future option values such as future drug discoveries from wetland plants and future recreation, existence values from satisfaction that a water resource exists but may never be visited, and bequest values such as preserving water quality for future generations.

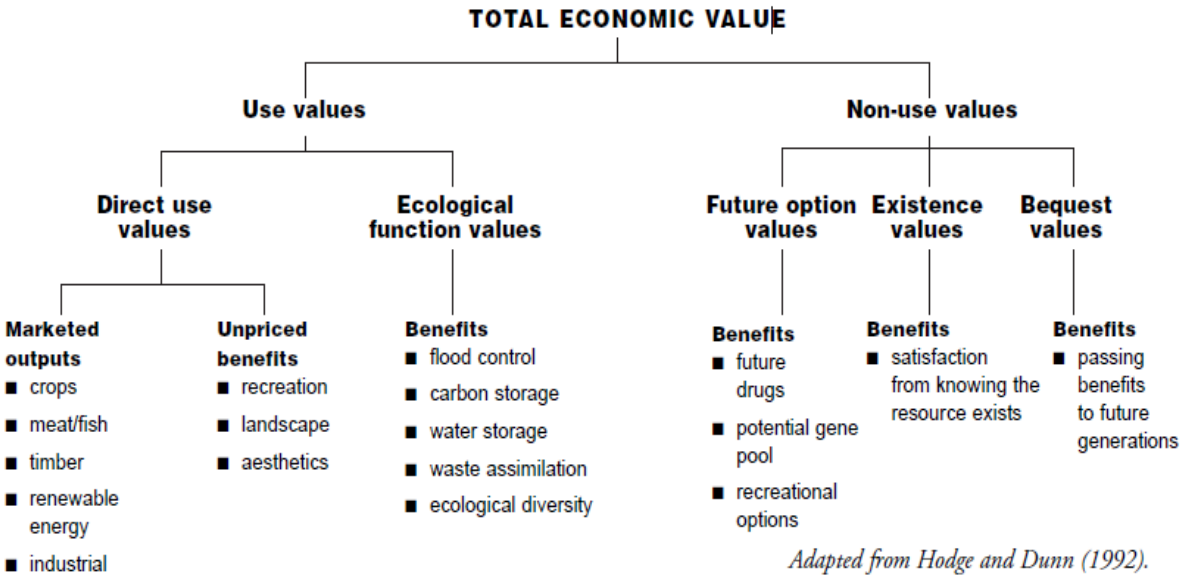


Figure 3.1. Economic value of water resources (Hodge and Dunn, 1992)

The economic value of the New Jersey tributary watersheds in the Delaware River Basin from water quality, water supply, fish and wildlife, recreation, agriculture, forests, and public parks benefits exceeds $1.8 billion annually (Table 3.1 and Figure 3.2). Summary of the economic value of the New Jersey tributary watersheds in the Delaware River Basin:

Public Parks	$480 million
Recreation	$341 million
Forests	$384 million
Water Quality	$185 million
Water Supply	$170 million
Fish and Wildlife	$148 million
Agriculture	$118 million
Total	**> $1.8 billion**

Table 3.1. Annual economic activity supported by New Jersey tributary watersheds

Activity	2020 ($ million)	Sources
Water Quality		
Boatable (WTP = $17.82/person	5.0	Helm et al. (2003), Univ. of Delaware
Fishable (WTP = $17.84/person)	5.0	Helm et al. (2003), Univ. of Delaware
Swimmable (WTP = $152.21/person)	43.0	Helm et al. (2003), Univ. of Delaware
Increased Property Value (+8%, 2000 ft of river)	109.3	EPA (1973), Brookings Institute (2010)
Water Treatment by Forests ($102/mgd)	2.6	Trust for Public Land, AWWA (2004)
Wastewater Treatment (26.4 mgd @$4.00/1000 gal)	38.5	DRBC and USEPA
Water Supply		
Public Water Supply (69.2 mgd @ $4.78/1000 gal)	120.8	UDWRA and DRBC (2020)
Reservoir Storage (16 bg @ $0.394/1000 gal)	6.3	NJWSA and DRBC (2020)
Irrigation Water Supply ($420/ac ft)	3.0	Resources for Future (1996), USDA (2014)
Thermoelectric Power Water Supply ($44/ac-ft)	0	EIA (2002), NETL (2009)
Industrial Water Supply ($200/ac-ft)	32.8	Resources for Future (1996), DRBC (2020)
Hydropower (145 mgd @ $0.14/1000 gal)	7.4	Resources for Future (1996), DRBC (2020)
Fish/Wildlife		
National Wildlife Refuge	0	USFWS (2020)
Fishing (11-18 trips/angler, $24-$49/trip)	77.5	U. S. Fish and Wildlife Service (2016)
Hunting (16 trips/hunter, $14-$45/trip)	15.0	U. S. Fish and Wildlife Service (2016)
Wildlife/Bird-watching (8-13 trips/yr, $23-$66/trip)	55.4	U. S. Fish and Wildlife Service (2016)
Recreation (Boating, Fishing, Swimming)		
Outdoor Recreation (105,400 participants)	105.6	Outdoor Industry Association (2016)
Paddling-based Recreation (23,492 paddlers)	13.7	Outdoor Industry Association (2006)
Powerboating	17.4	National Marine Manufacturers Assoc. (2014)
Del. Water Gap Natl. Rec. Area (4.3 million visits)	163.4	Cullinane et al (2022), National Park Service
NJ State Parks ($21/visit, 62,374 ac)	45	Mates and Reyes (2006), NJDEP
Agriculture		
Crop, poultry, livestock value (128,296 ac @ $922/ac)	118.3	USDA Census of Agriculture (2017)
Forests		
Carbon Storage (325,162 ac @ $827/ac)	268.9	U.S. Forest Service, Del. Center Hort. (2008)
Carbon Sequestration ($29/ac)	9.4	U.S. Forest Service, Del. Center Hort. (2008)
Air Pollution Removal ($266/ac)	86.5	U.S. Forest Service, Del. Center Hort. (2008)
Building Energy Savings ($56/ac)	18.2	U.S. Forest Service, Del. Center Hort. (2008)
Avoided Carbon Emissions ($3/ac)	1.0	U.S. Forest Service, Del. Center Hort. (2008)
Public Parks		
Health Benefits (141,440 ac @ $9,734/ac)	1,377	Trust for Public Land (2009)
Community Cohesion ($2,383/ac)	337.0	Trust for Public Land (2009)
Stormwater Benefit ($921/ac)	130.3	Trust for Public Land (2009)
Air Pollution ($88/ac)	12.5	Trust for Public Land (2009)
NJ Tributary Watersheds	**>$1.8 billion**	

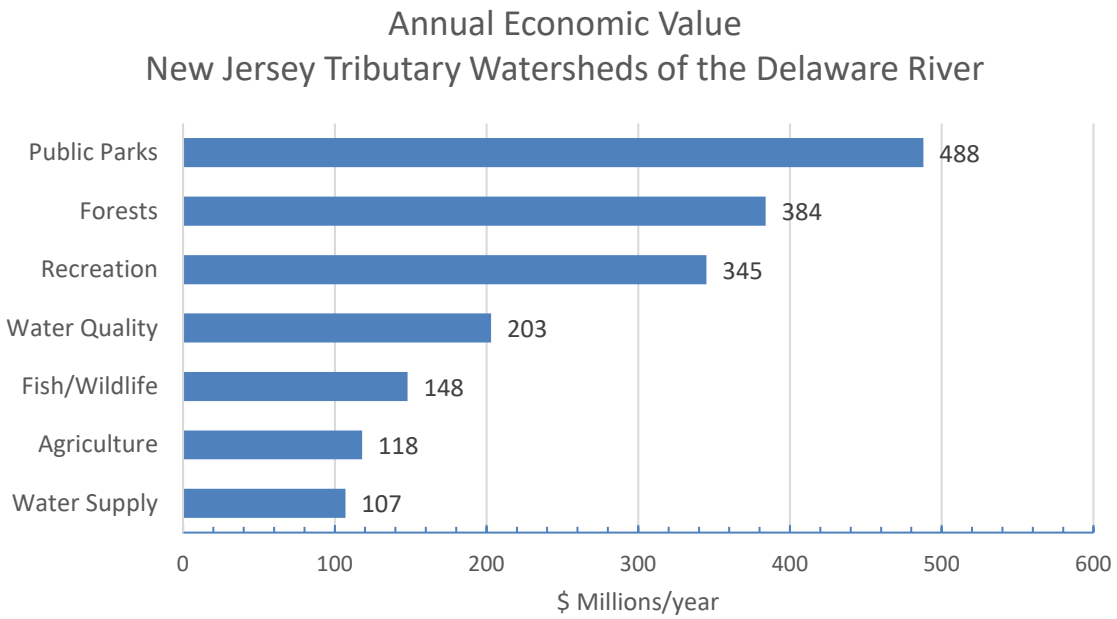


Figure 3.2. Annual economic value of New Jersey tributary watersheds of the Delaware River

Water Quality

Improved Water Quality

Helm, Parsons, and Bondelid (2003) from the University of Delaware measured the economic benefits of improved water quality to recreational users in the New England states and found per person willingness to pay (WTP) for good water quality was $8.25 annually for boating, $8.26 annually for fishing, and $70.47 annually for swimming use support in 1994 dollars. Adjusting to 2020 dollars based on mean 3% change in the Consumer Price Index (CPI) in the Northeast Region from the Bureau of Labor Statistics, annual per person WTP is $17.82 for boating, $17.84 for fishing, and $152.21 for swimming water quality (Table 3.2).

Table 3.2. Annual willingness to pay for water quality benefits in New England

WQ Use Support	WTP per person[1] ($1994)	WTP per person[2] ($2020)
Boatable	8.25	17.82
Fishable	8.26	17.84
Swimmable	70.47	152.21
Total	**86.98**	**187.88**

1. Helm, Parsons, and Bondelid (2003). 2. Adjusted to 2020 based on 3% annual change in Northeast Region CPI.

In 2020, the NJ tributary watershed population range was 282,673. Based on value transfer from the New England study, annual WTP for improved New Jersey tributary water quality is $5,037,233 for boating, $5,042,886 for fishing, and $43,025,657 for swimming water quality or $53,108,603 total (Table 3.3).

Table 3.3. Willingness to pay for water quality in New Jersey tributary watersheds

WQ Use Support	Population (2020)	WTP/person[1] ($2020)	WTP/year ($2020)
Boatable	282,673	17.82	5,037,233
Fishable	282,673	17.84	5,042,886
Swimmable	282,673	152.21	43,025,657
Watershed Total	**282,673**	**187.88**	**53,108,603**
Boatable	32,718	17.82	583,035
Fishable	32,718	17.84	583,689
Swimmable	32,718	152.21	4,980,007
Mercer Co.	**32,718**	**187.88**	**6,147,058**
Boatable	32,659	17.82	581,983
Fishable	32,659	17.84	582,637
Swimmable	32,659	152.21	4,971,026
Hunterdon Co.	**32,659**	**187.88**	**6,135,973**
Boatable	32,282	17.82	575,265
Fishable	32,282	17.84	575,911
Swimmable	32,282	152.21	4,913,643
Morris Co.	**32,282**	**187.88**	**6,065,142**
Boatable	109,667	17.82	1,954,266
Fishable	109,667	17.84	1,956,459
Swimmable	109,667	152.21	16,692,414
Warren Co.	**109,667**	**187.88**	**20,604,236**
Boatable	75,345	17.82	1,342,648
Fishable	75,345	17.84	1,344,155
Swimmable	75,345	152.21	11,468,262
Sussex Co.	**75,345**	**187.88**	**14,155,819**

1. Helm, Parsons, and Bondelid (2003) adjusted to $2020 based on change in Northeast Region CPI.

Increased Property Value

Studies along rivers and bays in the United States indicate that improved water quality can increase shoreline property values by 4% to 18% (Table 3.4). In the San Diego Bay, Kanawha, Ohio, and Willamette River, Oregon watersheds, the USEPA (1973) estimated improved water quality can raise property values by up to 18% next to the water, 8% at 1,000 feet from the water, and 4% at 2,000 feet from the water. Leggett et al. (2000) estimated improved bacteria levels to meet water quality standards along the western shore of Chesapeake Bay in Maryland could raise property values by 6%. Poor et al. (2007) studied 1,377 residential property sales on the St. Mary's River on the western shore of Chesapeake Bay and concluded that a 1 mg/l increase in dissolved inorganic nitrogen reduced the average ($200,936) property value of a house by $17,642 or 8.8%.

With improved water quality, property values within 2,000 feet of the streams are estimated to increase by 8%, which is the adjusted midpoint between 18% next to the water and 4% at 2000 ft from the water. The watersheds have 1,127 miles of streams. The average land value near the streams was $100,000 per acre. Therefore, properties within 2,000 feet of the streams have an estimated value of $27.3 billion. Property values within 2,000 feet of the water would increase by 8% or $2.18 billion due to improved water quality (Table 3.5). Since increased property value is a one-time benefit, the annual value over a 20-year period is $109.3 million.

Table 3.4. Increased property value resulting from improved water quality

Study	Watershed	Increased Property Value
USEPA (1973)	San Diego Bay, Calif.	8.2%
Next to water	Kanawha, Ohio	18%
1000 ft from water	Willamette River, Ore.	8%
2000 ft from water	Willamette River, Ore.	4%
Leggett et al. (2000)	Chesapeake Bay	6%
Poor et al. (2007)	Chesapeake Bay	9%

Table 3.5. Added property value due to improved water quality in New Jersey tributaries (EPA 1973, Leggett et al. 2000, Poor et al. 2007)

State	Streams (mi)	Streams (ft)	Area within 2000 ft of streams (ac)	Property Value @ $100,000/ac ($)	Increased Value @ 8% ($)	Annual Value 20-yr ($/yr)
Flat Brook	93.1	491,568	22,570	2,256,969,697	180,557,576	9,027,879
Lopatcong Creek	24.6	129,888	5,964	596,363,636	47,709,091	2,385,455
Lower Delaware Tribs	287.4	1,517,472	69,673	6,967,272,727	557,381,818	27,869,091
Middle Delaware Tribs	112.7	595,056	27,321	2,732,121,212	218,569,697	10,928,485
Musconetcong River	149.5	789,360	36,242	3,624,242,424	289,939,394	14,496,970
Paulins Kill	205.6	1,085,568	49,842	4,984,242,424	398,739,394	19,936,970
Pequest River	169.0	892,320	40,970	4,096,969,697	327,757,576	16,387,879
Pohatcong Creek	84.9	448,272	20,582	2,058,181,818	164,654,545	8,232,727
Total	**1,127.1**	**5,951,088**	**273,236**	**27,323,636,364**	**2,185,890,909**	**109,294,545**

Water Treatment by Forests

Forests provide significant water quality and water treatment benefits. The Trust for Public Land and American Water Works Association (2004) found for every 10% increase in forested watershed land, drinking water treatment and chemical costs are reduced by approximately 20% (Table 3.6). If the public drinking water supply is 69 million gallons per day (mgd) and forests cover 325,163 acres (57%) of the watershed, then loss of these forests would increase drinking water treatment costs by $102 per million gallons per day ($139/mgd @ 0% forested minus $37/mgd @ 60% forested) or $7,038 per day or $2,568,870 per year.

Table 3.6. Water treatment costs based on forest land in the New Jersey tributary watersheds (Trust for Public Land and AWWA 2004)

Watershed Forested	Treatment Costs ($/mg)	Change in Costs
0%	139	21%
10%	115	19%
20%	93	20%
30%	73	21%
40%	58	21%
50%	46	21%
60%	37	19%

Wastewater Treatment

Five wastewater treatment plants have a total capacity of 26.4 million gallons per day (NJDEP 2020) that discharge to the New Jersey tributary watersheds (Table 3.7). The average wastewater rate in the watershed is $4.00 per 1,000 gallons, which for an average residence of 4 people (at 50 gpcd) is a fee of $292 per year. The value of treated wastewater assimilation capacity in the watershed is $105,600 per day or $38.5 million per year. Groundwater discharge wastewater treatment systems were not included.

Table 3.7. Value of wastewater treatment surface water discharges in the New Jersey tributary watersheds

NPDES ID	Facility	Location	State	Flow[1] (mgd)	Value[2] ($/day)	Wastewater ($/year)
	Hackettstown MUA	Hackettstown	NJ	3.3	13,200	4,818,000
NJ0020915	Lambertville City Sewer Authority	Lambertville	NJ	1.5	6,000	2,190,000
	Musconetcong Sewerage Authority	Budd Lake	NJ	4.3	17,200	6,278,000
NJ0020184	Newton Town DPW	Newton	NJ	1.4	5,600	2,044,000
NJ0024716	Phillipsburg Town STP	Phillipsburg	NJ	3.5	14,000	5,110,000
	NJ Tributaries Total			**14.0**	**56,000**	**20,440,000**

1. DRBC and USEPA. 2. Value at @ $4.00/1000 gal

Water Supply

Public Water Supply

The NJDEP (2020) reported that surface water withdrawals in the New Jersey tributary watersheds total 69.2 mgd for public water supply. Figure 3.3 shows the public water supply areas in the Delaware River Basin. The New Jersey Water Supply Authority (2012) established the value of raw (untreated) public water supplies from the Manasquan system at $1.168 per million gallons or

$1.17 per 1,000 gallons. The average value of treated drinking water based on rates set by public and private water purveyors in New Jersey is $4.78 per 1,000 gallons (Corrozi and Seymour 2008). At $1.168 per million gallons, the value of untreated public water supplies in the New Jersey tributary watersheds for 69.2 mgd is $80,872 per day or $29.5 million per year. At $4,780 per million gallons, the value of treated public water supplies in the New Jersey tributary watersheds for 69.2 mgd is $330,967 per day or $120.8 million per year (Table 3.8).

Table 3.8. Value of public water supplies in New Jersey tributaries watersheds (UDWRA and DRBC 2020)

Water Purveyor	Supply (mgd)	Value/day untreated ($1.17/ 1,000 gal)	Value/year untreated ($1.17/ 1,000 gal)	Value/day treated ($4.78/ 1,000 gal)	Value/year treated ($4.78/ 1,000 gal)
NJ American Water	39.37	45,984	16,784,218	188,189	68,688,839
Trenton	26.10	30,485	11,126,952	124,758	45,536,670
Hackettstown MUS	2.57	3,002	1,095,642	12,285	4,483,879
NJ American Oxford	1.20	1,402	511,584	5,736	2,093,640
NJ Tributaries	**69.24**	**80,872**	**29,518,397**	**330,967**	**120,803,028**

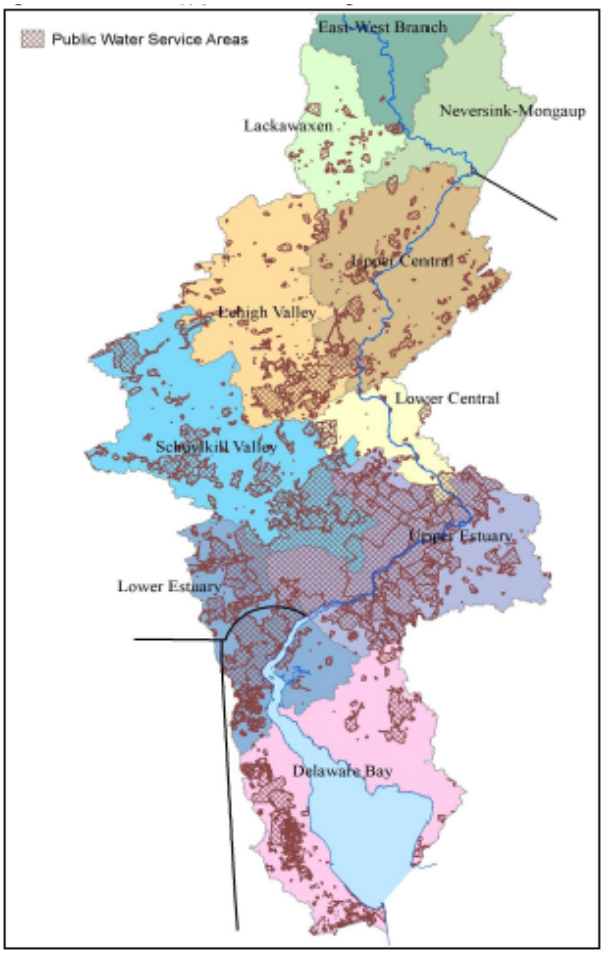


Figure 3.3. Public water supply service areas in the Delaware River Basin (DRBC 2011)

Reservoir Storage

Merrill Creek reservoir stores 16 billion gallons of water for interstate flow management and hydroelectric cooling in the Delaware River Basin (Table 3.9). The New Jersey Water Supply Authority (NJWSA) operates a reservoir system and the Delaware & Raritan Canal diversion from the Delaware River to New Jersey. The NJWSA delivers untreated water to public water purveyors from these systems at an estimated market price of $0.394 per 1,000 gallons (NJDEP 2007). Given the raw water value of drinking water storage (before treatment) is $0.394 per 1,000 gallons, the annual value of reservoir storage for flow management purposes in the New Jersey tributary watersheds is $6.3 million.

Table 3.9. Economic value of reservoir storage in the New Jersey tributary watersheds

Reservoir	Storage (BG)	Value ($) ($0.394/1,000 gal)
Merrill Creek	16	6,304,000

Irrigation Water Supply

In a study of the economic value of freshwater in the United States, Resources for the Future (Frederick et al. 1996) estimated the median value of irrigation water withdrawals was $198 per acre-foot in 1996 dollars or $428 per acre-foot ($1.31 per 1,000 gallon) in 2020 dollars, adjusting for 3% annual change in the CPI (Table 3.10). During 2014, 128,297 acres of cropland in the watershed in the 5 counties were cultivated and 9,399 acres were irrigated (USDA 2014). These values are based on land use data and 2014 county level data from USDA Census, scaled by proportion of farmland within the watershed. Annual irrigation water needs from June through September are 9 inches for corn, soybeans, and grain (2,600 gpd/acre for 14,904 irrigated acre or 38.75 mgd). In the New Jersey tributary watersheds, the annual value of water needed to irrigate 9 inches of water over 9,399 acres at a use value of $428 per acre-foot is $3 million per year (Table 3.11).

Table 3.10. Freshwater-use values in the United States

Use	1996 Median[1] ($/ac-ft.)	2020 Median[2] ($/ac-ft.)	2020 Median ($/1,000 gal)
Navigation	10	22	0.07
Irrigation	198	428	1.31
Industrial Process	132	285	0.88
Thermoelectric Power	29	63	0.19
Hydropower	21	46	0.14

1. Frederick et al. 1996. 2. Adjusted to $2020 based on change in Northeast Region CPI (BLS).

Table 3.11. Value of agriculture irrigation water demand in the New Jersey tributary watersheds

County	Cropland by county[1] (ac)	Irrigation by county[1] (ac)	Farmland in basin (ac)	Irrigated land in basin (ac)	Value of irrigation[2] @ $428/ac-ft
Hunterdon	100,027	1,501	41,202	618	198,466
Mercer	21,736	1,028	4,591	217	69,699
Monmouth	44,130	5,976	1,349	183	58,640
Sussex	65,242	454	22,041	153	49,234
Warren	74,975	2,426	59,113	1,913	613,991
Total	**2,864,870**	**209,882**	**128,297**	**9,399**	**3,017,115**

1. Census of Agriculture 2012 (USDA 2014). 2. Frederick, VandenBerg, and Hansen 1996.

Thermoelectric Power Water Supply

There are no thermoelectric power plants within the New Jersey tributary watersheds. However, the Martins Creek Power Generating Stations in Pennsylvania does utilize Delaware River Water downstream from several New Jersey tributaries. The value of its water supply was not included.

Hydropower Water Supply

Hydropower water supply withdrawals allocated by DRBC total 145 million gallons per day in the upper Delaware Basin at the Delaware Water Gap at Yards Creek Reservoir (Table 3.12). A study of the economic value of freshwater in the United States indicates the median value of hydropower withdrawals is $21 per acre-foot in $1996 (Frederick et al. 1996) or $46 per acre-foot ($0.14 per 1,000 gallons) in $2020 adjusting for 3% annually. The value of hydropower water withdrawals based on DRBC allocated supplies in the New Jersey tributary watersheds is $20,300 per day or $7.4 million per year.

Table 3.12. Value of hydroelectric water supplies in the New Jersey tributary watersheds

Watershed	Withdrawal[1] (mgd)	Hydropower Value/day[2] ($0.14/1,000 gal)	Hydropower Value/year ($0.14/1,000 gal)
Upper Central	145	20,300	7,409,500
Lower Central	0	0	0
Delaware Basin	**145**	**20,300**	**7,409,500**

1. DRBC water allocations. 2. Frederick et al. 1996 adjusted to $2020 at 3% annually

Industrial Water Supply

Industrial water withdrawals allocated by DRBC total 102 million gallons per day in the New Jersey tributary watersheds in the Upper Central and Lower Central regions (Table 3.13). Discharge of less than 10,000 gpd are not tracked by DRBC. A study of the economic value of freshwater in the United States indicates the median value of industrial withdrawals is $132 per acre-foot in $1996 (Frederick et al. 1996) or $285 per acre-foot ($0.88 per 1,000 gallons) in $2020 adjusting for 3% annually. The value of industrial withdrawals based on DRBC allocated supplies is $89,760 per day or $32.8 million per year.

Table 3.13. Value of industrial water withdrawals in the New Jersey tributary watersheds

Watershed	Withdrawal [1] (mgd)	Industry Value/day[2] ($0.88/1,000 gal)	Industry Value/year ($0.88/1,000 gal)
Upper Central	31	27,280	9,957,200
Lower Central	71	62,480	22,805,200
NJ tributary watersheds	**102**	**89,760**	**32,762,400**

1. DRBC water allocations. 2. Frederick et al. 1996 adjusted to $2020 at 3% annually

Fish/Wildlife

National Wildlife Refuge

The U.S. National Wildlife Refuge system provides significant economic benefits and jobs to society. While the Walkill River, Great Swamp, and Cherry Valley national wildlife refuges are close by, there are no national wildlife refuges within the boundaries of the New Jersey tributary watersheds.

Fishing, Hunting, and Bird/Wildlife Watching

The NJ tributary watersheds have significant forest, wetlands, and open water habitat that draw fishing, hunting, and bird/wildlife watching to the region. Waterfowl include mallard, American black duck, blue winged teal, snow geese, and Canada goose. Birds of prey such as golden eagles, bald eagles, and hawks fly through the Delaware Valley during the fall migration. In New Jersey, the U.S. Fish and Wildlife Service (2016) estimated the annual economic value of recreational fishing, hunting, birding/wildlife viewing activities was $1.4 billion (Table 3.14). Average daily trip expenditures range from $24–$49 per trip for fishing, $14–$45 per trip for hunting, and $23–$66 per trip for wildlife/birdwatching.

The New Jersey tributary watersheds cover 915 square-miles or 12% of the land area of New Jersey (7,654 mi^2). Scaling by the ratio of watershed area to state land area, the estimated annual economic value of fishing, hunting, and wildlife/birdwatching recreation in the watershed is $148 million including $78 million from fishing, $15 million from hunting, and $55 million from wildlife/bird watching.

Table 3.14. Value of fishing, hunting, wildlife/birding in the New Jersey tributary watersheds

Recreation Activity	New Jersey[1] ($ million)	NJ Tributary Watersheds[2] ($ million)
Fishing ($24–$49/trip)	752.3	77.5
Trip Related	471.2	48.5
Equipment/other	281.1	29.0
Hunting ($14–$45/trip)	145.9	15.0
Trip Related	72.6	7.5
Equipment/other	73.3	7.5
Wildlife/Birdwatching ($23–$66/trip)	537.4	55.4
Trip Related	146.3	15.1
Equipment/other	391.1	40.3
Total	**1,435.6**	**147.9**

1. USFWS 2016. 2. Scaled by ratio of watershed area to state area (10.3%).

Recreation

Outdoor Recreation

The Outdoor Industry Association (2016) concluded 4.7 million people participated in recreation such as bicycling, camping, fishing, hunting, paddling, hiking, and wildlife viewing in New Jersey and supported $3.1 billion and 335,000 jobs in the state economy. New Jersey 2020 population is 8.9 million, so by proportion outdoor recreation in the New Jersey tributary watersheds (pop. 282,673) contributes $106 million in spending by 150,400 participants with 10,720 jobs (Table 3.15).

Table 3.15. Economic value of outdoor recreation in the New Jersey tributary watersheds (OIA 2016)

Economic Activity	New Jersey	NJ Tributary Watersheds[1]
Consumer Spending	$3.3 billion	$105,600,000
Participants	4.7 million	150,400
Jobs	335,000	10,720

1. Scaled by proportion of NJ tributary watershed population to NJ population = 3.2%

Paddling-based Recreation

Canoeing, kayaking, and rafting are popular recreational activities and key drivers to the local economy along the upper Delaware River and tributaries. In the Mid-Atlantic census division (NY, NJ, PA), the Outdoor Industry Association (2006) estimates that paddling-based recreation is practiced by 11% of the population and is responsible for 3,356,000 participants, $356 million in

gear retail sales, $1.6 billion in trip related sales, and 22,844 jobs. Given the New Jersey tributary watersheds are home to 282,673 people or 0.7% of the three state's total population of 40,800,000 people, then the prorated paddling-based recreation in the watershed is responsible for 23,492 participants, $2.5 million in gear retail sales, $11.2 million in trip related sales ($13.7 million in total sales), and 160 jobs (Table 3.16).

Table 3.16. Economic value of paddling-based recreation in the New Jersey tributary watersheds

Paddling Based Recreation	States of NJ, NY, PA[1]	NJ Tributary Watersheds[2]
Population	40,800,000	282,673
Participants	3,356,000	23,492
Gear retail sales	$356,000,000	$2,492,000
Trip related sales	$1,600,000,000	$11,200,000
Total Sales	$1,956,000,000	$13,692,000
Jobs	22,844	160

1. OIA 2006. 2. Prorated ratio (0.7%) of population in New Jersey tributary watersheds (282,673) to population of New Jersey, New York, and Pennsylvania (40,800,000).

Powerboating

The National Marine Manufacturers Association (NMMA) (2014) announced that New Jersey ranked 17th in the United States respectively in total expenditures of $544,000,000 for new powerboats, outboard engines, boat trailers, and accessories. The Marine Trades Association of New Jersey (2008) estimated that New Jersey recreational boaters spent $2.1 billion in 2006 and the recreational boating industry generated 18,000 jobs. New Jersey's registered recreational boaters accounted for $2.1 billion in total recreational boating expenditures including $938 million in annual boating expenses and $1.1 billion on trip purchases. The average cost of a boat trip was $273 including boat fuel ($60 per trip), fuel to travel to access point ($24 per trip), fishing supplies ($37 per trip), restaurants ($36 per trip), and boat accessories ($35 per trip). Boaters spent $6,340 on annual boating expenditures such as boat purchases ($2,980) and seasonal rental charges for slips and moorings ($726). Powerboat expenditures in New Jersey tributary watersheds scaled by ratio (3.2%) of watershed population (282,673) to New Jersey population (8.9 million) is $17.4 million/year (Table 3.17).

Table 3.17. Recreational powerboat expenditures in the New Jersey tributary watersheds (NMMA 2014)

State	Rank Expenditures	Powerboat Expenditures ($)	Ratio of watershed pop. to state pop.	Watershed Expenditures[1] ($)
New Jersey	17	544,000,000	3.2%	17,408,000

1. Scaled by ratio of watershed population to state total.

Public Parks

National Parks

The Delaware Water Gap National Recreation Area (DWGNRA) preserves 70,000 acres (109 mi^2) of forest and floodplain along 40 miles of the upper Delaware River and 29 miles of the Appalachian Trail. The National Parks Conservation Association estimated visitors to DWGNRA spent $175 million in 2021 including $43.7 million for restaurants, $32.6 million for recreation and amusement, $30.9 million for hotels and motels, and $25.7 million for museum, zoos, and historic sites. In 2021, the DWGNRA generated $106 million in sales and supported 2,686 jobs with $84 million in wages. Cullinane, Flyr, and Koontz (2022) from the National Park Service estimated in 2021 the DWGNRA hosted 4,340,902 park visits with visitor spending of $163,399,000 and supported 2,290 jobs with $108 million in wages.

State Parks

New Jersey has 50 state parks, forests, and historic sites that cover 422,000 acres (659 mi^2). Mates and Reyes (2006) from the NJDEP reported at a central estimate of $21 per visit, 14.2 million visitors per year to the New Jersey state park and forest system contributed $304 to $347 million annually from 2000–2005 to the State economy and supported about 7,000 jobs. In fiscal year 2011, the state parks recorded 18.8 million visitors. Ten state parks and forests cover 62,374 acres in the watershed (Table 3.18). Scaling by proportion of state park area in the watershed to the state parks in New Jersey (62,374 acres out of 422,000 acres or 14.8%), state parks in the watershed contribute approximately $45 to $51 million annually to the local economy.

Table 3.18. Economic value of state parks/forests in the New Jersey tributary watersheds

State Park or Forest	Area (ac)	Statewide Area (ac)	Statewide Economic Value ($ mil)	Watershed Economic Value ($ mil)
Washington's Crossing SP	3,575	422,000	304–347	2.6–2.9
Allamuchy Mtn SP	9,092	422,000	304–347	6.5–7.5
Stephens SP	805	422,000	304–347	0.6–0.7
Lake Hopatcong SP	163	422,000	304–347	0.1–0.1
Worthington SF	6,421	422,000	304–347	4.6–5.3
Jenny Jump SF	4,466	422,000	304–347	3.2–3.7
Stokes SF	16,025	422,000	304–347	11.5–13.2
High Point SP	16,091	422,000	304–347	11.6–13.2
Kittantiny Valley SP	5,656	422,000	304–347	4.1–4.7
Bulls Island Rec. Area	80	422,000	304–347	0.1–0.1
Total	**62,374**	**422,000**	**304–347**	**45–51**

Agriculture

Farmland covers 200 square miles or 22% of the 915-square-mile area of the New Jersey tributary watersheds. In the five counties of the New Jersey tributary watersheds, the USDA (2017) estimates the annual market value of agricultural products sold is $253.3 million on 274,674 acre (429 mi^2) or $922 per acre for crops (corn, wheat, oats, barley, soybeans, potatoes, and vegetables) and livestock and poultry (Table 3.19). On 128,296 acres (200 mi^2) of farmland within the New Jersey tributary watersheds, the prorated annual market value of agricultural products sold is $118.3 million.

Table 3.19. Value of cropland and agriculture in the New Jersey tributary watersheds

County	Farmland by county[1] (ac)	Products sold by county[1] ($ million)	Products sold by county ($/ac)	Farmland in NJ Tributary Watersheds (ac)	Products sold NJ Tributary Watersheds ($ million)
Hunterdon	101,290	92.2	910	41,202	37.5
Mercer	25,230	24.9	987	4,591	4.5
Morris	14,514	24.8	1,709	1,349	2.3
Sussex	59,766	18.2	305	22,041	6.7
Warren	73,874	93.2	1,262	59,113	74.6
Total	**274,674**	**253.3**	**922**	**128,296**	**118.3**

1. Census of Agriculture (USDA 2017)

Forests

The U.S. Forest Service (Nowak et al. 2008) estimated that forests provide environmental benefits such as carbon storage of $5.9 million ($827/ac) and air pollution removal of $1.9 million ($266/ac/yr). Applying these multipliers, 325,163 acres (508 mi^2) of forests in the New Jersey tributary watersheds have benefits of carbon storage ($269 million), carbon sequestration ($9.4 million), air pollution removal ($86 million), and building energy savings ($18.2 million). Forests in the watershed provide carbon, air pollution, and environmental benefits including 13 million tons of carbon storage capacity, 455,228 tons of carbon sequestration, 13,007 tons of air-pollution removal, and 45,523 tons of avoided carbon emissions capacity (Table 3.20).

Table 3.20. Economic/environmental benefits of forests in the New Jersey tributary watersheds

Benefits	Forests[1]		Forests in NJ Tributary Watersheds[2]	
	Environmental (ton/ac)	Economic ($/ac)	Environmental (ton)	Economic ($)
Carbon Storage	40.00	$827	13,006,520	$268,909,801
Carbon Sequestration	1.4	$29	455,228	$9,429,727
Air Pollution Control	0.04	$266	13,007	$86,493,358

Energy Savings	0	$56	0	$18,209,128
Avoided Carbon Emissions	0.14	$3	45,523	$975,489

1. Nowak et al. (2008). 2. Computed for 325,163 acres of forest in the watershed.

Public Parks

Public parks and protected open space cover 221 square miles or one-fourth of the 915-square-mile area of the New Jersey tributary watersheds (Figure 3.4). The Trust for Public Land (2009) found the 444-acre park system in the City of Wilmington, Delaware, provides annual economic value and savings to the public from health benefits from exercise in the parks ($9,734 per acre), community cohesion benefit from people socializing in the parks ($2,383 per acre), water pollution benefits from parks in treating stormwater ($921 per acre), and air pollution mitigation value from tree and shrub absorption ($88 per acre). Using value transfer from the City of Wilmington study, public parks and open space (221 mi^2) within the New Jersey tributary watersheds provide the following annual economic benefits (Table 3.21):

- Health benefits from exercise in the parks ($1.4 billion).
- Community cohesion benefit from people socializing in the parks ($337 million).
- Water pollution benefit from parks in treating stormwater ($130 million).
- Air pollution mitigation value from tree and shrub absorption ($12.5 million).

Table 3.21. Value of public parks and open space in the New Jersey tributary watersheds

County	Parks in NJ Tributary Watersheds (mi^2)	Parks in NJ Tributary Watersheds (ac)	Health Benefits ($9,734/ac)	Community Cohesion ($2,383/ac)	Stormwater Benefit ($921/ac)	Air Pollution ($88/ac)
Mercer	20	12,800	124,595,200	30,502,400	11,788,800	1,126,400
Hunterdon	25	16,000	155,744,000	38,128,000	14,736,000	1,408,000
Morris	6	3,840	37,378,560	9,150,720	3,536,640	337,920
Warren	80	51,200	498,380,800	122,009,600	47,155,200	4,505,600
Sussex	90	57,600	560,678,400	137,260,800	53,049,600	5,068,800
NJ Tributary Watersheds	**221**	**141,440**	**1,376,776,960**	**337,051,520**	**130,266,240**	**12,446,720**

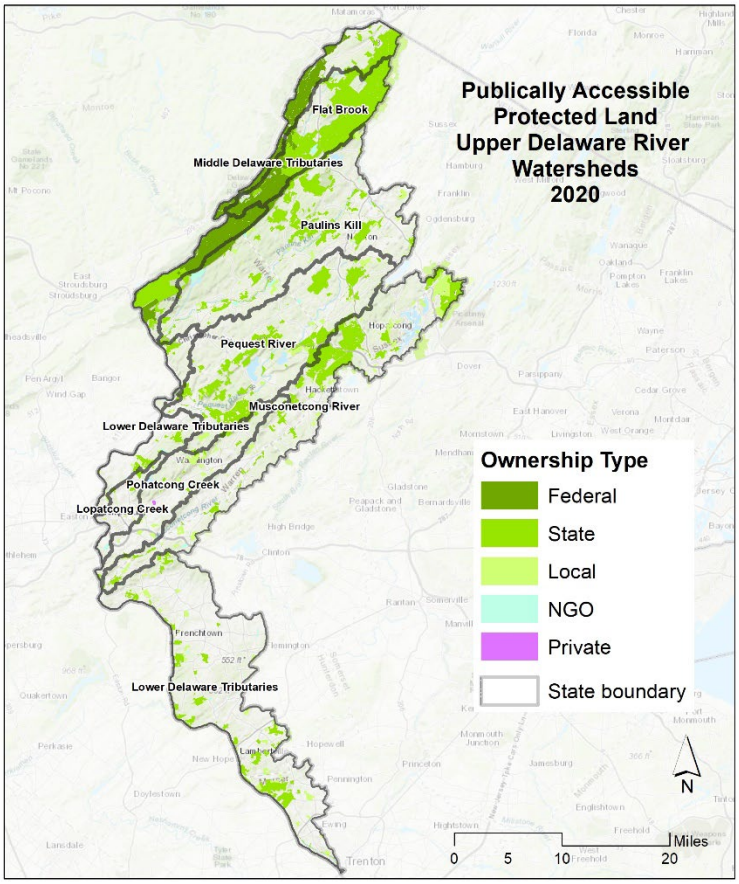


Figure 3.4. Public parks and open lands in the New Jersey tributary watersheds study area

Chapter 4. Ecosystem Goods and Services

Ecosystem services (natural capital) are the sum of goods (commodities like water, crops, and timber that can be sold) and services (functions like flood control, water filtration, and fisheries habitat) provided by watershed habitat, such as wetlands, forests, farms, and open water. The following studies were examined to estimate ecosystem services values for the Delaware River watershed:

- Cecil County green infrastructure study by the Conservation Fund, Annapolis, Maryland (2007)
- New Jersey Department of Environmental Protection with the University of Vermont (2007)
- Ecosystem services value of forests by the Wilderness Society (2001)
- Ecosystem services value of Peconic Estuary watershed by University of Rhode Island (2002)
- U.S. National Wildlife Refuges by University of Maryland and Nature Conservancy (2008)
- Economic value of ecosystem services in Massachusetts by the Audubon Society (2003).

Related Research

Ecosystem services include air filtration, water filtration, recycling nutrients, soil conservation, pollinating crops and plants, climate regulation, carbon sequestration, flood/stormwater control, and hydrologic cycle regulation. Ecological resources provide marketable goods and services such as timber, fish and wildlife recreation, hiking, and boating/kayaking.

The New Jersey Department of Environmental Protection (2007) partnered with the University of Vermont and estimated the value of New Jersey's natural capital at $20 billion per year in 2004 dollars with a net present value (NPV) of $681 billion. NPV takes the value of a dollar today and projects it into the future summed annually over a lifetime (say, 100 years), given the annual value is discounted by a rate (3%) due to inflation based on the Consumer Price Index.

Others have calculated the value of natural capital in ecosystems along the Atlantic seaboard and across the United States. Weber (2007) from the Conservation Fund found the largest ecosystem services values in Cecil County, Maryland, are from stormwater/flood control, water supply, and clean water functions (Table 4.1). A contingent value study by University of Rhode Island economists found that natural resources values in the Peconic Estuary watershed in Suffolk County on Long Island, New York, ranged from $6,560 per acre for wetlands to $9,979 per acre for farmland in 1995 dollars (Johnston et al., 2002). The University of Maryland studied the U.S. National Wildlife Refuge System and determined that ecosystem values of freshwater wetlands and forests are $6,268 per acre and $845 per acre, respectively (Ingraham and Foster, 2008). The Audubon Society found ecosystem services in Massachusetts ranged from $984 per acre for forests to $15,452 per acre for saltwater wetlands (Breunig, 2003). The USDA Census of Agriculture (2017) reported that the market value of agricultural products sold in the counties of the New Jersey tributary watersheds was $2,503 per acre. Table 4.2 compares ecosystem services values from studies in other watersheds. Data from the NJDEP study (Table 4.3) and crop value from the USDA census are used for value transfer to the New Jersey tributary study area with similar ecosystems (forests/wetlands), climate (humid continental at 40º north latitude), physiographic provinces, aquifers, and soils.

Table 4.1. Ecosystem services values for Cecil County, Maryland (Weber, 2007)

Ecosystem Service	Upland Forest ($/ac/yr)	Riparian Forest/Wetland ($/ac/yr)	Nonriparian Wetlands ($/ac/yr)	Tidal Marsh ($/ac/yr)
Carbon sequestration	31	65	65	65
Clean air	191	191	191	
Soil and peat formation	17	946	450	1,351
Stormwater/flood control	679	32,000	32,000	1,430
Water supply	8,630	8,630	8,630	
Clean water	1,100	1,925	1,100	11,000
Erosion/sediment control	151	3,418	151	12,700
Water temperature regulation		4,450		
Pest control	50	50	50	
Pollination	75	75	75	
Wood products	142			
Recreation, fish, wildlife habitat	486	534	534	544
Community services savings	439	439	439	439
Increase in property values	42	42		
Total	**12,033**	**52,765**	**43,685**	**27,529**

Table 4.2. Comparison of ecosystem goods and services values from various studies

Ecosystem	Cecil Co. Md. 2006 ($/ac/yr)	NJDEP 2007 ($/ac/yr)	Liu et al. 2010 ($/ac/yr)	Peconic Estuary 1995 ($/ac/yr)	U.S. Wildlife 2008 ($/ac/yr)	Mass. Audubon 2003 ($/ac/yr)	USDA Census[1] 2007 ($/ac/yr)
Freshwater wetland	43,685	11,802	8,695		6,268	15,452	
Marine		8,670					
Farmland		6,229	23	9,979		1,387	2,503[1]
Forest land	12,033	1,714	1,283		845	984	
Saltwater wetland	28,146	6,269		6,560		12,580	
Urban		296	0				
Open freshwater		1,686	765		217	983	
Riparian buffer	52,765	3,500	3,382				
Shellfish areas				4,555			

1. Value of natural goods only measured by crops, livestock, and poultry sold in Warren County (USDA 2017).

Table 4.3. Ecosystem services values in the New Jersey tributary watersheds (Liu et al. 2010)

Ecosystem	$/ac/yr 2004	$/ac/yr 2020[1]
Freshwater wetlands	8,695	13,953
Riparian/Floodplain	3,382	5,427
Farmland	23	37
Forest land	1,283	2,059
Urban	0	0
Open water	765	1,228

1. Translated to $2020 from annual change in CPI in northeastern United States at 3% annually.

Watershed Ecosystem Services

The estimated annual value of ecosystem goods and services provided by the New Jersey tributary watersheds of the Delaware River is $2.3 billion (in 2020 dollars) with a net present value (NPV) of $74.61 billion (Table 4.4). Ecosystem services areas within the watershed include freshwater wetlands (9.5%), riparian/floodplain (11.8%), farmland (19.7%), forest land (50%), urban (7.2%), and open water (1.7%) (Figure 4.1). Freshwater wetlands ($858 million), forest ($670 million), floodplains ($417 million), and farmland ($321 million) provide the highest ecosystems goods and services values (Figures 4.2 and 4.3). The natural capital value of the watershed will decrease if urban land replaces forest land, which currently cover one-third of the drainage area (Figures 4.4 and 4.5).

Table 4.4. Ecosystem goods and services in the New Jersey tributary watersheds (2020)

Ecosystem	Area (ac)	$/ac/yr	PV $	NPV $
Freshwater wetlands	61,518	13,953	858,360,654	27,896,721,255
Riparian/Floodplain	76,918	5,427	417,433,986	13,566,604,545
Farmland	128,297	2,503	321,127,391	10,436,640,208
Forest land	325,263	2,059	669,716,517	21,765,786,803
Urban	46,955	342	16,058,610	521,904,825
Open water	11,214	1,228	13,770,792	447,550,740
Total	**650,165**		**2,296,467,950**	**74,635,208,375**

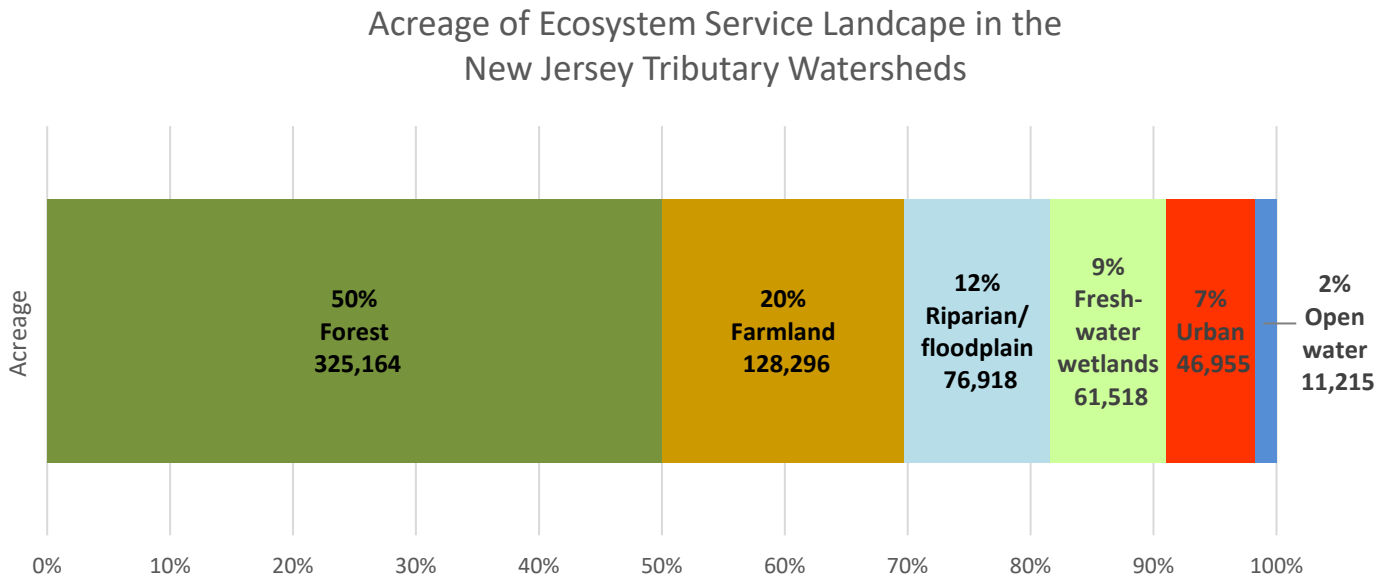


Figure 4.1. Ecosystem service area of landscapes in the New Jersey tributary watersheds

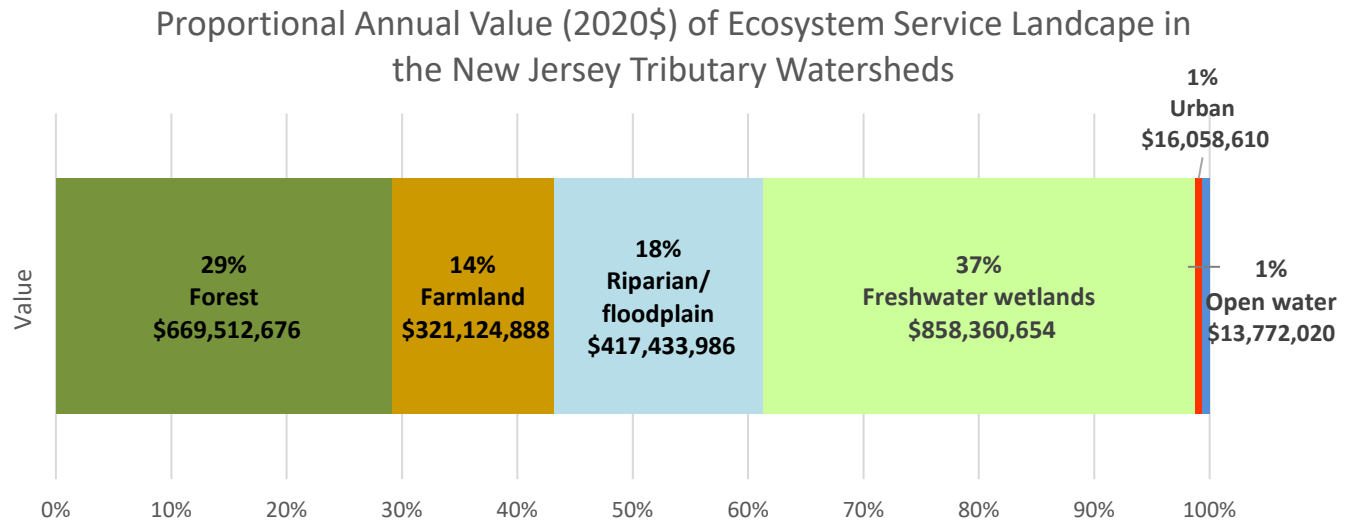


Figure 4.2. Proportional annual value of ecosystem services in the New Jersey tributary watersheds

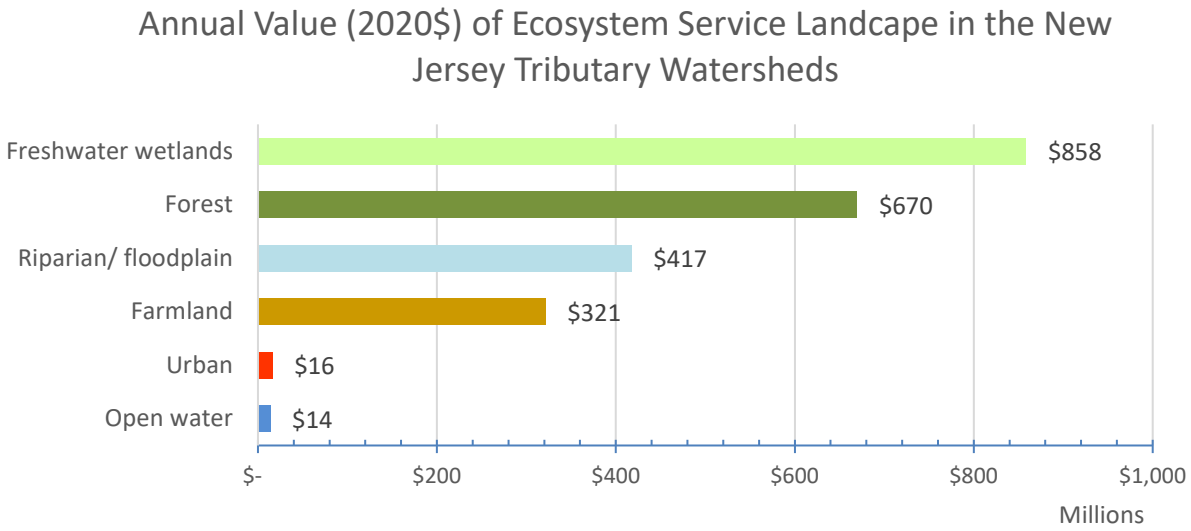
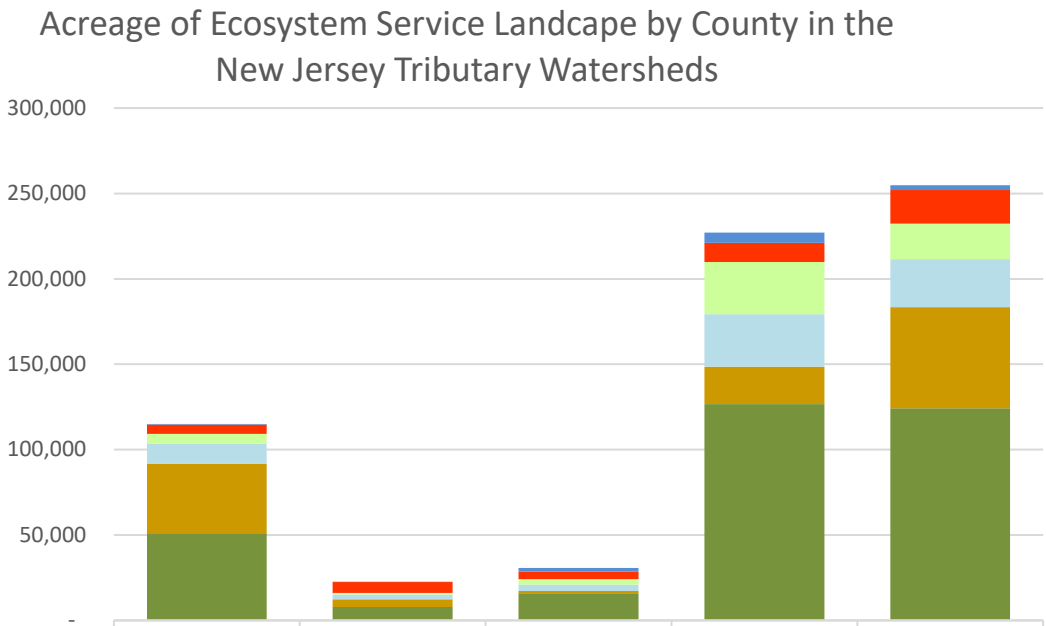


Figure 4.3. Annual value of ecosystem services in New Jersey tributary watersheds

In the New Jersey tributary watersheds, Warren (254,836 acres), Sussex (227,019 acres), and Hunterdon (114,958 acres) counties account for the largest area of the watershed (Figure 4.3 and 4.4), contributing annual ecosystem services value of $858.5 million, $919.7 million, and $354.0 million, respectively (Table 4.5).

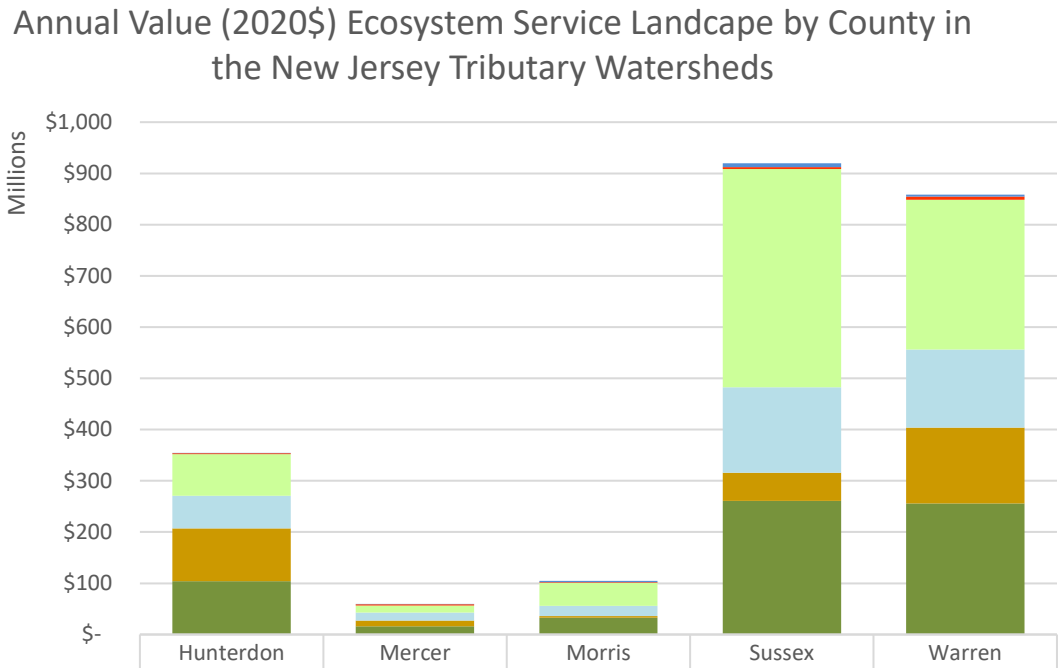
Table 4.5. Ecosystem goods and services in NJ tributary watersheds by county

Ecosystem	Area (ac)	$/ac/yr 2020	$/yr 2020	NPV $
Freshwater wetlands	61,518	13,953	858,360,654	27,896,721,255
Riparian/Floodplain	76,918	5,427	417,433,986	13,566,604,545
Farmland	128,297	2,503	321,127,391	10,436,640,208
Forest land	325,263	2,059	669,716,517	21,765,786,803
Urban	46,955	342	16,058,610	521,904,825
Open water	11,214	1,228	13,770,792	447,550,740
NJ Tributaries	**650,165**		**2,296,467,950**	**74,635,208,375**
Freshwater wetlands	5,808	13,953	81,039,024	2,633,768,280
Riparian/Floodplain	11,738	5,427	63,702,126	2,070,319,095
Farmland	41,202	2,503	103,128,606	3,351,679,695
Forest land	50,519	2,059	104,018,621	3,380,605,183
Urban	5,460	342	1,867,320	60,687,900
Open water	231	1,228	283,668	9,219,210
Hunterdon	**114,958**		**354,039,365**	**11,506,279,363**
Freshwater wetlands	1,008	13,953	14,064,624	457,100,280
Riparian/Floodplain	2,807	5,427	15,233,589	495,091,643
Farmland	4,591	2,503	11,491,273	373,466,373
Forest land	7,780	2,059	16,019,020	520,618,150
Urban	6,231	342	2,131,002	69,257,565
Open water	41	1,228	50,348	1,636,310
Mercer	**22,458**		**58,989,856**	**1,917,170,320**
Freshwater wetlands	3,229	13,953	45,054,237	1,464,262,703
Riparian/Floodplain	3,612	5,427	19,602,324	637,075,530
Farmland	1,349	2,503	3,376,547	109,737,778
Forest land	15,957	2,059	32,855,463	1,067,802,548
Urban	4,571	342	1,563,282	50,806,665
Open water	2,077	1,228	2,550,556	82,893,070
Morris	**30,795**		**105,002,409**	**3,412,578,293**
Freshwater wetlands	30,534	13,953	426,040,902	13,846,329,315
Riparian/Floodplain	30,701	5,427	166,614,327	5,414,965,628
Farmland	22,041	2,503	55,168,623	1,792,980,248
Forest land	126,609	2,059	260,687,931	8,472,357,758
Urban	11,130	342	3,806,460	123,709,950
Open water	6,004	1,228	7,372,912	239,619,640
Sussex	**227,019**		**919,691,155**	**29,889,962,538**
Freshwater wetlands	20,939	13,953	292,161,867	9,495,260,678
Riparian/Floodplain	28,060	5,427	152,281,620	4,949,152,650
Farmland	59,113	2,503	147,959,839	4,808,694,768
Forest land	124,299	2,059	255,931,641	8,317,778,333
Urban	19,563	342	6,690,546	217,442,745
Open water	2,862	1,228	3,514,536	114,222,420
Warren	**254,836**		**858,540,049**	**27,902,551,593**



	Hunterdon	Mercer	Morris	Sussex	Warren
Open water	231	41	2,077	6,004	2,862
Urban	5,460	6,231	4,571	11,130	19,563
Freshwater wetlands	5,808	1,008	3,229	30,534	20,939
Riparian/ floodplain	11,738	2,807	3,612	30,701	28,060
Farmland	41,202	4,591	1,349	22,041	59,113
Forest	50,519	7,780	15,957	126,609	124,299

Figure 4.4. Area (acres) of ecosystem service landscapes by county in the New Jersey tributary watersheds



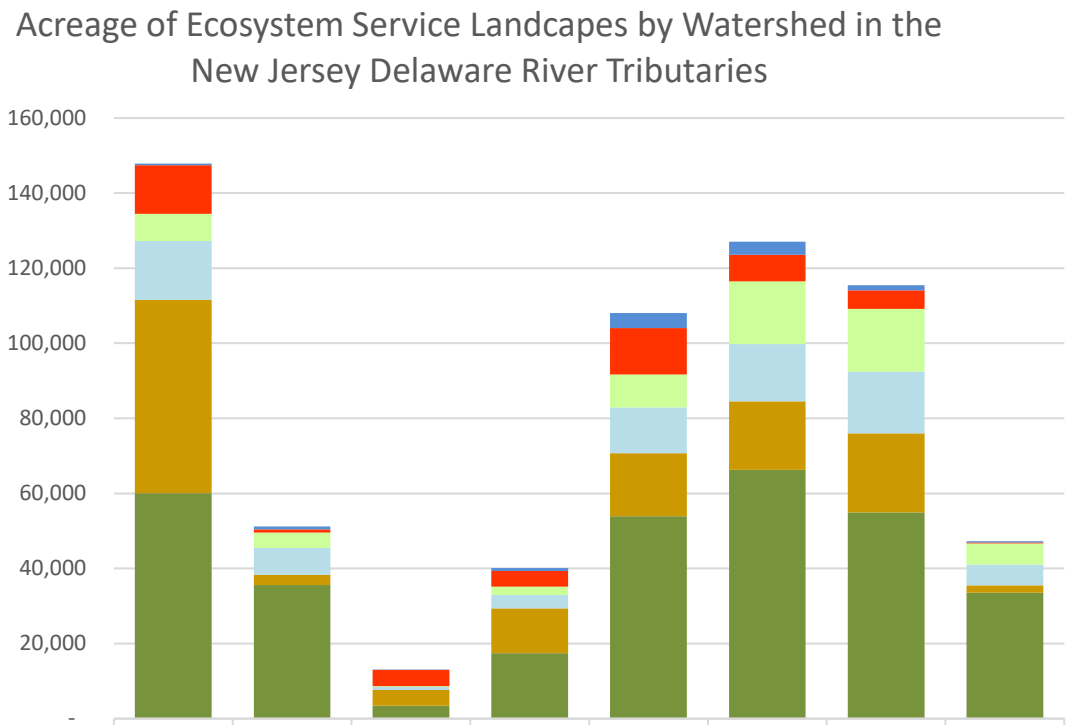
	Hunterdon	Mercer	Morris	Sussex	Warren
Open water	$283,668	$50,348	$2,550,556	$7,372,912	$3,514,536
Urban	$1,867,320	$2,131,002	$1,563,282	$3,806,460	$6,690,546
Freshwater wetlands	$81,039,024	$14,064,624	$45,054,237	$426,040,902	$292,161,867
Riparian/ floodplain	$63,702,126	$15,233,589	$19,602,324	$166,614,327	$152,281,620
Farmland	$103,128,606	$11,491,273	$3,376,547	$55,168,623	$147,959,839
Forest	$104,018,621	$16,019,020	$32,855,463	$260,687,931	$255,931,641

Figure 4.5. Value (2020$) of ecosystem service landscapes by county in the New Jersey tributary watersheds

The largest creeks and rivers in the New Jersey tributary watersheds are the Flat Brook, Pequest River, Paulins Kill, Musconetcong River, Pohatcong Creek, Lopatcong Creek, Middle Delaware Tributaries, and Lower Delaware Tributaries. The Lower Delaware Tributaries (147,897 acres), the Musconetcong River (108,038 acres), and Paulins Kill (127,088 acres) cover the greatest area (Table 4.6). Annual ecosystem services in the Lower Delaware Tributaries total $444 million, in the Musconetcong River $351 million, and in the Paulins Kill $505 million. Forest and freshwater wetlands contribute the highest ecosystem services value (Table 4.6 and Figures 4.5 and 4.6).

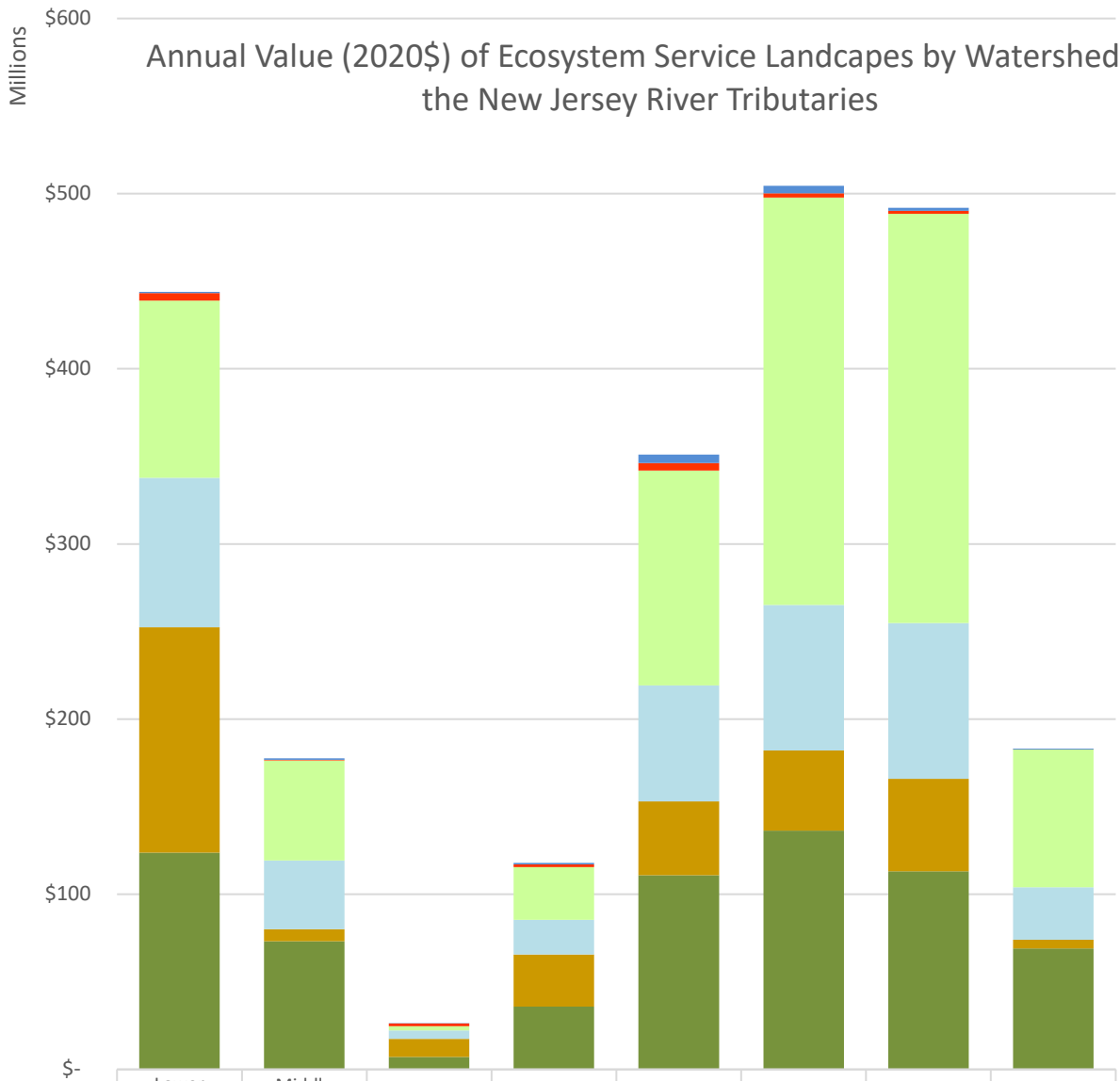
Table 4.6. Ecosystem goods and services of New Jersey watersheds by tributary

Ecosystem	Area (ac)	$2020/ac/yr	$2020/yr	NPV ($)
Freshwater wetlands	61,518	13,953	858,360,654	27,896,721,255
Riparian/Floodplain	76,918	5,427	417,433,986	13,566,604,545
Farmland	128,297	2,503	321,127,391	10,436,640,208
Forest land	325,263	2,059	669,716,517	21,765,786,803
Urban	46,955	342	16,058,610	521,904,825
Open water	11,214	1,228	13,770,792	447,550,740
NJ tributary watersheds	**650,165**		**2,296,467,950**	**74,635,208,375**
Freshwater wetlands	7,239	13,953	101,005,767	3,282,687,428
Riparian/Floodplain	15,739	5,427	85,415,553	2,776,005,473
Farmland	51,427	2,503	128,721,781	4,183,457,883
Forest land	60,084	2,059	123,712,956	4,020,671,070
Urban	12,940	342	4,425,480	143,828,100
Open water	468	1,228	574,704	18,677,880
Lower Delaware Tributaries	**147,897**		**443,856,241**	**14,425,327,833**
Freshwater wetlands	4,102	13,953	57,235,206	1,860,144,195
Riparian/Floodplain	7,216	5,427	39,161,232	1,272,740,040
Farmland	2,733	2,503	6,840,699	222,322,718
Forest land	35,560	2,059	73,218,040	2,379,586,300
Urban	858	342	293,436	9,536,670
Open water	760	1,228	933,280	30,331,600
Middle Delaware Tributaries	**51,229**		**177,681,893**	**5,774,661,523**
Freshwater wetlands	177	13,953	2,469,681	80,264,633
Riparian/Floodplain	877	5,427	4,759,479	154,683,068
Farmland	4,133	2,503	10,344,899	336,209,218
Forest land	3,465	2,059	7,134,435	231,869,138
Urban	4,310	342	1,474,020	47,905,650
Open water	29	1,228	35,612	1,157,390
Lopatcong Creek	**12,991**		**26,218,126**	**852,089,095**
Freshwater wetlands	2,155	13,953	30,068,715	977,233,238
Riparian/Floodplain	3,649	5,427	19,803,123	643,601,498
Farmland	11,890	2,503	29,760,670	967,221,775
Forest land	17,439	2,059	35,906,901	1,166,974,283
Urban	4,249	342	1,453,158	47,227,635
Open water	736	1,228	903,808	29,373,760
Pohatcong Creek	**40,118**		**117,896,375**	**3,831,632,188**
Freshwater wetlands	8,792	13,953	122,674,776	3,986,930,220
Riparian/Floodplain	12,216	5,427	66,296,232	2,154,627,540
Farmland	16,800	2,503	42,050,400	1,366,638,000
Forest land	53,882	2,059	110,943,038	3,605,648,735
Urban	12,365	342	4,228,830	137,436,975
Open water	3,983	1,228	4,891,124	158,961,530
Musconetcong River	**108,038**		**351,084,400**	**11,410,243,000**
Freshwater wetlands	16,673	13,953	232,638,369	7,560,746,993
Riparian/Floodplain	15,297	5,427	83,016,819	2,698,046,618
Farmland	18,277	2,503	45,747,331	1,486,788,258
Forest land	66,240	2,059	136,388,160	4,432,615,200
Urban	7,072	342	2,418,624	78,605,280
Open water	3,529	1,228	4,333,612	140,842,390
Paulins Kill	**127,088**		**504,542,915**	**16,397,644,738**
Freshwater wetlands	16,746	13,953	233,656,938	7,593,850,485
Riparian/Floodplain	16,405	5,427	89,029,935	2,893,472,888
Farmland	21,059	2,503	52,710,677	1,713,097,003
Forest land	54,953	2,059	113,148,227	3,677,317,378
Urban	4,910	342	1,679,220	54,574,650
Open water	1,367	1,228	1,678,676	54,556,970
Pequest River	**115,440**		**491,903,673**	**15,986,869,373**
Freshwater wetlands	5,635	13,953	78,625,155	2,555,317,538
Riparian/Floodplain	5,518	5,427	29,946,186	973,251,045
Farmland	1,978	2,503	4,950,934	160,905,355
Forest land	33,541	2,059	69,060,919	2,244,479,868
Urban	251	342	85,842	2,789,865
Open water	342	1,228	419,976	13,649,220
Flat Brook	**47,265**		**183,089,012**	**5,950,392,890**



	Lower Delaware Tribs.	Middle Delaware Tribs.	Lopatcong Creek	Pohatcong Creek	Musconetcong River	Paulins Kill	Pequest River	Flat Brook
Open water	468	760	29	736	3,983	3,529	1,367	342
Urban	12,940	858	4,310	4,249	12,365	7,072	4,910	251
Freshwater wetlands	7,239	4,102	177	2,155	8,792	16,673	16,746	5,635
Riparian/ floodplain	15,739	7,216	877	3,649	12,216	15,297	16,405	5,518
Farmland	51,427	2,733	4,133	11,890	16,800	18,277	21,059	1,978
Forest	60,084	35,560	3,465	17,439	53,882	66,240	54,953	33,541

Figure 4.6. Acreage of ecosystem service landscapes in New Jersey watersheds by tributary



	Lower Delaware Tributaries	Middle Delaware Tributaries	Lopatcong Creek	Pohatcong Creek	Musconetcong River	Paulins Kill	Pequest River	Flat Brook
Open water	$574,704	$933,280	$35,612	$903,808	$4,891,124	$4,333,612	$1,678,676	$419,976
Urban	$4,425,480	$293,436	$1,474,020	$1,453,158	$4,228,830	$2,418,624	$1,679,220	$85,842
Freshwater wetlands	$101,005,767	$57,235,206	$2,469,681	$30,068,715	$122,674,776	$232,638,369	$233,656,938	$78,625,155
Riparian/ floodplain	$85,415,553	$39,161,232	$4,759,479	$19,803,123	$66,296,232	$83,016,819	$89,029,935	$29,946,186
Farmland	$128,721,781	$6,840,699	$10,344,899	$29,760,670	$42,050,400	$45,747,331	$52,710,677	$4,950,934
Forest	$123,712,956	$73,218,040	$7,134,435	$35,906,901	$110,943,038	$136,388,160	$113,148,227	$69,060,919

Figure 4.7. Annual ecosystem service values (2020$) in New Jersey watersheds by tributary

Chapter 5. Jobs and Wages

The five counties of the New Jersey tributary watersheds (Mercer, Hunterdon, Morris, Warren and Sussex) host a 2020 population of 1,279,460 with 611,213 jobs (Table 5.1). Within the New Jersey tributary watersheds, the population is 282,773 with 93,387 jobs.

Table 5.1. Population and jobs in the counties of the New Jersey tributary watersheds

County	County Pop[1]	County Jobs[1]	NJ Tributary Pop.[2]	NJ Tributary Jobs[3]
Mercer	387,340	202,228	32,718	17,082
Hunterdon	128,947	45,314	32,659	11,477
Morris	509,285	302,883	32,384	19,259
Warren	109,667	28,921	109,667	28,921
Sussex	144,221	31,867	75,345	16,648
NJ Tributary Watersheds	**1,279,460**	**611,213**	**282,773**	**93,387**

1. County population and jobs from U.S. Census Bureau (2020). 2. Watershed population based on U.S. Census Bureau (2020). 3. Scaled using a ratio of New Jersey tributary watersheds population to county population.

The New Jersey tributary watersheds have water resources and habitat that supports over 40,000 direct/indirect jobs with over $2 billion in annual wages in the water, agriculture, fishing/hunting/birding, tourism, and recreation sectors (Table 5.2).

Table 5.2. Jobs and wages directly/indirectly related to New Jersey tributary watersheds

Sector	Jobs	Wages ($ mil)	Data Source
Direct Watershed-Related	10,100	1,051,094,814	U.S. Bureau of Labor Statistics (2020)
Indirect Watershed-Related	12,120	840,875,851	Latham and Stapleford 1990
Farm	1,848	88,900,000	U.S. Department of Agriculture (2017)
Fishing/Hunting/Birding	4,503	147,900,000	U.S. Fish and Wildlife Service (2016)
Outdoor Recreation	10,720		Outdoor Industry Association (2016)
State Parks	1036		Mates and Reyes (2006)
National Parks	2,290	108,000,000	Cullinane, Flyr, and Koontz (2022), NPS
Watershed Organizations	45	2,160,000	UDWRC (2023)
Craft Breweries	36	1,440,000	UDWRC (2023)
Wineries	34	1,360,000	UDWRC (2023)
Fishing Tackle/Outfitting	27	1,080,000	UDWRC (2023)
Water Supply Utilities	85	4,709,595	UDWRC (2023)
Wastewater Utilities	38	1,900,000	UDWRC (2023)
NJ Tributary Watersheds	**>40,000**	**>$2 billion**	

Jobs and wages in New Jersey tributary watersheds are identified by NAICS code from Bureau of Labor Statistics (2020) databases. In Mercer, Hunterdon, Morris, Sussex, and Warren Counties, the Bureau of Labor Statistics (BLS) reports 46,413 nonfarm water-related jobs with wages of $10.8 billion (Table 5.3). Jobs directly associated with New Jersey tributary watersheds such as water and

sewer construction, water utilities, fishing, recreation, and tourism employed 10,100 people with $1.05 billion in wages (Tables 5.4). Indirect jobs in the watershed based on multipliers of 2.2 for jobs and 1.8 for salaries (Latham & Stapleford 1990) employed 12,120 with $841 million in wages.

Table 5.3. Water-related jobs and wages in New Jersey tributary watersheds (BLS 2020)

Category	Jobs	Wages ($ mil)
Total Counties, NJ	46,413	10,830
Direct Tributary Watersheds	10,100	1,051
Indirect Tributary Watersheds	12,120	841

Table 5.4. Water-related direct and indirect jobs in New Jersey tributary watersheds

Category	NAICS	County Jobs	County Wages ($2020)	County Pop.	Watershed Pop.	Watershed Jobs	Watershed Wages $2020)	Indirect Jobs	Indirect Wages
Boat Building									
Ship and Boat Building	3366	0	0	1,279,425	278,408	0	0	0	0
Construction									
Water/Sewer onstruction	23711	0	0	1,279,425	278,408	0	0	0	0
Environmental									
Architectural, Engineering	541	23,150	3,892,000,000	1,279,425	278,408	5,038	846,914,775	6045.03917	677,531,820
Civic Social Organizations	8134	1,510	37,312,422	1,279,425	278,408	329	8,119,332	394.2984513	6,495,466
Environ., Conservation	813211	201	20,554,055	1,279,425	278,408	44	4,472,645	52.48608523	3,578,116
Living Resources									
Fishing, hunting, rapping[3]	114	0	0	1,279,425	278,408	0	0	0	0
Agriculture and Forestry	115	232	9,351,288	1,279,425	278,408	50	2,034,878	60.5809541	1,627,902
Seafood Prep./Packaging	3117	0	0	1,279,425	278,408	0	0	0	0
Wineries	31213	8	417,291	1,279,425	278,408	2	90,804	2.088998417	72,643
Fish and Seafood Wholesalers	42446	784	18,521,516	1,279,425	278,408	171	4,030,356	204.7218449	3,224,285
Nursery, Garden, Farm	44422	244	7,129,470	1,279,425	278,408	53	1,551,401	63.71445173	1,241,121
Fish and Seafood Markets	44522	26	1,127,443	1,279,425	278,408	6	245,336	6.789244856	196,269
Fruit and Vegetable Markets	44523	121	2,783,301	1,279,425	278,408	26	605,657	31.59610106	484,526
Minerals									
Mining, Quarrying	21	253	20,303,573	1,279,425	278,408	55	4,418,139	66.06457495	3,534,511
Electric Power Generation	2211	1,076	146,667,535	1,279,425	278,408	234	31,915,443	280.9702871	25,532,354
Tourism/Recreation									
Museums, Historical Sites	712	287	14,073,720	1,279,425	278,408	62	3,062,498	74.94281822	2,449,998
Accommodation	721	2,139	76,744,822	1,279,425	278,408	465	16,699,980	558.5459518	13,359,984
Amusement Parks/Arcades	7131	262	6,184,009	1,279,425	278,408	57	1,345,665	68.41469817	1,076,532
Amusement/Recreation	7139	3,775	103,270,446	1,279,425	278,408	821	22,472,062	985.7461281	17,977,650
Recreational Vehicle, Camps	7212	167	4,908,437	1,279,425	278,408	36	1,068,096	43.60784196	854,476
Sporting/Recreat. Conservation	42391	147	14,260,395	1,279,425	278,408	32	3,103,119	38.38534592	2,482,495
Recreational Vehicle Dealers	44121	29	1,735,038	1,279,425	278,408	6	377,551	7.572619263	302,041
Sporting Goods Stores	45111	872	28,415,724	1,279,425	278,408	190	6,183,375	227.7008275	4,946,700
Golf Courses	71391	1,136	37,985,423	1,279,425	278,408	247	8,265,780	296.6377753	6,612,624
Marinas	71393	54	2,752,012	1,279,425	278,408	12	598,849	14.10073932	479,079
Fitness/Recreational Sports	71394	2,567	63,010,082	1,279,425	278,408	559	13,711,246	670.3073671	10,968,997
Amusement/Recreation	71399	655	15,279,560	1,279,425	278,408	143	3,324,893	171.0367454	2,659,915
Hotels and Motels	72111	1,116	46,801,277	1,279,425	278,408	243	10,184,145	291.4152792	8,147,316
Food Service Contractors	72231	2,636	80,427,762	1,279,425	278,408	574	17,501,403	688.3249785	14,001,122
Mobile Food Services	72233	4	201,677	1,279,425	278,408	1	43,886	1.044499209	35,109
Boat Dealers	441222	38	1,620,510	1,279,425	278,408	8	352,629	9.922742482	282,104
Recreational Goods Rental	523292	0	0	1,279,425	278,408	0	0	0	0
Commer.Water Transport.	532411	354	6,525,682	1,279,425	278,408	77	1,420,015	92.43817996	1,136,012
Bed-and-Breakfast Inns	721191	0	0	1,279,425	278,408	0	0	0	0
Limited-Service Restaurants	722211	41	1,231,125	1,279,425	278,408	9	267,898	10.70611689	214,318
Snack/Beverage Bars	722213	0	0	1,279,425	278,408	0	0	0	0
Transportation									
Scenic/Sightseeing Transport.	487	8	223,532	1,279,425	278,408	2	48,641	2.088998417	38,913
Inland Water Transportation	4832	164	12,297,563	1,279,425	278,408	36	2,675,999	42.82446755	2,140,799
Marine Cargo Handling	4883	51	2,456,213	1,279,425	278,408	11	534,482	13.31736491	427,585
Water Transportation	48839	0	0	1,279,425	278,408	0	0	0	0
Navigat. Services/Shipping	488320	354	9,835,302	1,279,425	278,408	77	2,140,201	92.43817996	1,712,161
Water/Wastewater									
Waste Management Services	562	1,927	142,705,241	1,279,425	278,408	419	31,053,232	503.1874938	24,842,585
Water, Sewage Systems	2213	25	1,196,681	1,279,425	278,408	5	260,403	6.528120054	208,322
NJ Tributaries		**46,413**	**10,830,480,074**			**10,100**	**1,051,094,814**	**12,120**	**840,875,851**

1. Direct jobs/wages are directly related to the New Jersey tributaries of the Delaware River (BLS 2020). 2. Direct jobs/wages derive purchases of goods and services by indirect jobs earners by multipliers of 2.2 for jobs and 1.8 for wages (Latham and Stapleford 1990). 3. Jobs and wages not reported by businesses to the Bureau of Labor Statistics.

Farm Jobs

In 2017 there were 1,894 farms in the New Jersey tributary watersheds within Mercer, Hunterdon, Morris, Warren, and Sussex Counties employing 1,848 farm laborers (USDA 2017). Assuming the average farm wage is $48,100, total farm wages were $88.9 million.

Fishing, Hunting, and Birding/Wildlife Recreation Jobs

The average annual salary per ecotourism job is $32,843 using figures from the 2011 U.S. Fish and Wildlife Service report on fishing-, hunting-, and birding/wildlife-associated recreation (NJDEP 2007). Fishing-, hunting-, birding/wildlife-associated recreation in the New Jersey tributary watersheds accounts for $147.9 million in annual economic activity dollars (USFWS 2016). At an average salary of $32,843, fishing-, hunting-, and birding/wildlife-associated recreation accounts for 4,503 jobs in the New Jersey tributary watersheds (Table 5.5). While this estimate of ecotourism jobs is not exact, it provides a reasonable estimate of the jobs provided by fishing-, hunting-, and birding/wildlife-associated recreation in the New Jersey tributary watersheds (Table 5.6).

Table 5.5. Jobs from fishing, hunting, wildlife/birding recreation in the New Jersey tributary watersheds

Recreation Activity	New Jersey[1] ($ mil)	NJ Tributary Watershed[2] ($ mil)	Jobs[3]
Fishing	**752.3**	**77.5**	**2,360**
Trip Related	471.2	48.5	
Equipment/other	281.1	29.0	
Hunting	**145.9**	**15.0**	**457**
Trip Related	72.6	7.5	
Equipment/other	73.3	7.5	
Wildlife/Birding	**537.4**	**55.4**	**1,687**
Trip Related	146.3	15.1	
Equipment/other	391.1	40.3	
Total	**1,435.6**	**147.9**	**4,503**

1. USFWS 2016. 2. Scaled by ratio of New Jersey tributary watershed area to New Jersey land area (10.3%). 3. Jobs estimated at $32,843 average salary.

Outdoor Recreation

The Outdoor Industry Association (2016) concluded that 4.7 million people participated in watershed-based recreation activities such as bicycling, camping, fishing, hunting, paddling, hiking, and wildlife viewing in New Jersey, and these activities contributed 335,000 jobs. Given that the population of New Jersey is 8.9 million, by proportion outdoor recreation activity in the New Jersey tributary watersheds (population 282,773) supports 10,720 jobs (Table 5.6).

Table 5.6. Outdoor recreation jobs in the New Jersey tributary watersheds

Recreation[1]	New Jersey[2]	NJ Tributary Watersheds[3]
Bicycling	--	--
Camping	--	--
Fishing	--	--
Hunting	--	--
Paddling	--	--
Hiking	--	--
Wildlife viewing	--	--
Total	**335,000**	**10,720**

1. Values for individual categories were not readily disaggregated, so only overall values are shown.
2. OIA 2016. 3. Scaled by ratio (3.2%) of the NJ tributary watersheds population to New Jersey state population.

State Parks

New Jersey has 50 state parks, forests, and historic sites that cover 422,000 acres (659 square miles). According to NJDEP (Mates and Reyes 2006), from 2000 to 2005 the New Jersey state park and forest system generated a central estimate of $21 per visit, welcomed 14.2 million visitors per year, and supported 7,000 jobs. Washington's Crossing State Park, Allamuchy State Park, Stephens State Park, Lake Hopatcong State Park, Worthington State Forest, Jenny Jump State Forest, Stokes State Forest, High Point State Park, Kittatinny Valley State Park, and Bulls Island Recreation Area cover 62,374 acres in the New Jersey tributary watersheds. Scaling by proportion of state park in the watersheds to total state park area in New Jersey (62,374 acres /422,000 acres or 14.8%), the state parks and forests in the watersheds support 1,036 jobs.

National Parks

Cullinane, Flyr, and Koontz (2022) from the National Park Service estimated in 2021 the Delaware Water Gap National Recreation Area hosted 4,340,902 park visits with visitor spending of $163,399,000 that supported 2,290 jobs with $108 million in wages.

Watershed Organization Jobs

Nine nonprofit watershed/environmental organizations employ 45 staff to work on programs to protect the New Jersey tributary watersheds (Table 5.7). Assuming the average salary is $48,000/person in a watershed organization, these jobs account for $2.2 million in annual wages.

Table 5.7. Watershed organization jobs in the New Jersey tributary watersheds

Watershed Organization	Jobs	Wages ($)
Delaware River Greenway Partnership	10	480,000
Foodshed Alliance	5	240,000
Highlands Coalition	5	240,000
Hunterdon Land Trust	5	240,000
Land Conservancy of New Jersey	2	96,000
Musconetcong Watershed Association	10	480,000
New Jersey School of Conservation	2	96,000
NJ Audubon, Wattles Center	3	144,000
Walkill River Management Group	3	144,000
NJ Tributary Watersheds	**45**	**2,160,000**

Craft Breweries

Craft brewing is a growing water-based enterprise in the New Jersey tributary watersheds where 10 businesses employ 36 people with wages of $1.4 million at an average salary of $40,000 (Table 5.8).

Table 5.8. Craft brewery jobs in the New Jersey tributary watersheds

Craft Brewery	Location	County	Jobs	Wages ($)
River Horse Brewing Co.	Ewing	Mercer	5	200,000
Odd Bird Brewing	Stockton	Hunterdon	4	160,000
Descendants Brewing Co.	Milford	Hunterdon	4	160,000
Invertase Brewing Co.	Phillipsburg	Warren	3	120,000
Buttzville Brewing Co.	Washington	Warren	3	120,000
Czig Meister Brewing	Hackettstown	Warren	3	120,000
Manskirt Brewing	Hackettstown	Warren	3	120,000
Jersey Girl Brewing	Budd Lake	Warren	3	120,000
Buckhill Brewing	Blairstown	Sussex	4	160,000
Angry Erik Brewing	Newton	Sussex	4	160,000
NJ Tributary Watersheds			**36**	**1,440,000**

Wineries

Wineries are a significant water-based sector in the New Jersey tributary watersheds where 11 vineyards employ 34 people with wages of $1.4 million at an average salary of $40,000 (Table 5.9).

Table 5.9. Winery jobs and wages in the New Jersey tributary watersheds

Winery	Location	County	Jobs	Wages ($)
Angelico Winery	Lambertville	Mercer	3	120,000
Tamosello Winery	Lambertville	Mercer	4	160,000
Alba Vineyard	Milford	Hunterdon	4	160,000
Villa Minagro Vineyards	Reigelsville	Hunterdon	2	80,000
Mt. Salem Vineyards	Pittstown	Hunterdon	4	160,000
Beneduce Vineyards	Franklin	Hunterdon	2	80,000
Federal Twist Vineyard	Stockton	Hunterdon	2	80,000
Four Sisters Winery	Belvidere	Warren	5	200,000
Little Ridge Vineyards	Phillipsburg	Warren	2	80,000
Brook Hollow Winery	Portland	Sussex	3	120,000
Adams Vineyard	Columbia	Sussex	3	120,000
NJ Tributary Watersheds			**34**	**1,360,000**

Fishing Tackle/Outfitting

Eleven fishing tackle and recreation outfitter businesses in the New Jersey tributary watersheds employ 27 people with wages of $1.1 million at an average salary of $40,000 (Table 5.10).

Table 5.10. Fishing tackle/recreation outfitting jobs in the New Jersey tributary watersheds

Outfitter	Location	County	Jobs	Wages ($)
Big Bear Gear	Lambertville	Hunterdon	2	80,000
Skips Outdoors	Stockton	Hunterdon	3	120,000
Old Man River Bait and Tackle	Milford	Hunterdon	2	80,000
Owls Nest	Pohatcong	Warren	2	80,000
Paddlers Cove	Washington	Warren	3	120,000
Jumbos Bait and Tackle	Hackettstown	Warren	3	120,000
Bait and Tackle Ship's Store	Lake Hopatcong	Sussex	2	80,000
Andover Hunt and Fish	Andover	Sussex	4	160,000
Golden Stone Outfitters	Sparta	Sussex	2	80,000
Keitech USA	Branchville	Sussex	2	80,000
Stoke Forest Sports Shop	Layton	Sussex	2	80,000
NJ Tributary Watersheds			**27**	**1,080,000**

Water Purveyor Jobs

Public/private water utilities withdraw 69 million gallons per day of drinking water from surface and groundwater supplies in Mercer, Hunterdon, Morris, Warren, and Sussex Counties. The American Water Works Association indicates the salary of a water system employee is $55,407.

Water utilities in the New Jersey tributary watersheds support 85 jobs with annual wages of $4.7 million (Table 5.11).

Table 5.11. Water-utility-related jobs and wages in the New Jersey tributary watersheds

Water Utility	Supply (mgd)	Jobs	Wages ($)
NJ American Water	39.37	40	2,216,280
Trenton	26.10	30	1,662,210
Hackettstown MUA	2.57	10	554,070
NJ American Oxford	1.20	5	277,035
NJ Tributary Watersheds	**69.24**	**85**	**4,709,595**

Wastewater Utility Jobs

Five wastewater utilities employ 38 staff with wages of $1.9 million at wastewater treatment facilities with a capacity of 38.4 million gallons per day in the New Jersey tributary watersheds (Table 5.12).

Table 5.12. Wastewater utility related jobs and wages in the New Jersey tributary watersheds

Wastewater Utility	Location	Flow[1] (mgd)	Jobs	Wages ($)
Hackettstown MUA	Hackettstown	3.3	10	500,000
Lambertville City Sewer Auth.	Lambertville	1.5	5	250,000
Musconetcong Sewerage Authority	Budd Lake	4.3	8	400,000
Newton Town DPW	Newton	1.4	5	250,000
Phillipsburg Town STP	Phillipsburg	3.5	10	500,000
NJ Tributary Watersheds		**14**	**38**	**1,900,000**

Chapter 6. Economic Survey Research

Overview

In collaboration with the Musconetcong Watershed Association (MWA) staff and volunteers, the University of Delaware Water Resources Center (UDWRC) carried out survey-based interviews to collect primary economic data related to the use of various watershed resources. Over an eight-month period from May to December 2022, 200 survey responses were recorded and analyzed from over 40 locations. The survey types included: fishing, general recreation, boating, and hunting. Table 6.1 shows the survey dates with the surveyor name, type of survey, and total effort hours (total hours by all surveyors expended in the course of conducting the surveys.

Table 6.1. Musconetcong River survey dates with surveyor names, survey types, and effort hours

Survey Trip #	Date	Surveyors	Survey Type(s)	Total Effort Hours
1	April 30 & May 1, 2022	Andrew, Nancy, Bill, Doug	Fishing	11.0
2	May 27 & June 4, 2022	Bill, Andrew, Liz & Hayley	Fishing	8.0
3	June 28, 2022	Hayley, Jerry, Andrew	Recreation, Boating	3.0
4	July 15, 2022	Andrew, Jerry, Liz	Recreation, Boating	8.3
5	September 30, 2022	Andrew	Recreation	2.0
6	October 19, 2022	Liz & Lydia, Andrew	Recreation	4.0
7	November 19, 2022	Andrew, Lydia	Recreation	4.0
8	November to December 2022	Alan	Hunting	2.5
				42.8

Over eight separate trips, nine surveyors (see Table 6.2) spent a total of 42.8 effort hours interviewing respondents. The purpose of this economic survey research was to learn how people are using the watershed resources, where they are coming from, and how much money they are spending. The intention of the survey was to understand how people utilize the water-related recreational resources of the Musconetcong Watershed and the direct economic impact of these resources. The dollar values were then generalized and extrapolated across the entire study area to estimate the overall economic impact of recreational activity in the northwest New Jersey tributary watersheds to the Delaware River.

Table 6.2. Musconetcong River surveyors

Surveyor Name
Lydia Franks
Andrew Homsey
Alan Hunt
Jerry Kauffman
Nancy Lawler
Bill McQuaide
Doug O'Malley
Hayley Rost
Liz Shields

Methods

With assistance from the UDWRC, MWA staff scientists developed a series of survey questions and 4" x 6" postcards designed to capture participant responses. These cards varied in design and types of questions based on the target recreational

activity. Each card was numbered to enable tracking and provided brief instructions and contact information, as well as postage so that respondents could return their filled-out postcards by mail. Figure 6.1 shows a sample card (front and back) used in surveying. Cards were produced for each of four recreational activities: fishing (or angling), general recreation (hiking, biking, picnicking, relaxing, etc.), boating, and hunting.

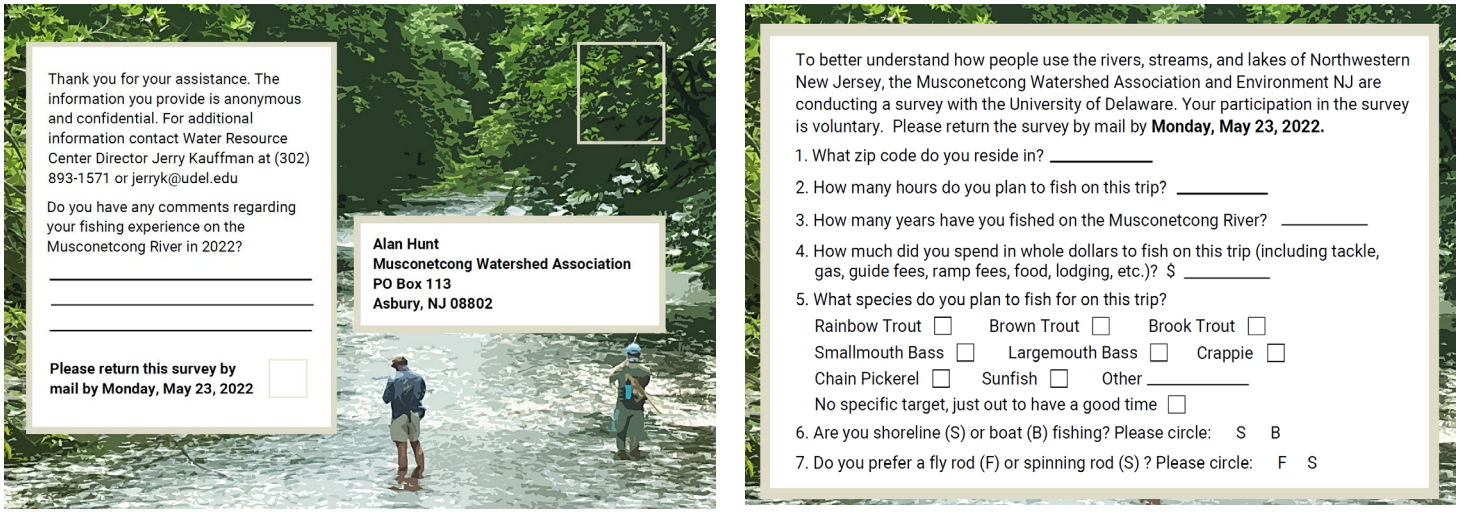


Figure 6.1. Sample Musconetcong River survey card (fishing, front and back)

Key information requested on all cards includes home ZIP Code of respondent, total hours spent (or planned to be spent) on this activity, years active in the Musconetcong Watershed or Merrill Creek Reservoir engaging in this activity, estimated total monetary outlay for this trip, and several questions relating to the details of each activity type. Appendix A presents details on the cards deployed for each activity type, including a list of questions on each and facsimiles of the cards.

For each of three activity types, fishing, general recreation, and boating, researchers from UDWRC as well as MWA staff and volunteers conducted surveys of recreational users in the Musconetcong Watershed and Pohatcong Watershed (i.e., Merrill Creek Reservoir). Surveys were either conducted verbally and filled out by the researcher, left with the respondent to be filled out later and returned by mail, or left on potential respondents' cars to be filled out and returned by mail. In some cases, respondents refused the survey, and this was noted on data sheets. Survey cards were checked out at the start of each survey session, and the numbers were noted for tracking purposes.

Surveyor Name: _____ River: _____ Date: _____

Beginning Quantity of Postcards (e.g. 25): _____ Postcards by Number (e.g. #10-19, #42-47): _____

Postcard Number	Location	Time	Made Contact, but Refused Survey	Completed and Return by Hand	Handed Out but not Returned	Left on Vehicle Windshield
12	Example Access Point	10:10am		X		

Figure 6.2. Sample Musconetcong River field survey tracking sheet

In the field, the time, location, and outcome (verbal interview, left with respondent, left on car, interview refused) of each survey was recorded. Figure 6.2 shows an example of the survey field tracking sheet used by each interviewer.

The fourth survey type, for hunting, was administered exclusively by Alan Hunt, Director of Policy and Grants for the MWA. This was primarily a mail survey, though some surveys were conducted in-person if there were people present at the access point. Postcards were left on hunters' vehicles during the relevant hunting season (primarily deer and duck), for return by mail by each hunter, in November and December of 2022. The hunting survey trip was conducted twice a week by visiting three hunting access points at the Musconetcong Wildlife Management Area, resulting in 10 survey days during November and December 2022.

Survey efforts for each of the seven in-person surveys focused on the major recreational access points along the Musconetcong River and nearby parks and preserves, on the dates indicated in Table 6.1. Figure 6.3 shows the locations of each survey point for all survey trips. Note that all but the survey trip to Merrill Creek Reservoir (in the Pohatcong Creek Watershed) occurred in the Musconetcong Watershed and along the Musconetcong River or its lakes. Appendix A presents a complete inventory of survey sites for each of the seven trips, including location, date, and effort hours.

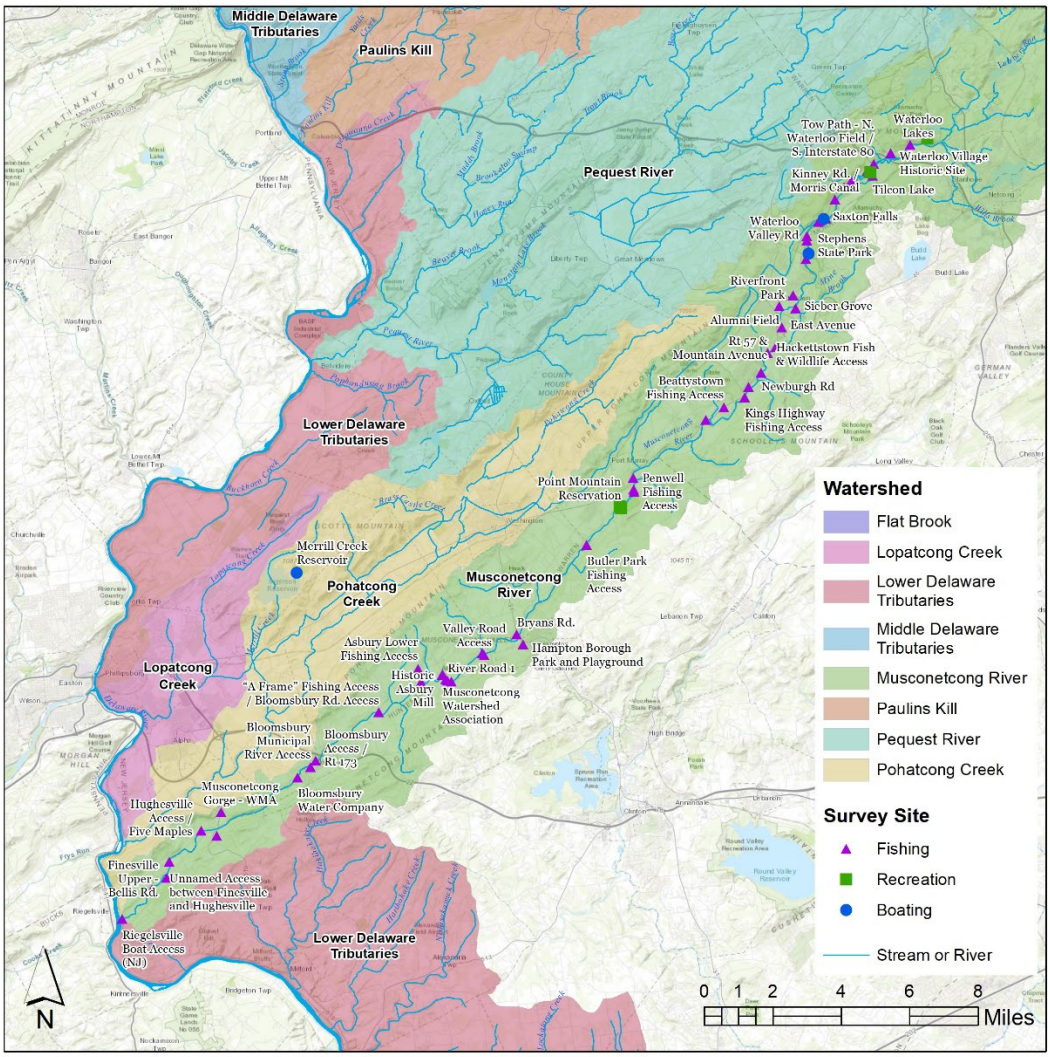


Figure 6.3. Survey locations showing survey type along the Musconetcong River

Once each survey effort was complete UDWRC staff and graduate research assistants compiled the data in spreadsheet format, transcribing the data from collected cards. Cards that were mailed in to the MWA offices were scanned and sent to UDWRC for subsequent inclusion in the data spreadsheets.

Following each survey trip data were added to the sheets. Summary statistics were calculated for each response and combined to produce comprehensive information. Summary statistics for each survey type included mean dollars spent per trip, count of home ZIP Code of respondents, average hours spent by recreational activity, and average number of years respondents have visited the area for recreational purposes.

To determine spending by recreational hunters, cards left on vehicles during the months of November and December 2022 and returned to the MWA were added to the spreadsheets and similar analysis was performed.

Results

In seven survey trips for the three recreational activities: fishing, general recreation, and boating, plus the additional activity of hunting, there were a total of 200 responses. Of those, 96 were angler (fishing) surveys, 82 were for general recreation, 17 for boating, and 5 for hunting. For the purposes of this report, summary data and statistics for the general recreation and boating categories were combined due to the relatively small number of respondents to the boating surveys, resulting in a combined number of recreational and boating responses of 99.

Table 6.3 shows the number of respondents per survey trip and hunting survey, by type of respondent. The table also indicates they type(s) of surveys administered for each trip and/or date. Cells marked with "X" indicate that a survey of that type was conducted for the date indicated.

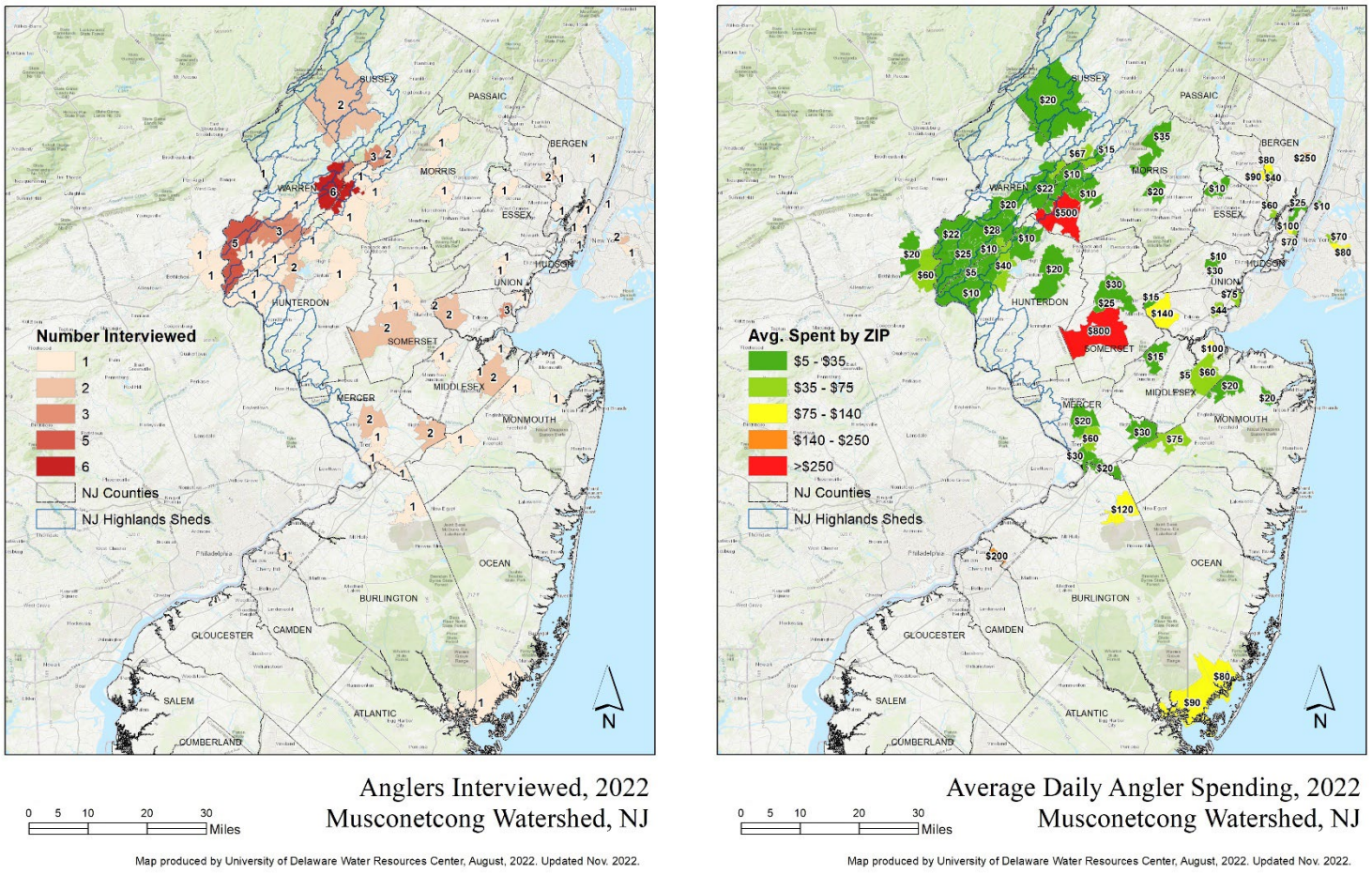
Table 6.3. Musconetcong watershed survey dates showing respondents by survey type

Trip No.	Date	Angler	Recreation	Boat	Hunting	Total
1	1-May-2022	62	-	-	-	62
2	4-Jun-2022	34	-	-	-	34
3	28-Jun-2022	-	20	5	-	25
4	15-Jul-2022	-	6	7	-	13
5	30-Sep-2022	-	11	1	-	12
6	18-Oct-2022	-	25	3	-	28
7	19-Nov-2022	-	20	1	-	21
8	Nov–Dec 2022	-	-	-	5	5
		96	**82**	**17**	**5**	**200**
			Rec. + Boat	**99**		

Home ZIP Codes

By collecting information on the home ZIP Code of each respondent, it is possible to determine sample distribution of users of the recreational resources of the Musconetcong Watershed. The following maps show the locations, to the ZIP Code level, of respondents to the seven in-person surveys (refer to Table 6.1).

Figure 6.4 presents the location (ZIP Code) and number of respondents for the 96 anglers interviewed (left map) and average spending by respondents in a particular ZIP Code. Of all angler respondents, approximately 60% live in ZIP codes outside the New Jersey highlands watersheds study area, while 40% reside within the study area. Those residing outside the study area spent an average of $51 per trip, while those from within the study area spent an average of $75 per trip.



Anglers Interviewed, 2022
Musconetcong Watershed, NJ

Map produced by University of Delaware Water Resources Center, August, 2022. Updated Nov. 2022.

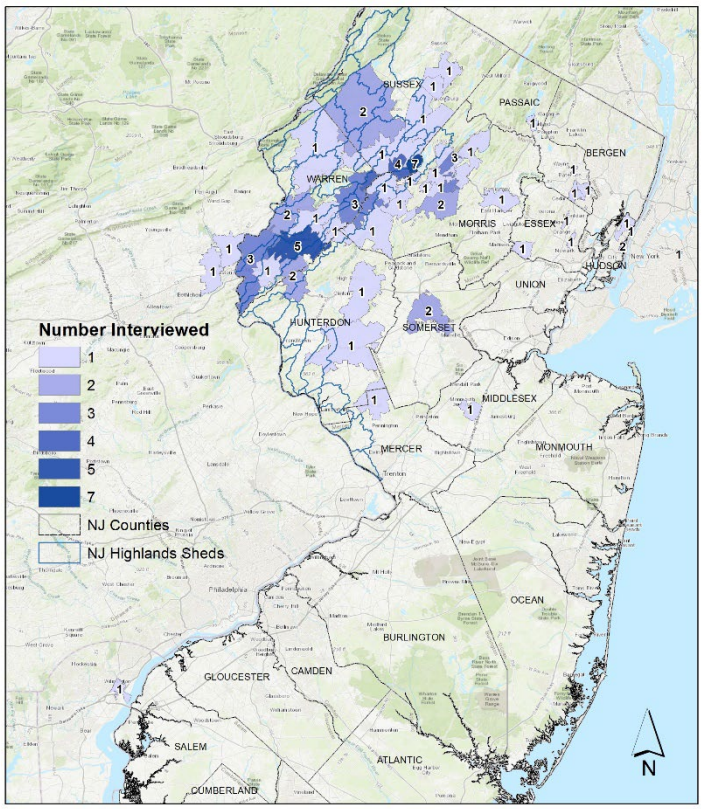
Average Daily Angler Spending, 2022
Musconetcong Watershed, NJ

Map produced by University of Delaware Water Resources Center, August, 2022. Updated Nov. 2022.

Figure 6.4. Home ZIP codes of anglers interviewed in the Musconetcong River Watershed, showing number of respondents per ZIP code and average per-trip spending

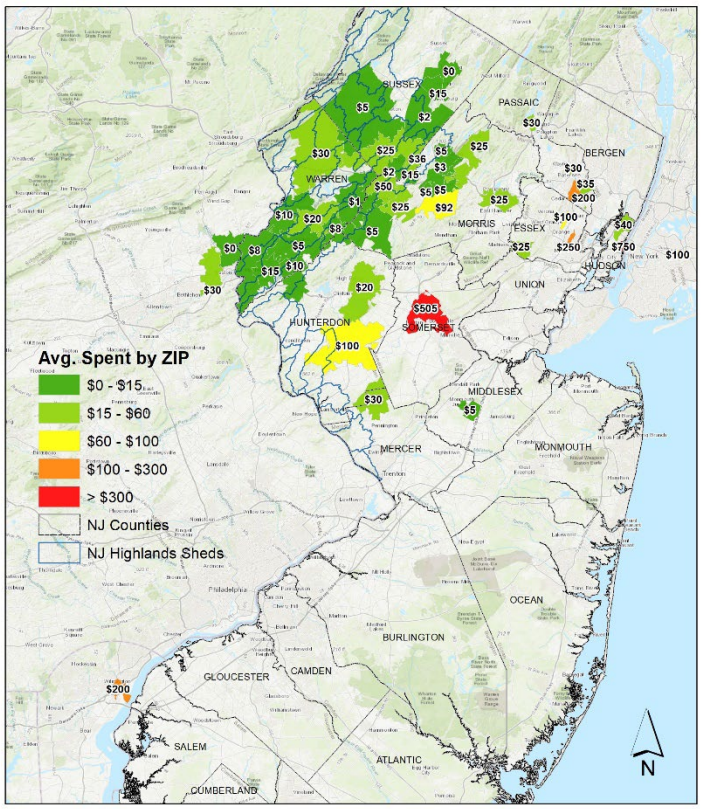
Figure 6.5 shows the location (ZIP Code) and number of respondents for the 99 recreational and boating users interviewed (left map) and average spending by respondents in a particular ZIP Code (right map). Note that for these maps the recreational and boating users were combined due to a small sample size in the number of boaters interviewed. While both maps indicate that the majority of users come from the areas in and immediately surrounding the Musconetcong Watershed, there are many recreational users, particularly anglers, who come from other regions, especially northeast and central New Jersey. While many users report a relatively small amount of money spent per trip, there are exceptions, with most of the higher amount of spending attributable to respondents who traveled from outside the watershed to fish or recreate.

Of the total number of recreational users using the resources of the New Jersey highlands study area, approximately 42% come from outside the study area, while 58% come from within the study area. Users coming from outside spend more on a per trip basis than those who reside within the study area—$97 versus $17 per trip, respectively.



Recreational Visitors Interviewed, 2022
Musconetcong Watershed, NJ

Map produced by University of Delaware Water Resources Center, August, 2022. Updated Nov. 2022.

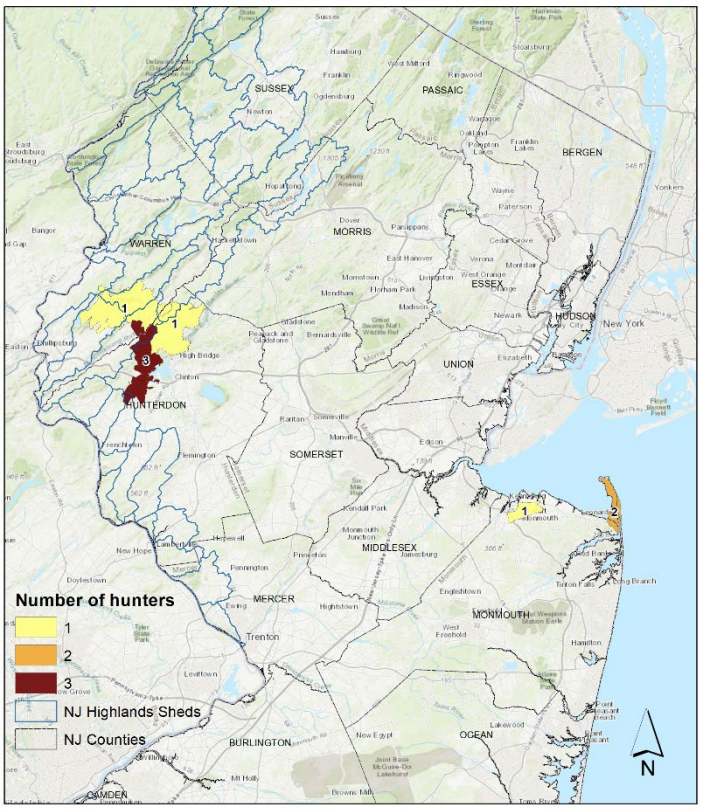


Average Daily Recreational Spending, 2022
Musconetcong Watershed, NJ

Map produced by University of Delaware Water Resources Center, August, 2022. Updated Nov. 2022.

Figure 6.5. Home ZIP codes of recreational (general recreation plus boating) users interviewed in the Musconetcong Watershed and Merrill Creek Reservoir, showing number of respondents per ZIP code and average per-trip spending

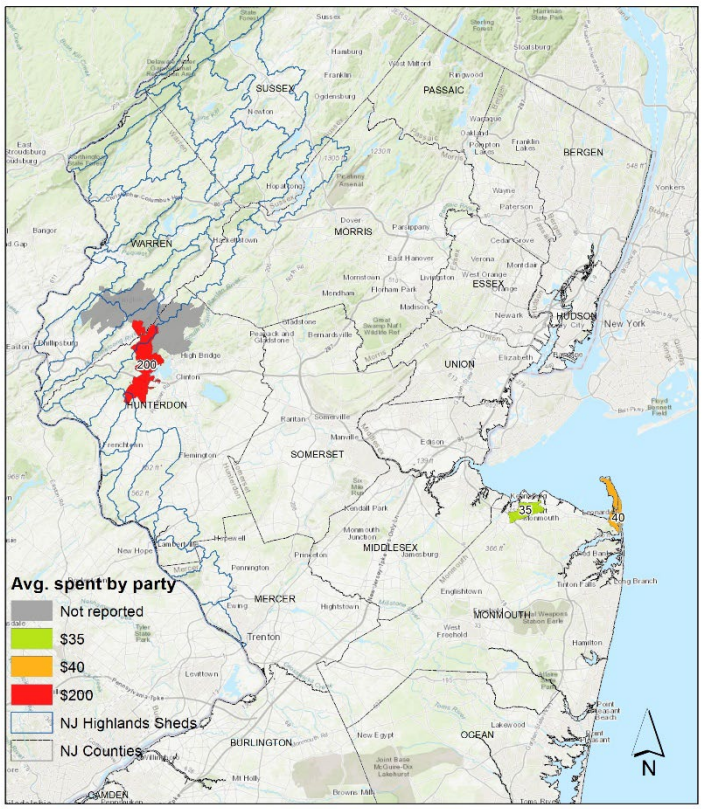
Figure 6.6 shows the home ZIP code locations of each of the respondents to the hunting survey. The map on the left indicates where each of the 8 total hunters in all hunting parties traveled from, and the map on the right shows the average spent by each hunter. Of all hunters who responded, 62% came from within the New Jersey highlands study area, while 38% came from outside. Of those hunters who reported their spending, those from within the study area spent an average of $200, while those coming from outside the study area reported spending an average of $37.



Hunters Interviewed, 2022
Musconetcong Watershed, NJ

0 4 8 16 24 Miles

Map produced by University of Delaware Water Resources Center, August, 2022. Updated Nov. 2022.



Average Daily Hunter Spending, 2022
Musconetcong Watershed, NJ

0 4 8 16 24 Miles

Map produced by University of Delaware Water Resources Center, August, 2022. Updated Nov. 2022.

Figure 6.6. Home ZIP codes of hunters interviewed in the Musconetcong Watershed, showing number of respondents per ZIP code and average per-trip spending

Demographics by New Jersey ZIP Code

Statewide Demographics

To understand the demographic characteristics of the anglers, recreational users, and hunters who use the watersheds of the upper Delaware tributaries (the study area), data based on ZIP Codes in New Jersey were considered. While the study area represents only 3.5% of the total population of the state, it makes up over 12% of the total land area. The map in Figure 6.7 presents the population density, by ZIP Code in the state of New Jersey, showing the relatively low density within the study area, based on the 2020 U.S. Decennial Census.

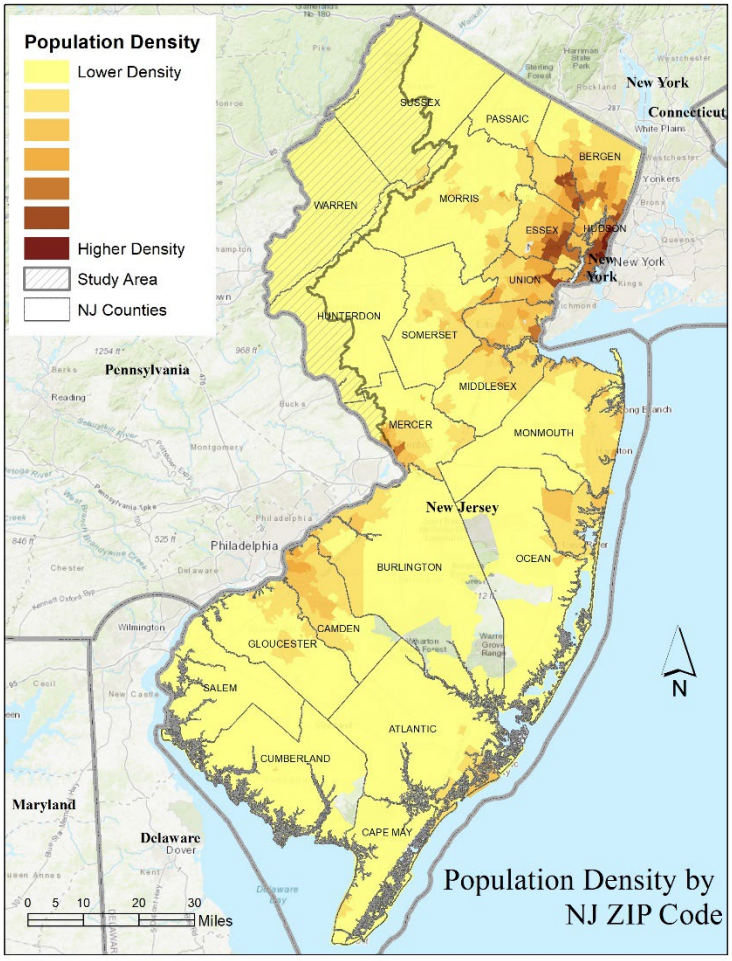
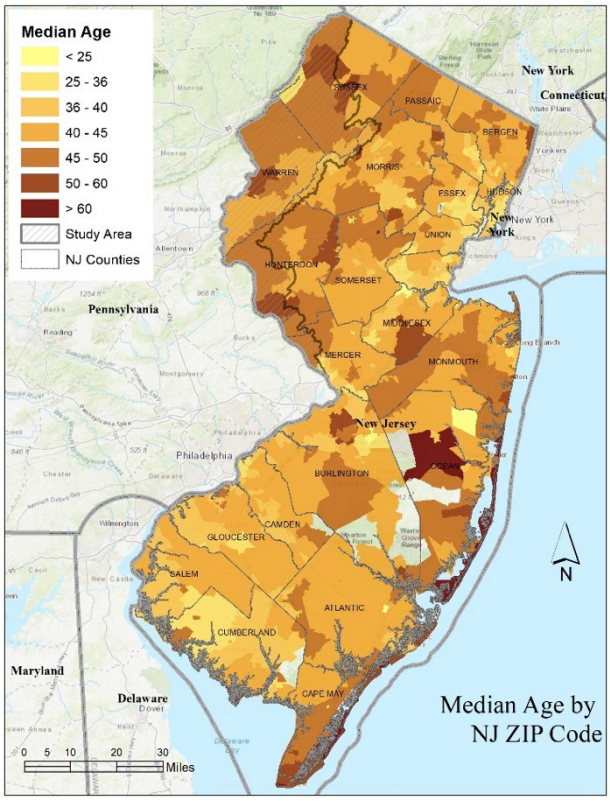
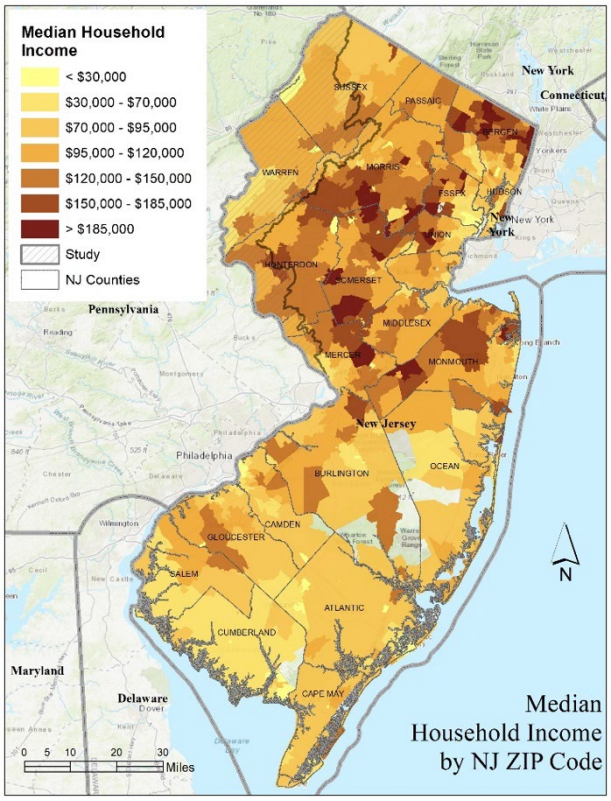
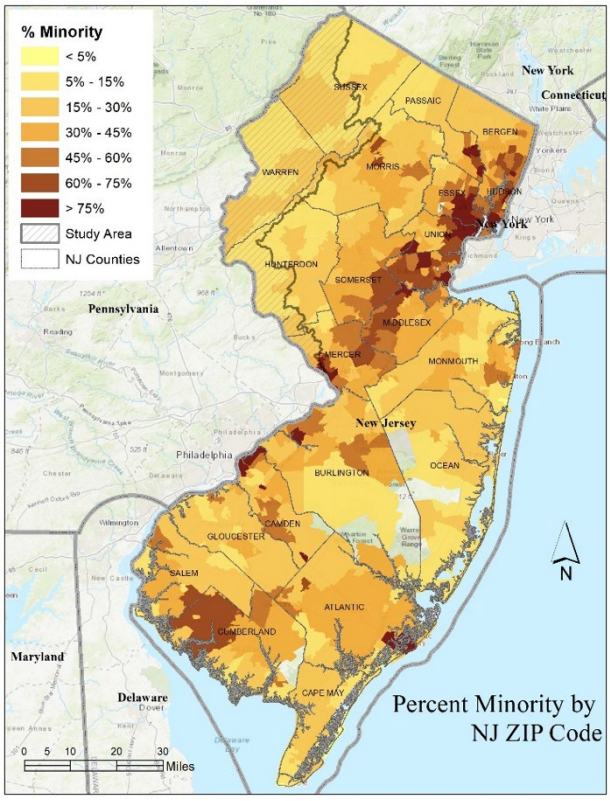


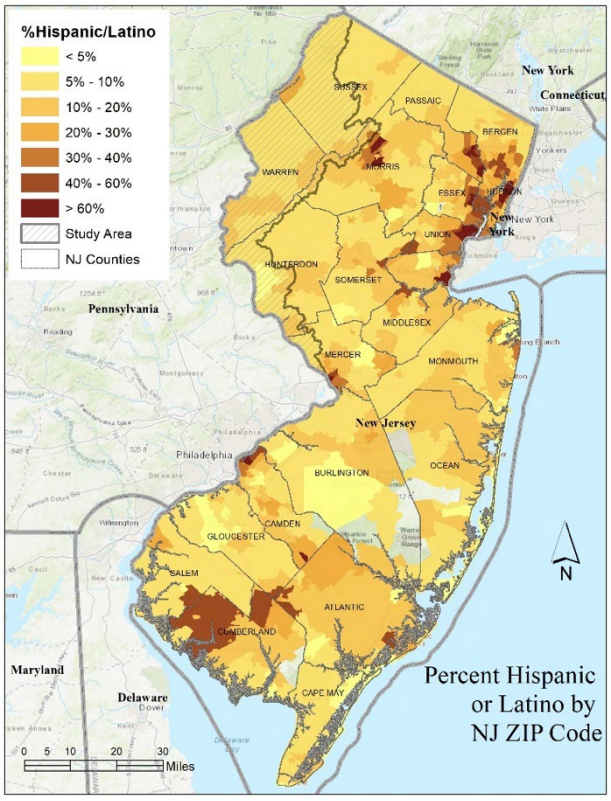
Figure 6.7. Population density in New Jersey, based on 2020 U.S. Decennial Census

Six additional characteristics were considered by New Jersey ZIP Code: median age, percentage minority, percentage Hispanic or Latino population, median household income, average household size, and percent of the population with a 4-year college degree or higher. The first three were derived from the 2020 Decennial Census and the last three from the 2021 American Community Survey 5-year estimates. For the purposes of this study, "minority" was any self-reported race other than "White Alone", which includes anyone who self-reports a heritage of two or more races. The maps in Figure 6.8 present these population metrics for the ZIP Codes of the state of New Jersey.


Median Age
< 25
25 - 36
36 - 40
40 - 45
45 - 50
50 - 60
> 60
Study Area
NJ Counties
Median Age by NJ ZIP Code
Miles


Median Household Income
< $30,000
$30,000 - $70,000
$70,000 - $95,000
$95,000 - $120,000
$120,000 - $150,000
$150,000 - $185,000
> $185,000
Study
NJ Counties
Median Household Income by NJ ZIP Code
Miles


% Minority
< 5%
5% - 15%
15% - 30%
30% - 45%
45% - 60%
60% - 75%
> 75%
Study Area
NJ Counties
Percent Minority by NJ ZIP Code
Miles


%Hispanic/Latino
< 5%
5% - 10%
10% - 20%
20% - 30%
30% - 40%
40% - 60%
> 60%
Study Area
NJ Counties
Percent Hispanic or Latino by NJ ZIP Code
Miles

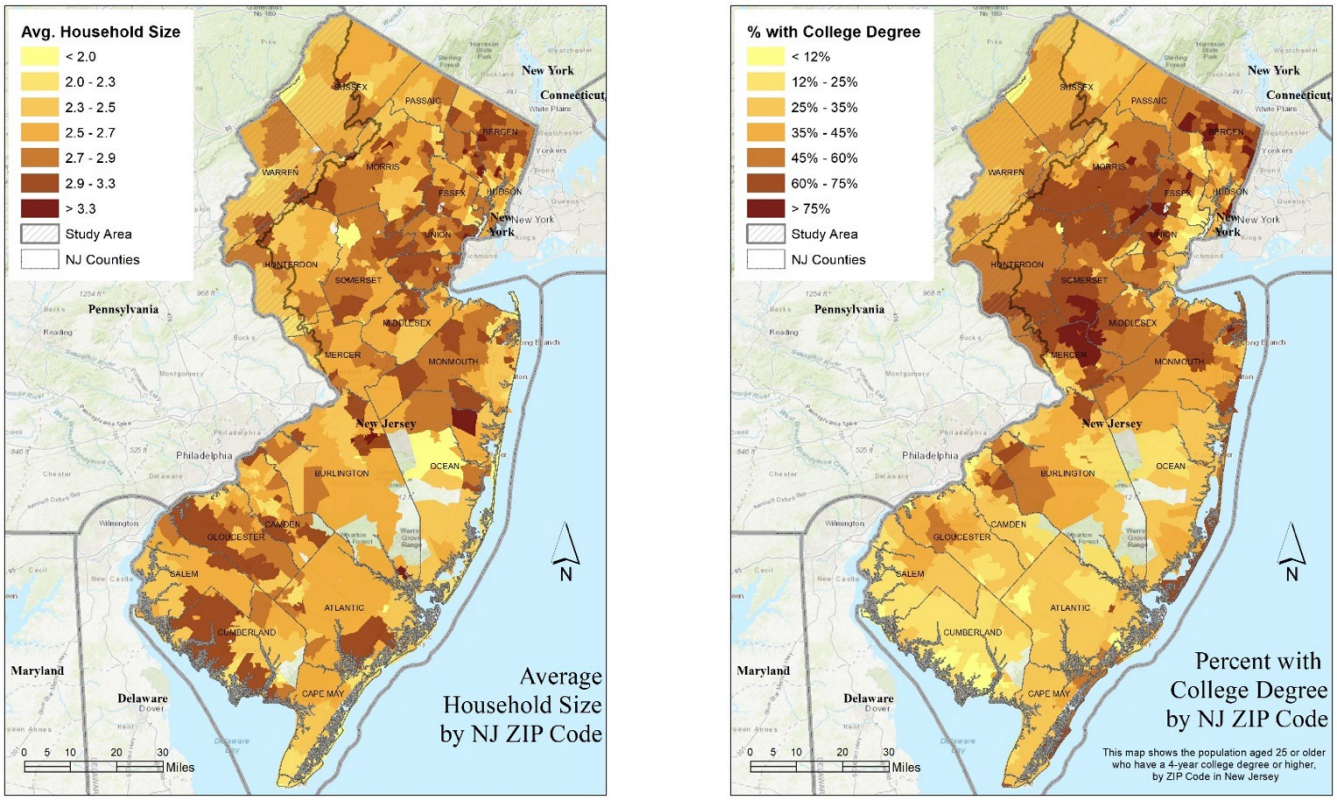


Figure 6.8. Maps of population metrics for the ZIP Codes of New Jersey

The average median age of the population within the study area averages slightly higher than those who live outside the area. For the purposes of this study, ZIP Codes are considered "inside" the study area if any part of the ZIP Code lies within the study area. Median household income is lower for those within the study are, as is average household size. The percentage minority population, percentage Hispanic or Latino population, and percentage with a 4-year college degree or higher is lower inside compared to outside the study area. Table 6.4 summarizes the characteristics for these measures based on ZIP Codes within and outside of the study area for the state of New Jersey.

Table 6.4. Population metrics for New Jersey ZIP Codes within and outside of the study area

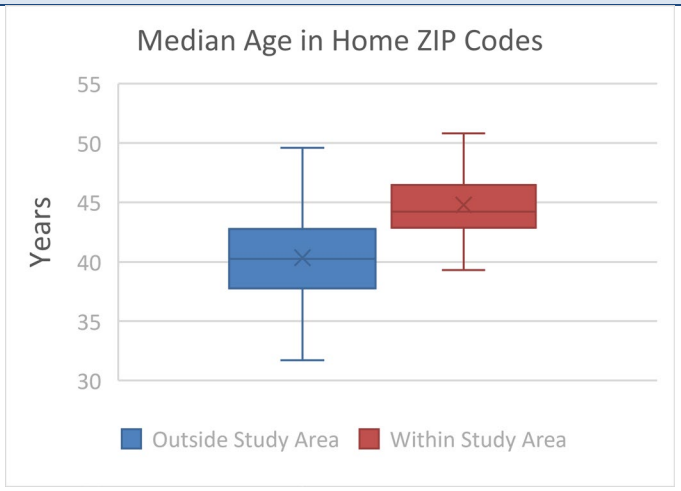
Demographic Metric, by New Jersey ZIP Code	Mean, Within Study Area (n=57)	Mean, Outside Study Area (n=536)
Median Age, Years	44.8	42.5
Median Household Income ($)	$94,389	$100,067
Percent Minority	23%	36%
Percent Hispanic	12%	17%
Average Household Size	2.56	2.66
Percent College Degree or Higher	40%	43%

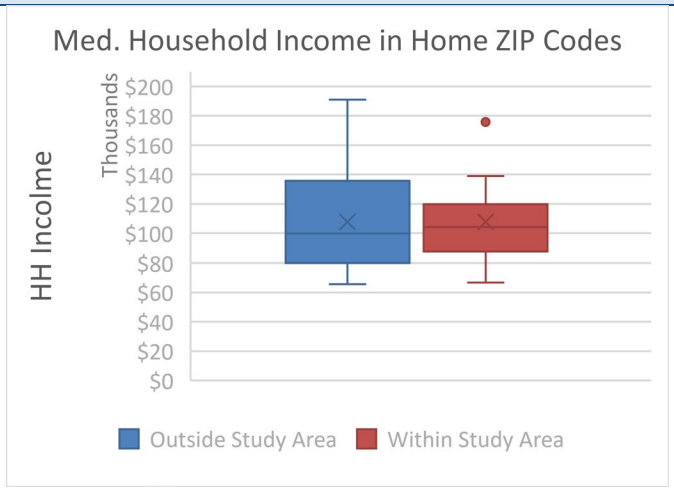
Demographics of Survey Respondents

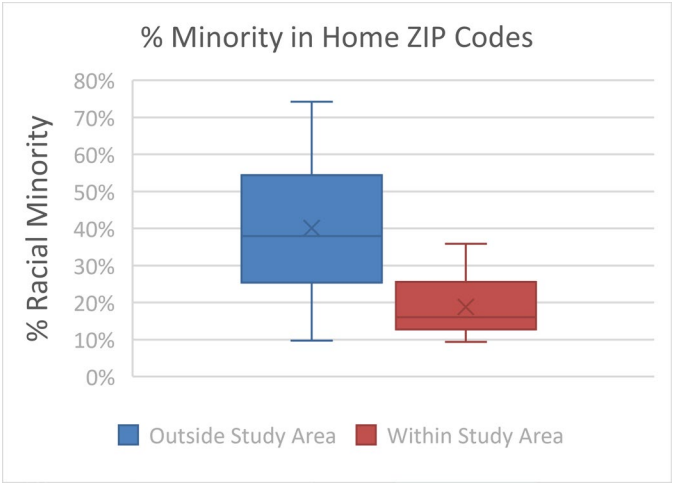
Comparing the underlying demographics for survey respondents (anglers, recreational users, and hunters) can help determine if those characteristics for each group differ based on whether the respondent is coming from within or outside of the study area. Considering each of the demographic measures for two separate groups (those from ZIP Codes within versus outside the study area) allows us to quantify the degree of difference and determine if statistically they are from the same or two distinct populations.

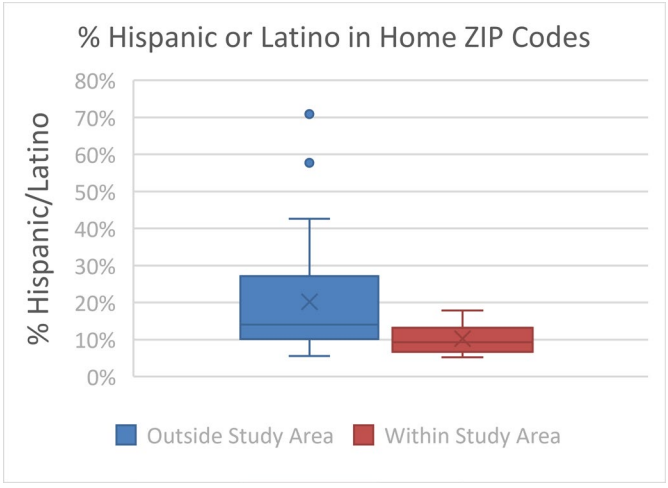
The following graphs show the distribution in each respondent pool, for each of the six demographic characteristics, based on the home ZIP Code of respondents, and whether that ZIP Code is inside or outside of the study area. Metrics consider all residents of each ZIP Code for each characteristic and compare the means between groups (inside v. outside the study area). Figure 6.9 shows the distribution in a box and whisker plot for each characteristic in anglers' home ZIP Codes.

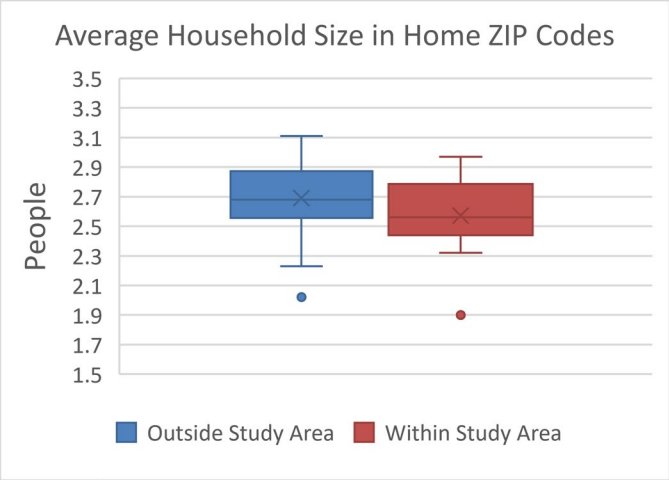
Anglers











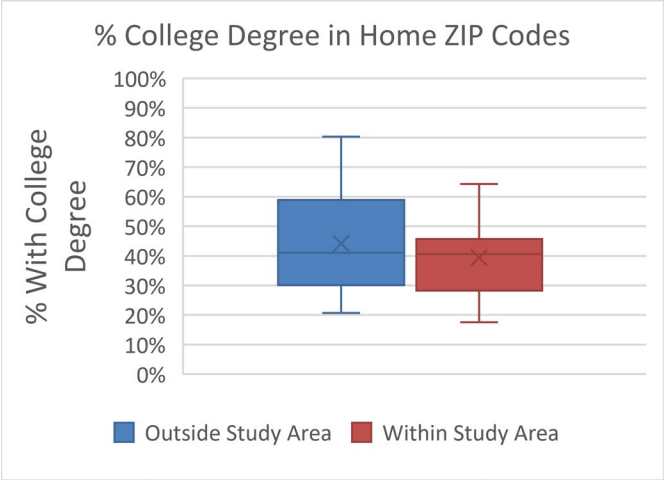


Figure 6.9. Box and whisker plots showing the distribution of demographic characteristics based on whether the ZIP Code is within or outside of study area, for anglers who responded to the survey

Figure 6.10 shows the distribution in the home ZIP Codes of recreational users (including general recreation and boating).

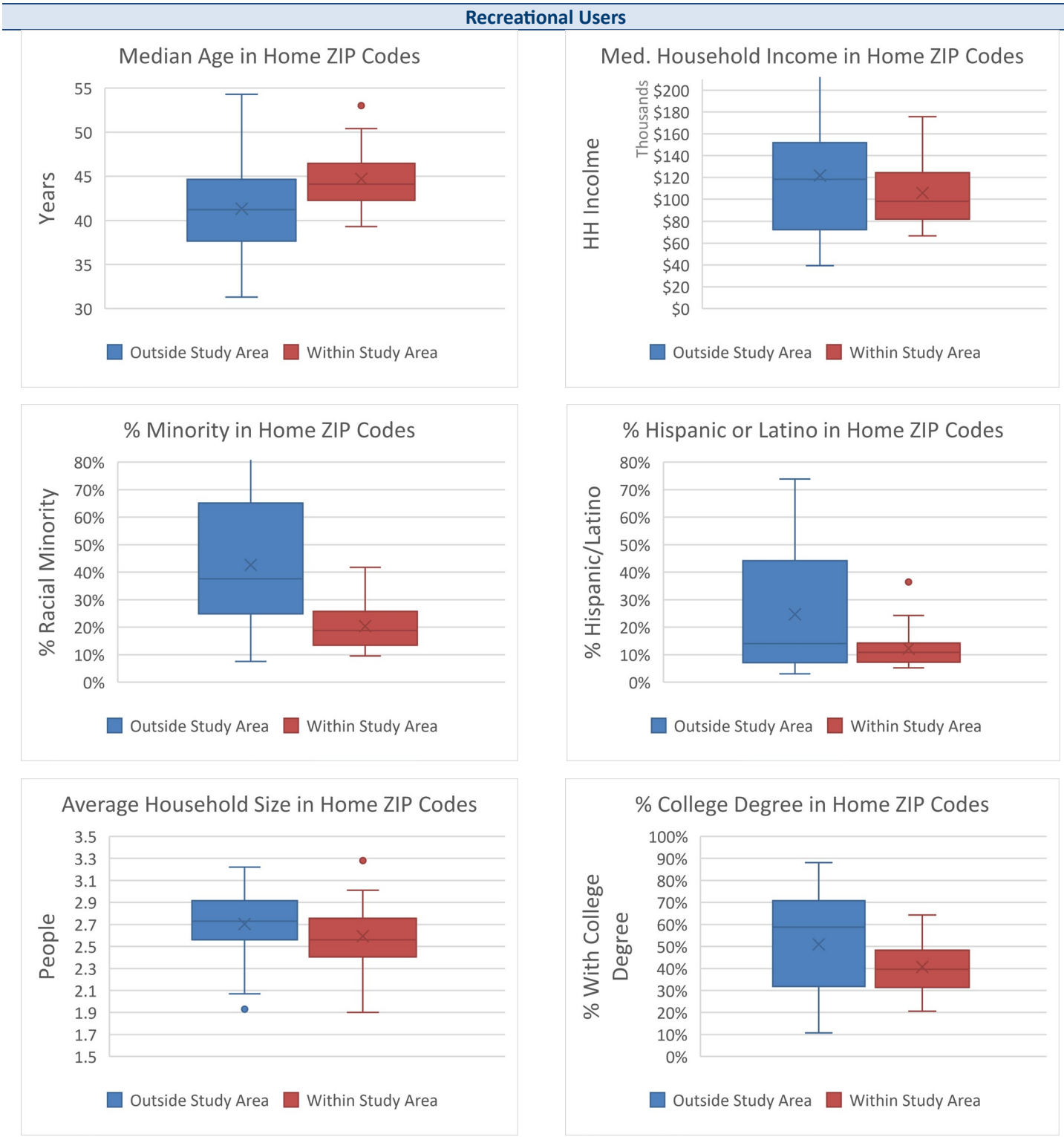


Figure 6.10. Box and whisker plots showing the distribution of demographic characteristics based on whether the ZIP Code is within or outside of the study area, for recreational users who responded to the survey

Figure 6.11 shows the distribution in the home ZIP Codes of hunters.

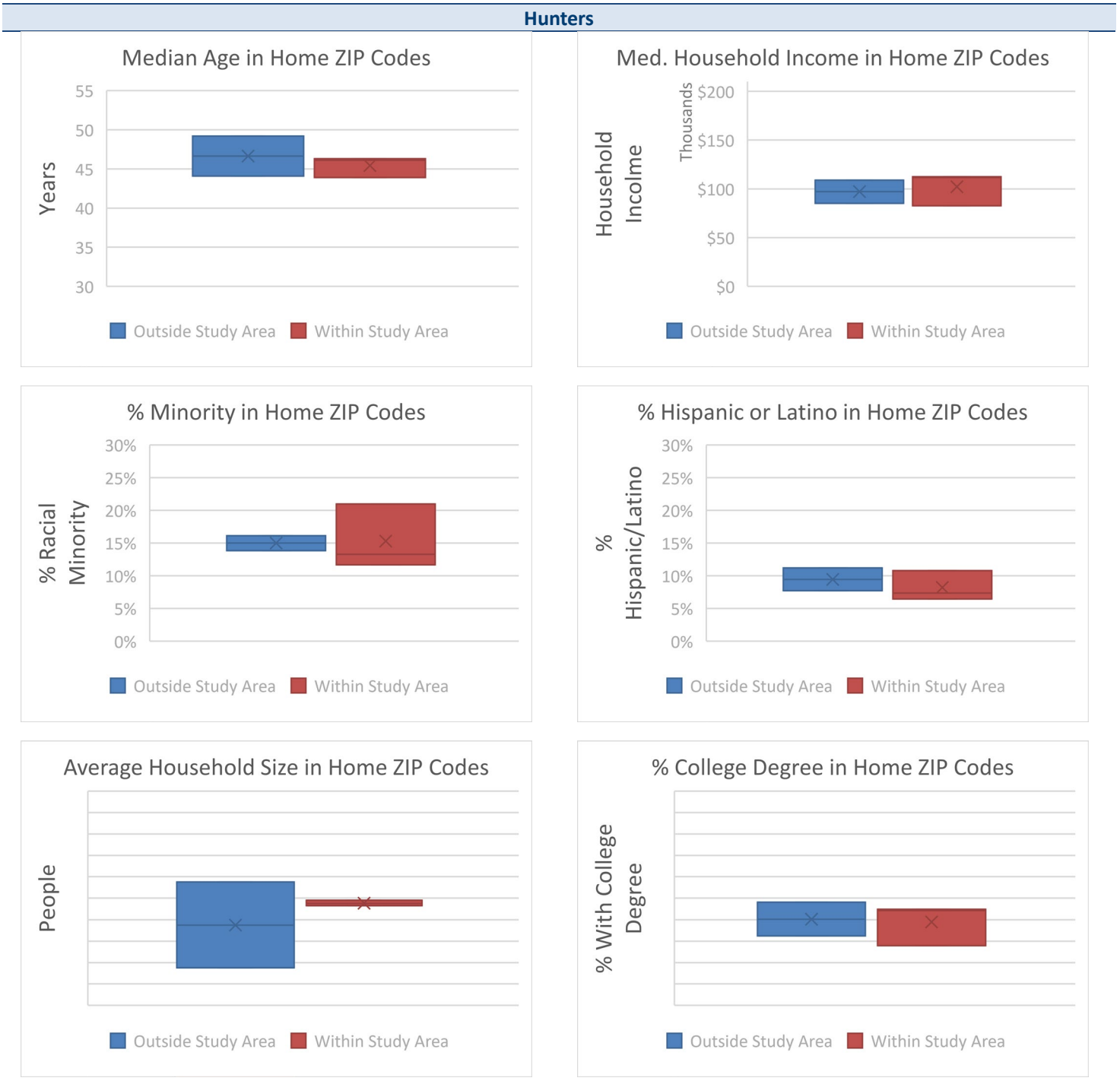


Figure 6.11. Box and whisker plots showing the distribution of demographic characteristics based on whether the ZIP Code is within or outside of the study area, for hunters who responded to the survey

To determine if the differences between the mean values for the demographic metrics show that there is a statistically significant difference between groups, a two-tailed T-test was performed on

each metric.[1] Characteristics of the two groups were tested to determine if their means were statistically the same or different at the 95% confidence level (α=0.05).

Table 6.5 shows the results of the T-test for the home ZIP Codes of the population of anglers. Metrics represent the population within the ZIP Codes where respondents reside. Rows for metrics that were found to be from statistically distinct groups (ZIP Codes within versus outside the study area) at the 95% confidence level are highlighted in green.

Table 6.5. Results of T-test to determine if home ZIP Codes of anglers from within versus outside the study areas are statistically significant

Anglers					
Demographic Metric, by New Jersey ZIP Code	**Mean, Residents of ZIP Codes Within Study Area (n=17)**	**Mean, Residents of ZIP Codes Outside Study Area (n=38)**	**T Score**	**P-Value**	**Significant Difference (Reject Null Hypothesis, α=0.05)**
Median Age	**44.8**	**40.3**	**-4.5906**	**3.98E-05**	**YES**
Median Household Income	$101,436	$107,902	0.62658	0.5360	NO
Percent Minority	**19%**	**40%**	**6.0689**	**1.44E-07**	**YES**
Percent Hispanic	**10%**	**20%**	**3.8399**	**0.0004**	**YES**
Average Household Size	2.6	2.7	1.5431	0.1332	NO
Percent College Degree or Higher	39%	44%	1.2656	0.2124	NO

Table 6.6 shows the results of the T-test for the home ZIP Codes of the population of recreational users, with rows highlighted in green indicating that there is a statistically significant difference between the ZIP Codes within versus outside the study area.

[1] The non-parametric Welch's Two-Sample T-Test was used, which does not assume equal variances between groups.

Table 6.6. Results of T-test to determine if home ZIP Codes of recreational users from within versus outside study areas are statistically significant

Recreational Users					
Demographic Metric, by New Jersey ZIP Code	**Mean, Residents of ZIP Codes Within Study Area (n=25)**	**Mean, Residents of ZIP Codes Outside Study Area (n=25)**	**T Score**	**P-Value**	**Significant Difference (Reject Null Hypothesis, α=0.05)**
Median Age	**44.7**	**41.3**	**-2.6302**	**0.0122**	**YES**
Median Household Income	$105,804	$121,714	1.2937	0.2043	NO
Percent Minority	**20%**	**43%**	**4.3697**	**1.41E-04**	**YES**
Percent Hispanic	**12%**	**25%**	**2.5312**	**0.0173**	**YES**
Average Household Size	2.6	2.7	1.2297	0.2248	NO
Percent College Degree or Higher	41%	51%	1.9503	0.0592	NO

Table 6.7 shows the results of the T-test for the home ZIP Codes of the population of hunters. Due in part to the small sample size, there was no statistical difference found between the ZIP Codes of hunters living within versus outside of the study area.

Table 6.7. Results of T-test to determine if home ZIP Codes of hunters from within versus outside study areas are statistically significant

Hunters					
Demographic Metric, by New Jersey ZIP Code	**Mean, Residents of ZIP Codes Within Study Area (n=3)**	**Mean, Residents of ZIP Codes Outside Study Area (n=2)**	**T Score**	**P-Value**	**Significant Difference (Reject Null Hypothesis, α=0.05)**
Median Age	45.4	46.7	0.4568	0.7174	NO
Median Household Income	$102,249	$97,129	-0.3326	0.7674	NO
Percent Minority	15%	15%	-0.1054	0.9238	NO
Percent Hispanic	8%	9%	0.5746	0.6202	NO
Average Household Size	2.5	2.3	-0.5080	0.7006	NO
Percent College Degree or Higher	39%	40%	0.1366	0.9038	NO

Based on the T-test, mean values in ZIP Codes for anglers and recreational users from within versus outside the study area *were* statistically different for median age, percent minority, and percent Hispanic/Latino, and *were not* different for median household income, average household size, and percent college degree or higher. The sample of hunters was small (n=8), and consequently there

was no statistical difference in metrics between the ZIP Codes of those who reside within versus outside of the study area.

Respondent Summary Metrics

For each respondent, information on the amount of time spent per trip, the number of years engaged in similar recreational activity, and the total amount spent on the current trip was recorded and summarized. Refer to Table 6.3 for reference dates for each type of survey and number of respondents. For the purposes of this section, the general recreation and boating categories were combined into a single category.

Anglers

Figure 6.12 shows the number of hours per trip reported by all anglers during the survey period. Most anglers spent less than 5 hours per trip, with the most (24) spending between 3 and 4 hours. The average trip length was 4.2 hours. Figure 6.8 shows the number of years each angler reported coming to the Musconetcong River to fish. Most anglers (39) reported having visited 5 years or less, with the next highest category being between 5 and 10 years (14). On average, anglers reported having fished the Musconetcong for 16.3 years. Most anglers (37) reported spending less than $25 per trip, with the next most (22) spending between $25 and $50. Only 5 anglers reported spending over $200 for their trip (see Figure 6.14). Figure 6.15 shows the average amount spent fishing in the Musconetcong River by number of years anglers had fished the region. The average amount spent by anglers per trip overall was $57.

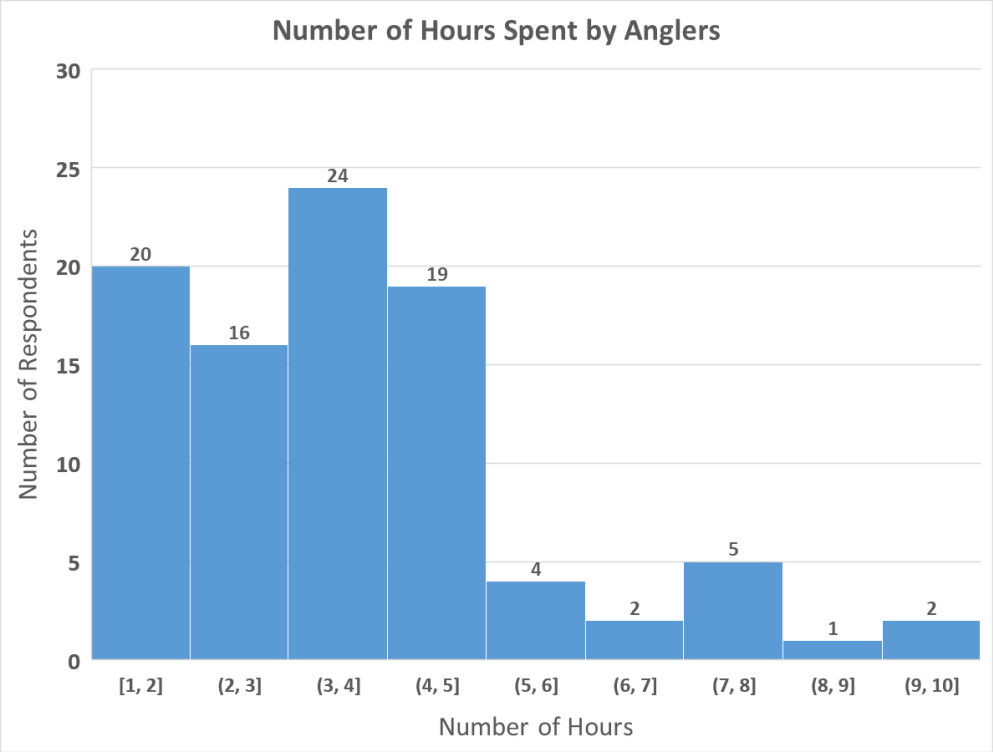


Figure 6.12. Number of hours reported spent by anglers on the Musconetcong River.

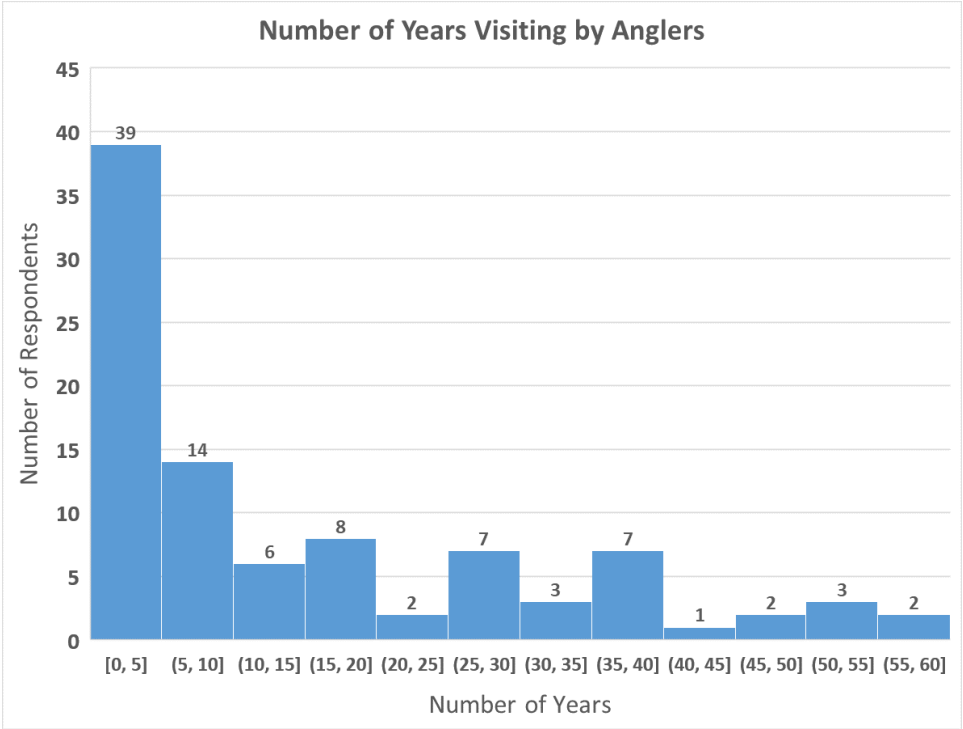


Figure 6.13. Number of years reported visiting by anglers on the Musconetcong River

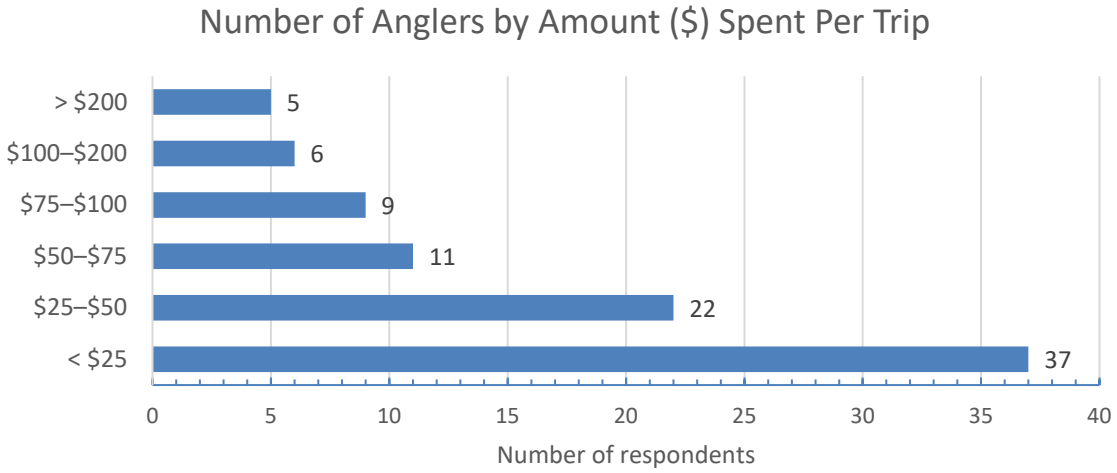


Figure 6.14. Reported spending per trip by anglers on the Musconetcong River

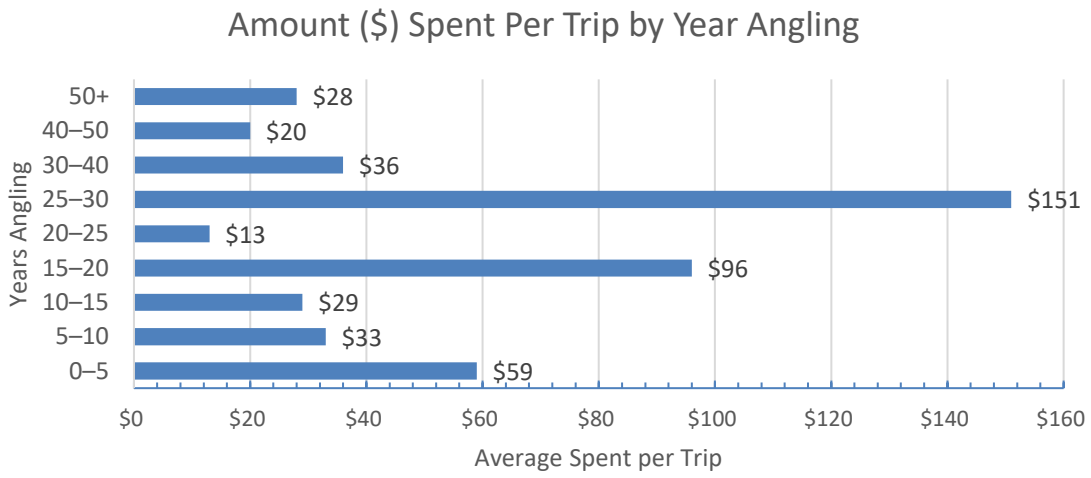


Figure 6.15. Average reported spending per trip by number of years angling in the region

The Musconetcong River is stocked in the spring, primarily with rainbow trout. Therefore, most of the angling survey work was conducted in the weeks following the stocking efforts. The following chart (Figure 6.16) shows the species that were reported as targeted by respondents.

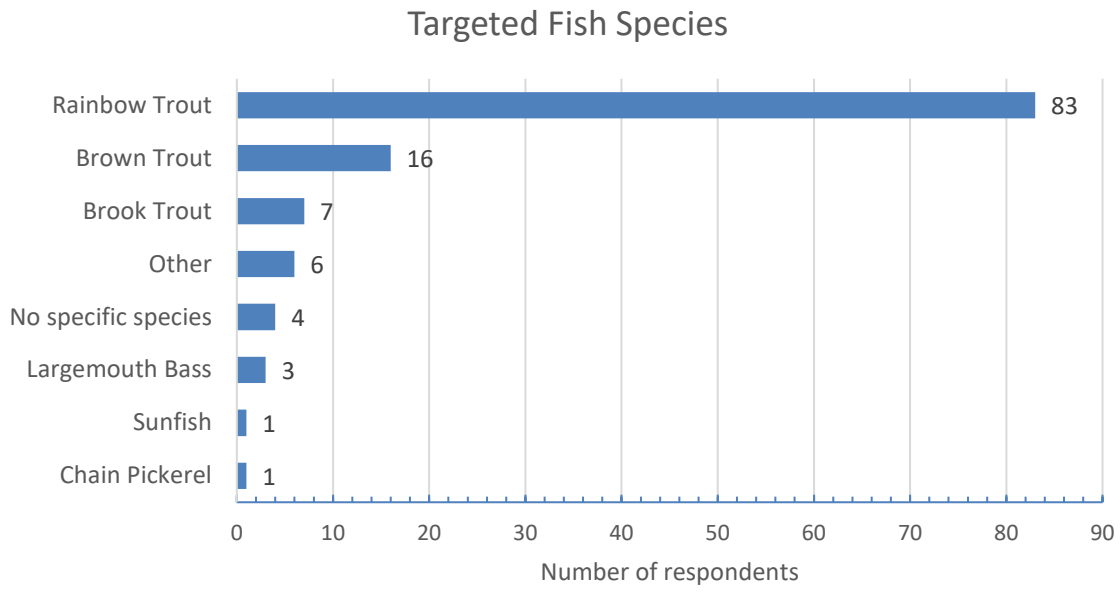


Figure 6.16. Targeted fish species by anglers surveyed on the Musconetcong River

Most anglers (96%) fished from the shore, as opposed to in a boat, either standing on land or wading, and most (79%) used a spinning reel as opposed to a fly rod. See Figure 6.17 for the proportions of each type of fishing.

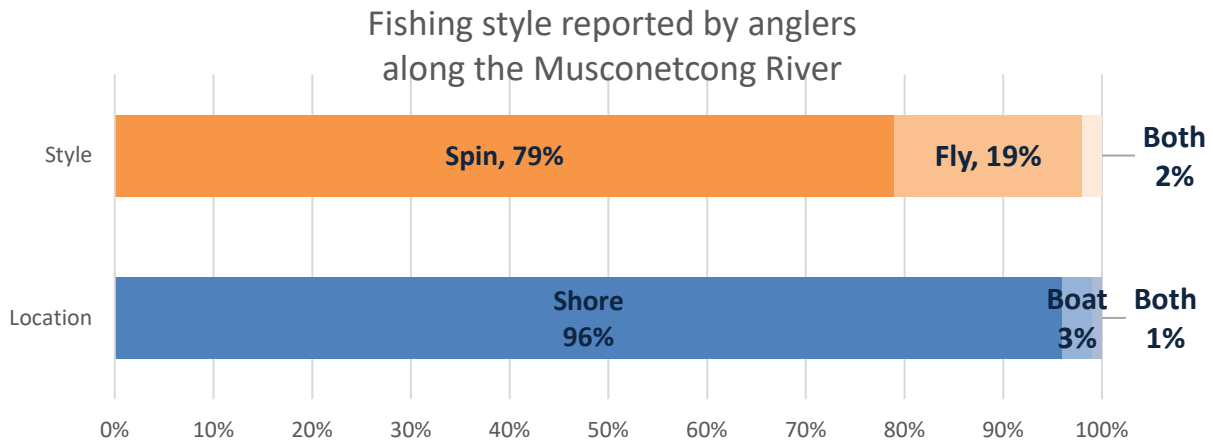


Figure 6.17. Fishing style reported by anglers along the Musconetcong River

Recreational Users

Most recreational users (56), including those engaged in general recreation and boating activities, spent less than two hours on their trip, with 23 spending more than two hours but less than 3.5 hours, for an average of 2.7 hours. Very few spent all or most of the day in recreational activities (see Figure 6.18).

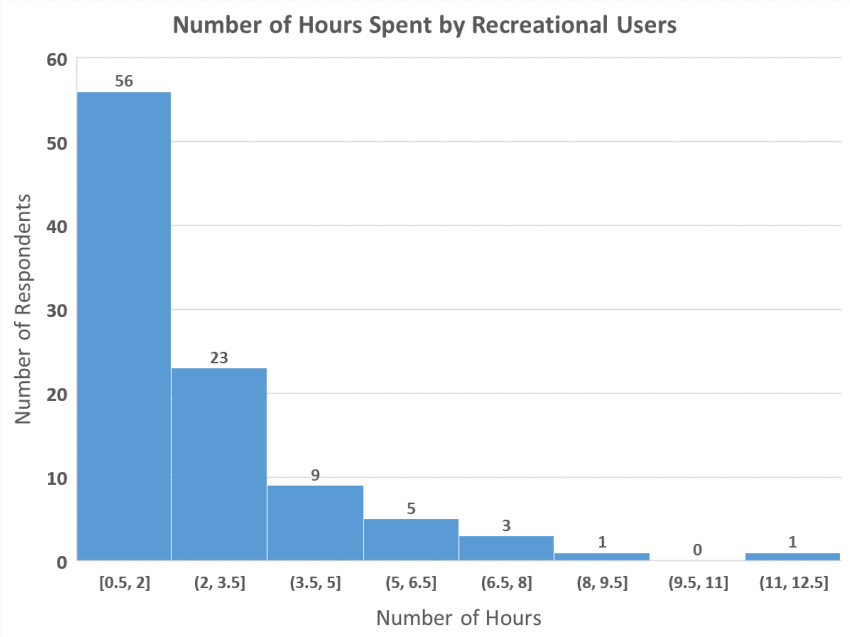


Figure 6.18. Number of hours reported spent by recreational users on the Musconetcong River

Figure 6.19 shows the number of years respondents reported visiting the Musconetcong watershed for recreational purposes. Most (53) reported having come to recreate less than 5 years, with a few indicating they had been coming all or most of their lives. The average number of years visiting for recreation and boating was 11.4 years.

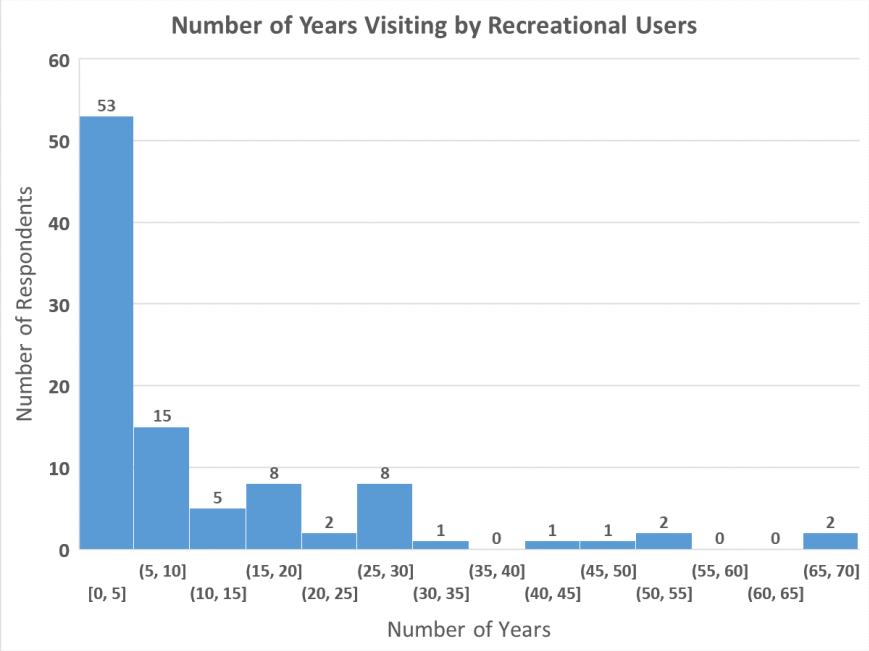


Figure 6.19. Number of years active by recreational users on the Musconetcong River

The majority of respondents (60) spent less than $25 for the day, with fewer spending more. However, 11 respondents reported spending over $200 for their recreational activities (Figure 6.20). The average spending per trip overall was $62.

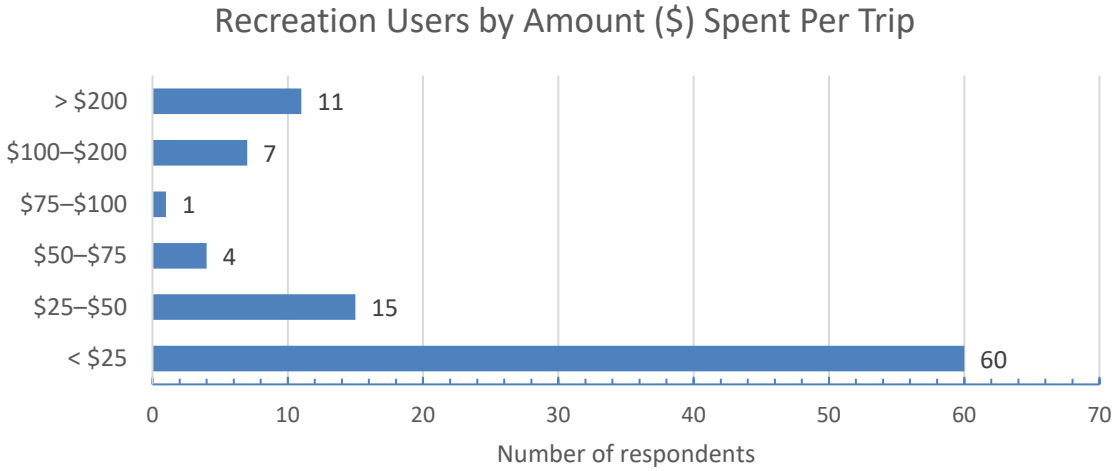


Figure 6.20. Reported spending by recreational users on the Musconetcong River

Table 6.8 presents metrics including average spending, total hours spent recreating, and number of years visiting for both the recreational and the boating surveys.

Table 6.8. Spending, time spent, recreational users, boaters on the Musconetcong River

Metric	Recreation	Boating	Recreation & Boat
Respondents	82	17	99
Avg. Spending	$46.39	$137.82	$62.09
Avg. Hours	2.5	3.8	2.7
Avg. Years	10.7	15.2	11.4

General recreation constitutes a wide range of activities, including walking/hiking, cycling, climbing, picnicking, bird watching, other wildlife viewing, and possibly other types of activities. Activities reported in the "Other" category included: botany, kids' programs, sunbathing, sitting, dog walking/pets, swimming, photography, running, educational program, and relaxing. The following figure (Figure 6.21) shows the proportions of each type of activity reported by recreational users of the Musconetcong Watershed. More than half (51%) of respondents report hiking/walking as their primary activity followed by wildlife watching (bird watching and other wildlife observation) next with 16% of respondents reporting this.

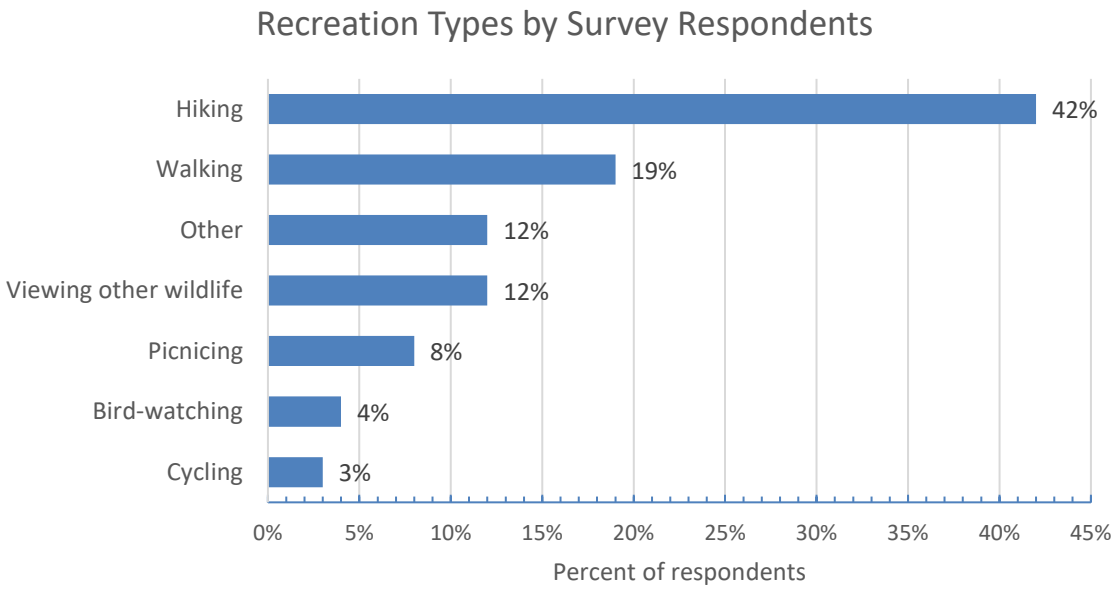


Figure 6.21. Recreation types by proportion of respondents in the Musconetcong Watershed

Boaters

There were fewer respondents (17 total) to the boating surveys than for either angler surveys or general recreation surveys. Potential activities related to boating included kayaking, canoeing, sailing, motor boating, paddle boarding, rowing, tubing, wading, swimming, fishing, or other activities. For those who indicated that they were fishing, respondents were asked to identify their target species, if any. Figure 6.22 shows the proportions of major boating-related activity as reported by respondents. The most common activity (45%) was fishing, with kayaking (27%) and

motor boating (14%) the next most common activities. Boating surveys were conducted at public boat ramps, and as a result, data may not include respondents who live along the lake and have a private dock. Merrill Creek Reservoir only has public boat ramps, and there is no private access.

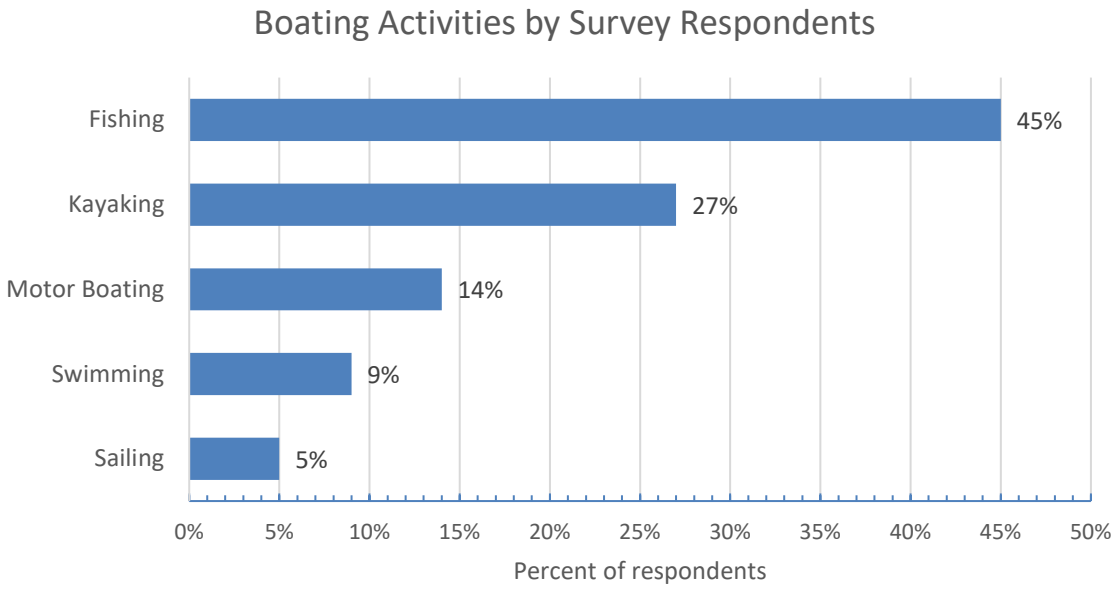


Figure 6.22. Boating activities by type in the Musconetcong River Watershed and Merrill Creek Reservoir

There was not a clearly favored type of fish that boating respondents were targeting. Bass and trout were the most named species, but most (10) indicated either "other" or "none specified" as target species, see Figure 6.23.

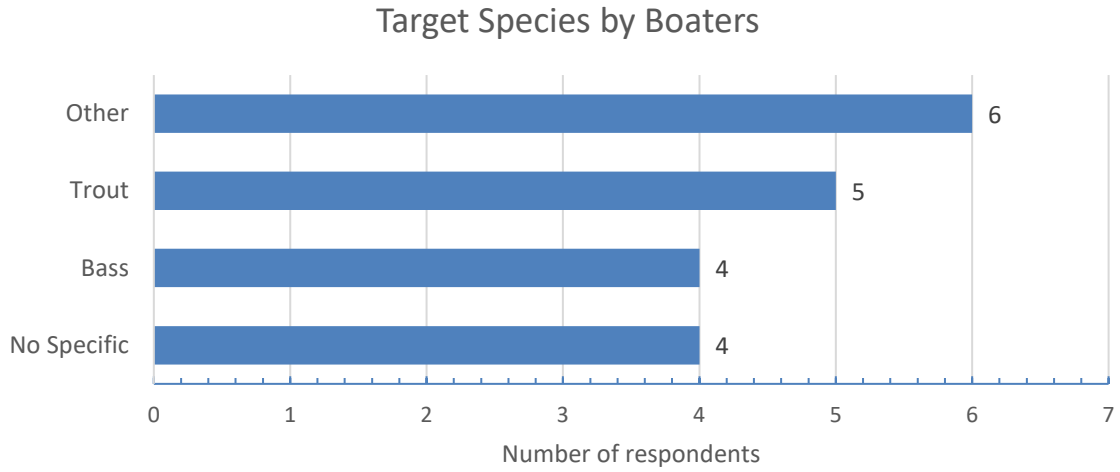


Figure 6.23. Target species by boaters who reported fishing activity on the Musconetcong River

Hunters

Hunters were surveyed during hunting season in November and December 2022. All hunting surveys were administered in-person or left on vehicles at Musconetcong Wildlife Management Area in Bethlehem and Franklin Townships in one of three parking areas: Valley Road, Shurts Road, and River Road. Table 6.9 shows responses (returned cards) with summary information for each hunting party. The five surveys returned represented 8 total hunters, who spent an average of 2.4 hours hunting, had been hunting the area an average of 8.4 years, and spent an average of $55 per trip.

Table 6.9. Summary of hunters surveyed in the Musconetcong Watershed

Home ZIP Code	Number in Hunting Party	Hours Spent	Years Hunted This Area	Total $ Spent by Party	Activities
08827	3	2	1	$200	Shotgun, duck
07730	1	3	2	$35	Shotgun, deer
07732	2	4	10	$40	Trapping, bow, shotgun, deer, duck, Other: goose
07882	1	1	4	-	Other: Hunting dog training
08826	1	2	25	-	Other: Hiking
Average	**1.6**	**2.4**	**8.4**	**$92**	
Total	**8**	**12**	**42**	**$275**	

For the purposes of hunting metrics, average spending was only calculated for respondents who reported the amount spent on their hunting activities (some hunters did not report their spending).

A total of five hunting parties were surveyed during the survey period (November–December 2022). Cards were left on hunters' cars during hunting season and were returned by mail by the respondents. Most hunters reported either hunting deer (40%) or ducks (40%), with 20% hunting goose (Figure 6.24). Trapping was also indicated; surveys did not include target species, as trapping seasons generally overlap in New Jersey.

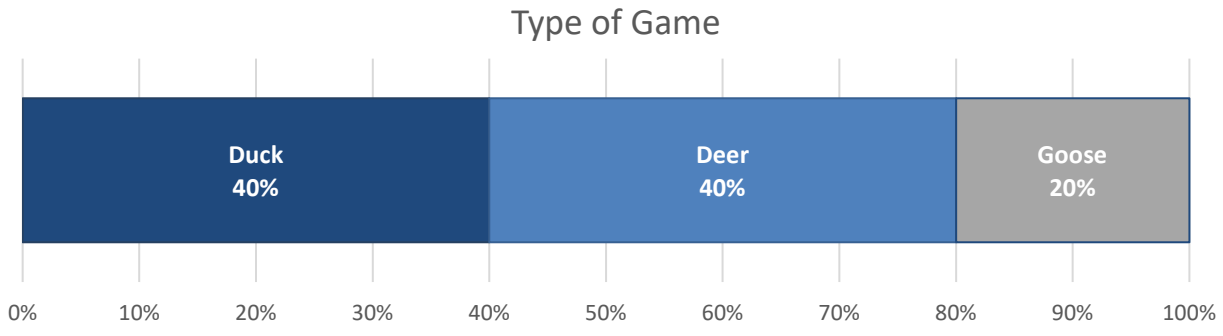


Figure 6.24. Game pursued by hunters surveyed in the Musconetcong Watershed

Of four types of hunting, including shotgun, bow (recurve, compound, or crossbow), trapping, or other, most (3) reported using a shotgun, while two reported other type of activity. Figure 6.25 summarizes the reported methods used by respondents.

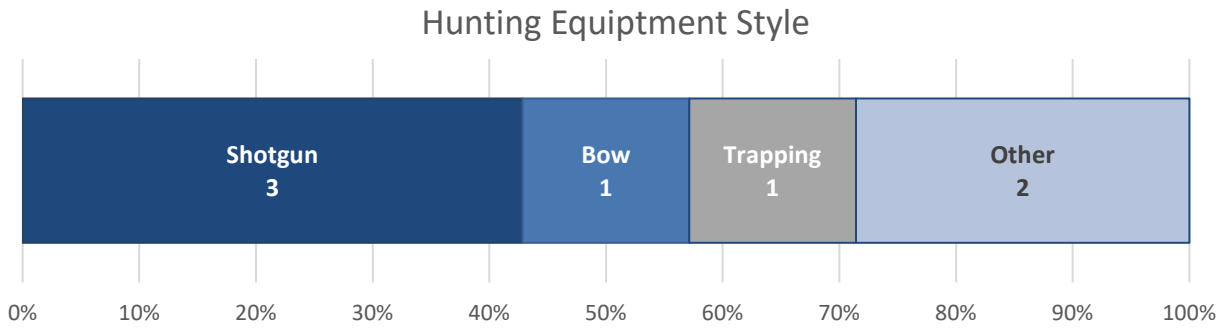


Figure 6.25. Number of hunters by hunting style in the Musconetcong Watershed

Combined Metrics

The major focus of the survey process was to gauge the spending of participants utilizing the watershed for various activities. Figure 6.26 shows the reported spending amounts across all survey types. Nearly half of respondents (99) reported spending less than $25 per trip, while 167 spent $100 or less. Only 8 respondents reported spending over $250 for their trip.

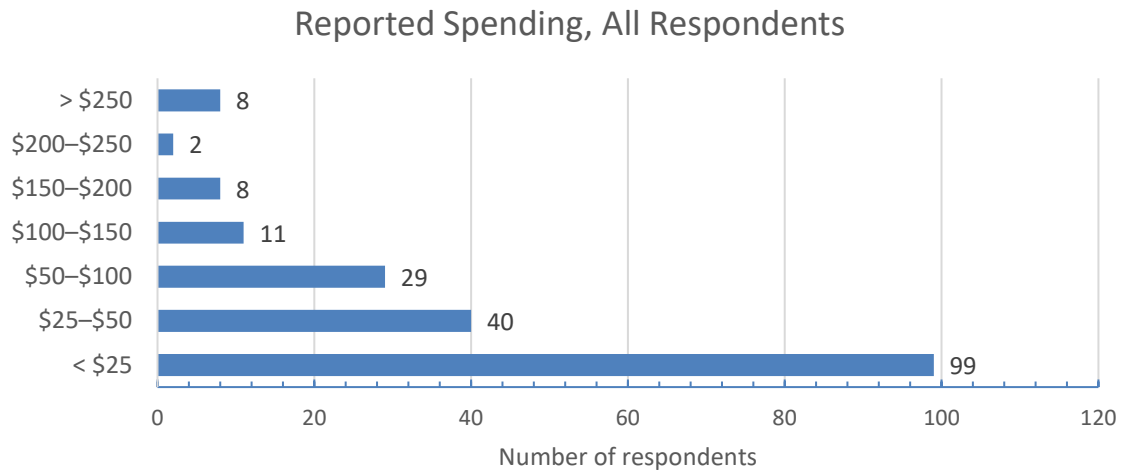


Figure 6.26. Reported spending, all survey respondents in the Musconetcong Watershed

Figure 6.27 presents the proportions of completed surveys for each of the four survey types. Nearly half (48%) of the surveys were angler surveys, while 40% were from recreational users. Boating and hunting represented 8% and 3% of the total number of respondents, respectively.

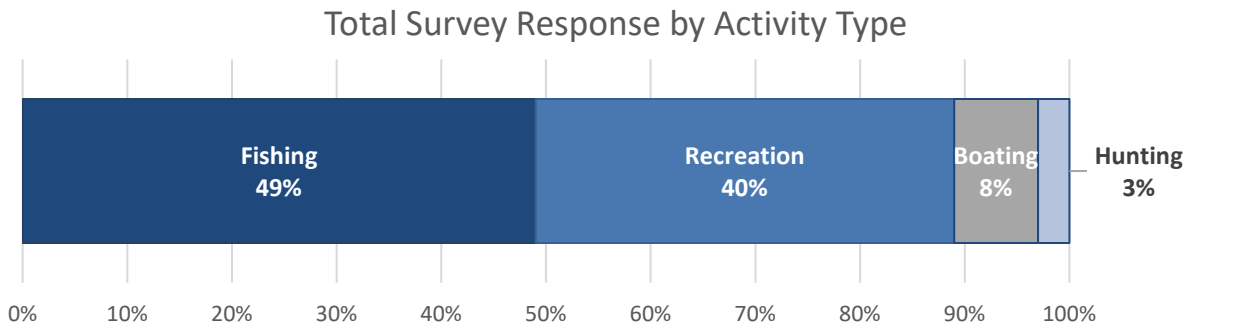


Figure 6.27. Proportion of all survey types in the Musconetcong Watershed and Merrill Creek Reservoir

Estimating Economic Impacts

By conducting direct surveys of users of the recreational resources of the Musconetcong Watershed it is possible to make inferences about the economic impact of the resources in the upper Delaware watersheds. Using self-reported metrics from users can be a powerful guide to the value, or "willingness to pay" for access to high-quality natural resources such as fishable and swimmable streams, open access, well-maintained public areas, and other outdoor assets. Such survey methods also provide an estimate of actual direct economic value that recreational resources bring to the region and the state. These methods also present some obvious challenges. One such challenge is the relatively costly and time-consuming activity of conducting the survey. Planning, design, and implementation of in-the-field surveying over an eight-month period and extensive area is a time-consuming process. Additionally, ensuring that there are enough respondents for each survey type is challenging, and in many ways beyond the control of the survey team.

Given these constraints, however, self-reported information gathered in direct surveys in aggregate can present an accurate picture of how people are using the natural resources of watersheds, how they value those resources, and what direct economic impact they are having on the overall economy. By calculating aggregate metrics from the survey responses, and extrapolating, using a variety of methods, it is possible to derive estimates of economic impact. Given certain known conditions, and data derived from other sources and using that information to estimate per capita impacts, the economic effects of each recreational activity type surveyed can be approximated. If we know the amount of spending by the average user of a resource, for instance, we may extrapolate that to determine impacts across a wider region.

Survey efforts undertaken by the MWA and UDWRC focused on the Musconetcong River and Watershed (and Merrill Creek Reservoir in the Pohatcong Creek Watershed), but many surrounding watersheds in the northern Delaware River region of New Jersey exhibit similar characteristics in terms of character and condition of outdoor resources, accessible open space, demographics, scenic quality, and watershed health. It may be expected therefore that the recreational value and use of the resources in the entire study area will exhibit a similar level of usage and thus economic impact as the waters and watershed of the Musconetcong. For each survey type (fishing, general recreation and boating, and hunting), the expected economic impacts were estimated using available ancillary

information and simple extrapolation techniques. General recreation (such as hiking, cycling, picnicking, etc.) was combined with boating, since these activities often occur in similar locations (such as the lakes of the Musconetcong watershed) and since the number of boating respondents was relatively small.

Each recreational activity tends to have a distinct profile in terms of how outdoor resources are used and how much is spent for each. In general, activities that require more planning, gear, and a greater travel time require participants to spend more on each trip. For example, hunting and fishing both require planning, licenses, specialized equipment, and a certain dedication of time. While other activities, such as cycling or kayaking can also represent significant outlays of money and dedication of time, general recreation such as walking, picnicking, or observing nature can generally be done with fewer resources and time.

For each activity type the average amount of money reported spent was calculated and summarized. Tables 6.10, 6.11, and 6.12 present the number of respondents, the average hours spent, and average reported dollar amount spent, by each survey date, and as aggregate values, for anglers (fishing survey), general recreation and boating, and hunting, respectively.

Table 6.10. Average spending by anglers surveyed on the Musconetcong River

Fishing	Number	Avg. Hours	Avg. $ Spent
April 30 & May 1, 2022	62	4.2	$70
June 4, 2022	34	4.0	$31
Total	**96**	**4.1**	**$57**

Table 6.11. Average spending by recreational users surveyed in the Musconetcong Watershed

General Recreation (Trail & Boating)	Number	Avg. Hours	Avg. $ Spent
June 15, 2022	13	2.6	$10
June 28, 2022	25	3.9	$125
September 30, 2022	12	2.5	$68
October 19, 2022	28	1.9	$57
November 19, 2022	21	2.4	$25
Total	**99**	**2.7**	**$62**

Table 6.12. Average spending by hunters surveyed in the Musconetcong Watershed

Hunting	Number of Parties	Number of Hunters	Effort Hours	Avg. $ Spent per Party
November & December 2022	5	8	20	$92
Total	**5**	**8**	**20**	**$92**

On average, anglers spent $57 per trip, general recreation and boating respondents spent $62 per trip, and hunters spent $92 per trip. These numbers, when scaled up, can be used to estimate a range of economic impact for each of the activities across the entire study area. The state of New Jersey comprises just over 7,354 square miles, and as of 2020 had 8,882,000 inhabitants (U.S. Decennial Census). Table 6.13 shows the tributary watersheds to the northern portion of the Delaware River (the study area).

Table 6.13. Area and population in the New Jersey tributary watersheds

Watershed	Area (sq. miles)	Area (ac)	Total Pop.
Flat Brook	65.8	42,094	2,408
Lopatcong Creek	19.4	12,415	24,056
Lower Delaware Tributaries	215.0	137,592	71,798
Middle Delaware Tributaries	69.2	44,280	4,008
Musconetcong River	155.0	99,175	88,414
Paulins Kill	177.0	113,264	38,163
Pequest River	156.4	100,114	33,941
Pohatcong Creek	58.1	37,175	20,057
Total	**915.8**	**586,107**	**282,845**

In total the tributary watersheds cover 915.8 square miles, or 12% of the total land area of the state, and contain 282,845 inhabitants, or approximately 3% of the state's population (see Table 6.14). These numeric factors can be used to downscale the economic impacts from state-level data (area or population) to the northern Delaware tributaries study area.

Table 6.14. Scaling factors, New Jersey to the New Jersey tributary watersheds

Region	Population	Area (sq. miles)	Area (ac)	% Population	% Area
NJ Totals, 2020	8,882,000	7,355	4,707,046	100%	100%
NJ tributary watersheds	282,845	896	586,107	3%	12%

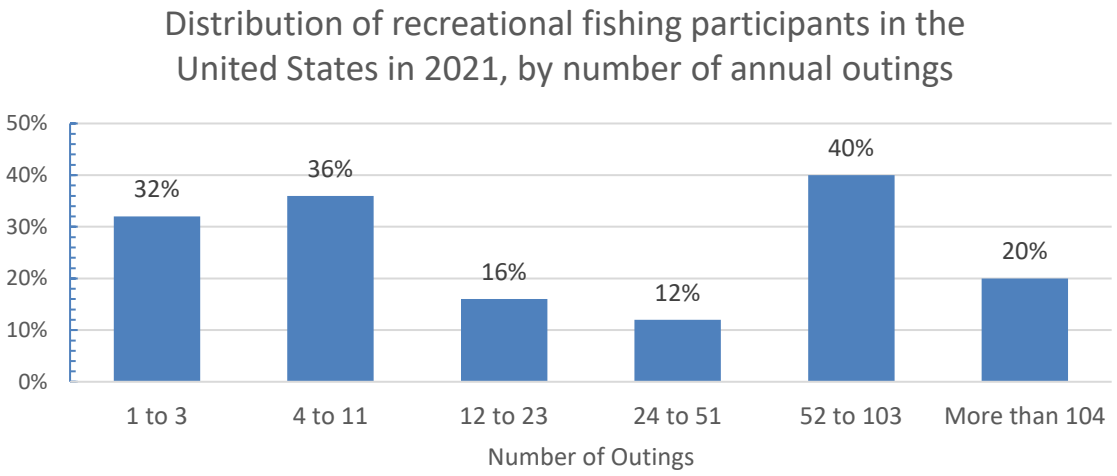
Fishing

To calculate fiscal impacts of recreational fishing the research team first estimated the number of anglers in the study area who use the streams and lakes. According to the NJDEP DFW, there were 142,825 fishing licenses in all categories sold in the state in 2022 (see Table 6.15). Using the scaling factor based on population in the study area compared to the entire state, there were an estimated 8,292 anglers in the study area in the same time period. Note that not all angling activity is confined to residents of the area; many residents and out-of-state residents came to this area to fish.

Table 6.15. New Jersey hunting and fishing licenses by category, 2021 and 2022

License Type	2021	2022
All-Around Sportsman	20,221	19,436
All-Around Buddy	16	11
Senior Bow & Arrow	6,031	6,039
Senior Fishing	11,673	11,362
Senior Hunting	10,575	10,609
Resident Buddy Fishing*	2,820	2,113
Non-Res. Buddy Fishing*	465	455
Non-Res. Bow & Arrow	2,846	2,748
Non-Res. Fishing	15,953	16,290
Non-Res. Hunting	3,877	3,963
Non-Res. Small Game	1,403	1,293
Non-Res. Trapping	12	14
Non-Res. Trout Stamp	9,129	9,137
Non-Res. 7-Day Fishing	922	938
Non-Res. 2-Day Fishing	4,760	4,640
Pheasant & Quail Stamp	13,388	13,127
Resident Bow & Arrow	15,663	14,374
Resident Fishing	118,074	107,027
Resident Hunting	26,350	24,496
Res. Trapping	1,137	1,188
Resident Trout Stamp	91,000	83,208
Resident Waterfowl	10,129	**
Non-Res. Waterfowl	1,975	**
Rifle Permit	17,918	**

To estimate the number of fishing trips each angler might be expected to make in a year the mode (most common value) from the 2021 data on participation in the United States was used. Figure 6.28 shows the distribution of recreational fishing participants in the United States, by number of annual outings. To derive the likely number of trips each angler undertakes annually within the study area, the upper and lower bounds of the mode (most common value) were used. The mode represents 36% of all respondents nationally (including those engaged in freshwater, saltwater, and fly fishing), with a low-end value of 4 trips per year, and a high-end value of 11 trips per year. These values were multiplied by the per trip expenditures for anglers in the Musconetcong Watershed, as derived from our surveys, $57 per trip.



Source: Statistica.com; RBFF; Outdoor Foundation; 2021; 18,000 respondents; 6 years and older

Figure 6.28. Number of annual outings based on angler interviews in the United States

Table 6.16 shows the number of anglers in the state and study area (in 2022), with an expected range of total expenditures based on the likely number of trips within the watershed taken by those anglers. Total expected direct economic impact ranges from $1,895,273 to $5,212,002.

Table 6.16. Number of anglers and expenditure range in the New Jersey tributary watersheds

Fishing Licenses (2021–2022)	NJ (2022)	Study Area (2022)	From Outside Study Area	Potential Total Anglers	Daily Expenditure per Angler	2022 Expenditure Low	2022 Expenditure High
All Sportsman	19,436	619	374	993	$57	$227,005	$624,263
All Buddy	11	0	0	1	$57	$128	$353
Senior Fishing	11,362	362	219	581	$57	$132,704	$364,935
Resident Buddy Fishing	2,113	67	41	108	$57	$24,679	$67,867
Non-resident Buddy Fishing	455	14	9	23	$57	$5,314	$14,614
Non-resident Fishing	16,290	519	314	832	$57	$190,261	$523,217
Non-Resident 2/7 Day Fishing	5,578	178	107	285	$57	$65,149	$179,159
Resident Fishing	107,027	3,408	2,061	5,469	$57	$1,250,033	$3,437,592
Total	**142,836**	**5,168**	**3,125**	**8,292**	**$57**	**$1,895,273**	**$5,212,002**

General Recreation and Boating

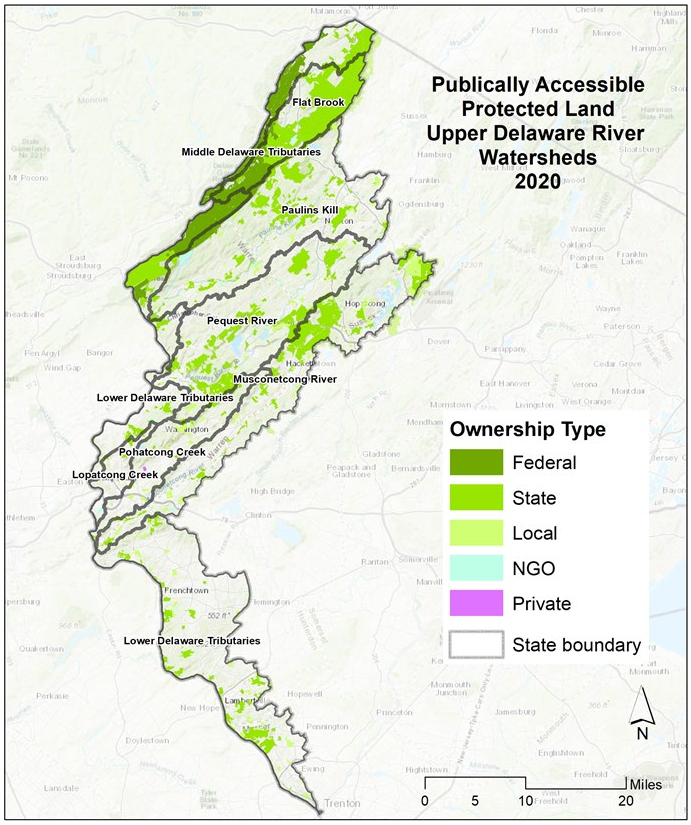


Figure 6.29. Publicly accessible lands in the New Jersey tributary watersheds

Northwest New Jersey has among the highest number of protected lands (i.e., where development cannot occur and where the public may engage in outdoor recreational activities) in New Jersey, offering over 140,000 acres of publicly accessible open space in federal, state, local, and privately owned or eased lands (see Figure 6.29). Outdoor recreational users contribute to the economy through expenditures related to their outdoor activities. Since the region offers so many outdoor recreational opportunities, these expenditures represent a significant economic benefit for local economies. Annual attendance at the many state-owned parks runs into the hundreds of thousands (see Table 6.17) (Green Acres Program, 2018), and the Delaware Water Gap National Recreation Area is one of the most highly visited National Park Service Units in the nation, with over 4.3 million visitors annually, just behind Zion National Park in Utah, and ahead of well-known destinations such as Rocky Mountain National Park, Acadia National Park, and Yosemite National Park (Table 6.18) (National Park Service, 2023).

Table 6.17. Annual attendance at state parks in the New Jersey tributary watersheds

State Park (SP) / State Forest (SF)	Attendance
D & R Canal SP/Washington Crossing SP	1,387,778
High Point SP/Swartswood SP	383,473
Hopatcong SP	427,247
Kittatinny Valley SP/Jenny Jump SP	180,400
Stokes SF/Worthington SF	1,386,565
Total	**3,765,463**

Table 6.18. Major U.S. national parks and recreational areas by annual attendance

Park	Rank	Recreation Visits	% of Total
Blue Ridge Parkway	1	15,711,004	5.0%
Golden Gate National Recreation Area	2	15,638,911	5.0%
Great Smoky Mountains National Park	3	12,937,633	4.2%
Gateway National Recreation Area	4	8,728,291	2.8%
Lincoln Memorial	5	7,825,397	2.5%
George Washington Memorial Parkway	6	7,397,120	2.4%
Natchez Trace Parkway	7	6,543,533	2.1%
Gulf Islands National Seashore	8	5,685,155	1.8%
Lake Mead National Recreation Area	9	5,578,226	1.8%
Vietnam Veterans Memorial	10	4,886,254	1.6%
World War II Memorial	11	4,815,309	1.5%
Grand Canyon National Park	12	4,732,101	1.5%
Zion National Park	13	4,692,417	1.5%
Delaware Water Gap National Recreation Area	**14**	**4,380,225**	**1.4%**
Rocky Mountain National Park	15	4,300,424	1.4%
Chesapeake & Ohio Canal National Historical Park	16	4,286,185	1.4%
Korean War Veterans Memorial	17	4,010,009	1.3%
Acadia National Park	18	3,970,260	1.3%
Cape Cod National Seashore	19	3,968,672	1.3%
Yosemite National Park	20	3,667,550	1.2%

To determine the estimated direct annual economic impact of these outdoor recreational areas to the northern New Jersey tributaries study area, two figures on park usage were used to derive an upper and lower range. The New Jersey Department of Environmental Protection (NJ DEP) Division of Science and Research determined the per capita annual park visits, as well as the visits per unit area based on acreage of state parks and forests. These values were used to determine an estimated range of direct economic impact of recreational users, by multiplying the mean spending per trip as derived through the survey methods, with both the number of visits by open space acreage (Table 6.19) and number of visits per unit population (Table 6.20). Using population and publicly accessible open space scaled to the study area from state totals provided a range of estimated direct economic benefit to the study area of outdoor recreation.

Table 6.19. Park visits per unit area of parkland in New Jersey (2004) and U.S. (2002)

	Visits	Area (ac)	Visits/ac
New Jersey	1,560,000	400,000	39
U.S. Average	11,100,000	245,000	45.3

Table 6.20. Park visits per capita in New Jersey (2004) and U.S. (2002)

	Visits	Population	Visits/person
New Jersey	1,560,000	8,700,000	1.8
U.S. Average	758,200,000	288,400,000	2.6

Downscaling the population of New Jersey to the study area based on acreage (12% of the area of the state of New Jersey) produces an estimated 1,101,873 visitors to the outdoor recreational open space of the region per year from inside and outside the study area. It is estimated that the pool of potential visitors on average visits these recreational areas 1.8 times per year, spending an average of $62 per visit, which translates to over $122 million in total direct spending in the region (Table 6.21).

Table 6.21. Visitor share, annual visits and expenditure in the New Jersey tributary watersheds

Visitor Share by Area	Visits per Person (2004)	Visits	Spending per Visit ($)	Annual Expenditure ($)
1,101,873	1.8	1,983,372	$62	$122,969,038

In 2004 it was found that each acre of available public parks and forest area generates approximately 39 visits annually. With over 140,000 acres of publicly accessible open space, including areas in publicly and privately owned or conserved lands, it is estimated that there might be over 5.4 million visits/year, yielding an annual direct expenditure of nearly $340 million annually in the tributaries to the northern Delaware River in New Jersey (Table 6.22).

Table 6.22. Public open space visits and annual expenditure in the New Jersey tributary watersheds

Public Open Space (ac)	NJ Visits/ac	Visits	Spending per Visit ($)	Annual Expenditure ($)
140,263	39	5,470,258	$62	$339,155,995

Together, these metrics result in an estimated range of direct economic benefit to the study area between $122,969,038 (based on proportional visits to each park/forest per capita) and $339,155,995 (based on proportional visits per acre) per year.

Hunting

The Division of Fish and Wildlife of the New Jersey Department of Environmental Protection (NJ DEP) conducted a hunter survey in 2021 to determine certain hunting metrics such as quarry pursued, estimated number of hunters, and average annual number of hunting days per hunter. Using these figures, the estimated number of hunters within the study area of the tributaries of the

northern Delaware River in New Jersey was derived. Based on the expected number of hunters within the study area, derived by scaling the total population of New Jersey to the region, multiplied by the average spending per trip as determined by the hunter survey, there is a total expected spending of $229,301 per hunting day. Multiplying that by the average days hunting for each type of quarry, there is an estimated $3.8 million in direct economic impact to the study area from hunting activity annually. Table 6.23 summarizes the total expenditures by all hunting activity for each type of quarry in the northern Delaware River tributaries region.

Table 6.23. Hunter spending and annual expenditure in the New Jersey tributary watersheds

Hunting (2021)	NJ Hunters	Study Area Hunters	From Outside Study Area	Potential Total Hunters	Spending per Trip	All Hunters Spending/Day	Avg. Days/Hunter	Total Spending/ Year
Crow	1,298	41	16	57	$92	$3,789	3.6	$13,640
Pheasant	13,102	417	156	574	$92	$38,246	9.2	$351,864
Quail	2,781	89	33	122	$92	$8,118	5.5	$44,649
Small Game Mammals	14,689	468	175	643	$92	$42,879	7.2	$308,726
White-tailed Deer	46,682	1,487	557	2,044	$92	$136,269	22.9	$3,120,569
Total	**78,552**	**2,501**	**938**	**3,440**	**$92**	**$229,301**		**$3,839,449**

Summary

Determining the total direct economic impact of the recreational activities (angling, general recreation and boating, and hunting) required that certain assumptions be made to estimate values that cannot be measured directly. Estimating the spending by individuals was done through direct surveys over an eight-month period. Respondents were asked about their recreational behavior and spending, and the responses were recorded. The greater the number of respondents, the more accurate those values. An attempt was made to contact enough users of each type to enable a reasonable estimate of average spending per trip.

Using the values derived from surveys to extrapolate the entire study area required the use of existing research and methods for pro-rating state-wide data to the tributaries of the northern Delaware River in New Jersey (the study area). Where feasible, a range of values representing the direct economic expenditures in the study area watersheds was derived.

Based on these methods, the direct value of fishing in the study area ranged from $1,895,273 to $5,212,002 annually. General recreation (e.g., trail use, cycling, climbing, etc.) and boating were combined for the purposes of estimating expenditures. It was found that direct spending for this recreational use ranged from $122,969,038 to $339,155,995. A single value of $3,839,449 was estimated for direct spending in the study area by all hunting activities annually. This results in an estimated annual expenditure for recreation in the study area from $128,703,760 to $348,207,446.

Chapter 7. Housing Value Case Study: Proximity to Lake Musconetcong

Overview

There has been considerable research on the impact of clean water on property values of houses based on proximity to water features such as lakes and rivers. A variety of studies have focused on the increase in property values due to improving water quality and/or distance to the resource (see Chapter 3, Increased Property Value). Many have relied on multi-variate regression models to determine the impact on value of a wide variety of conditions and housing and land characteristics. Others have relied on surveys of populations to assess the self-reported "willingness to pay" for a non-commodity value, such as clean water or access to the waterfront for recreation, aesthetics, or other reasons.

To gain insight into the economic benefits of clean and healthy waterways on the price of housing in the tributaries of the Northern Delaware River in New Jersey, the current study employed a direct measurement approach to test this relationship for one specific water body. Using the housing inventory and sales website Zillow.com, which provides a standardized and widely used method for estimating housing prices, various housing characteristic of properties in the area surrounding Lake Mustonectong were inventoried. While only a few properties might be offered for sale and any given time, Zillow has developed a model to determine estimated pricing of nearly all properties in its database, using a proprietary neural network-based model.[2] Prices are derived from a formula incorporating factors such as assessed value; property acreage and house square footage; number of bedrooms, baths, and other amenities; and comparable houses in the area. The estimates are continually updated and refined based on actual sales prices, and therefore offer a timely valuation comparable across broad geographies.

Lake Musconetcong

The study was conducted during the summer of 2023, during which time values and associated property data relating to select residential properties near Lake Musconetcong in the Musconetcong Watershed were collected. Lake Musconetcong is part of Hopatcong State Park in the upper section of the Musconetcong Watershed. The lake covers 329 acres along the Musconetcong River and lies at the boundary between Sussex and Morris Counties in New Jersey. The lake is a popular fishing and boating site, offering boat rentals, picnic areas, and other recreational amenities. Houses line the lake, and the town of Netcong lies at its southwestern end. While not as heavily used nor as large as Lake Hopatcong to the north, this lake was chosen as a more readily feasible case study given its relatively small size and manageable number of residential properties.

To determine the valuation, based on values reported by Zillow.com, of residential properties in relation to their distance to Lake Musconetcong, parcels were cataloged into one of three categories, or "rings," based on proximity to the lake: lakeside properties (those with direct access to and/or lakefront views of the lake), properties at a distance of 1,000 feet (nominally), and properties at a

[2] See, for example, https://zillow.mediaroom.com/2021-06-15-Zillow-Launches-New-Neural-Zestimate,-Yielding-Major-Accuracy-Gains

distance of 2,000 feet. The straight-line 1,000-foot-buffer distance was manually altered to account for the road network, certain barriers to access, and open spaces.

Information on estimated total value of house and property (the so-called "Zestimate" from Zillow.com), total acreage, and number of bedrooms was collected.

The map in Figure 7.1 shows the location of the lake, and each of the three rings, as well as residential parcels sampled for the study.

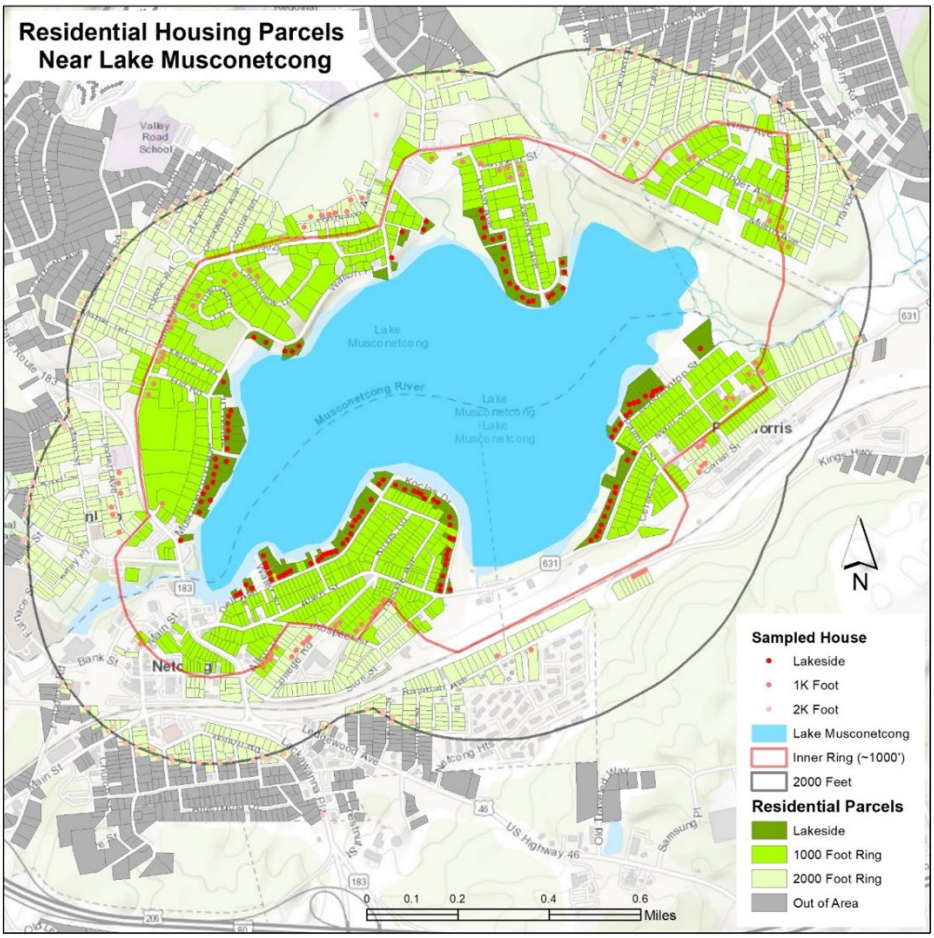


Figure 7.1. Housing parcels used in the analysis based on distance to Lake Musconetcong (lakeside, 1000-foot ring, 2000-foot ring)

Methods

To determine the effect of distance from Lake Musconetcong on overall housing values, a series of rings were developed defining certain fixed distances from the lake: lakeside, consisting of the physical shoreline of the lake, a nominal 1,000-foot distance—derived by buffering the lakeshore using GIS tools, and altering the resulting buffer by incorporating road networks, natural or human-made barriers, etc.—and a 2,000-foot buffer. It was assumed that the effects of the lake beyond 2,000 feet would be minimal.

Housing information, including total estimated value, property acreage, and number of bedrooms were compiled for all lakeside properties, all properties within the 1,000-foot ring, and for a sampling of houses along the perimeter of the 2,000-foot ring. For each sampled property a value per acre of property and value per square footage of house was calculated. Using this information, the average percentage difference in value for properties on the lakeside versus at 1,000 feet and 2,000 feet was determined.

A one-way ANOVA test was run on both parameters (total property value per acre and total property value per house square foot) to determine if either parameter was statistically significantly different among the three categories.

The study also estimated the total property value that might be attributable to the presence of Lake Musconetcong, based on the total number of housing parcels within the 1,000-foot buffer and along the lake. To do this, the average residential property value at 2,000 feet from the lake was taken as the value corresponding to the point at which the lake has no or minimal effect on the price. The value of houses within the 1,000-foot ring and on the lakeside, given no effect of proximity to the lake, was estimated by taking the total number of residential properties in those areas multiplied by the "baseline" average property value (i.e., the value at 2,000 feet). These values were compared to the total values derived from multiplying the number of residential properties in the 1,000-foot and lakeside rings by the corresponding calculated average property values as determined above. Summing the extra value provided by the lake to those houses within the 1,000-foot ring plus those along the lakeside provides an estimate of the total monetary impact of Lake Musconetcong on the housing market in the surrounding area.

Results

Average Property Values

To assess the impact on the value of a residential property based on proximity to Lake Musconetcong, the estimated property value of lots along the lakeshore were compared with values at 1,000 feet and 2,000 feet from the lake. The price for properties with residences (i.e., "improved" properties) averages just over $450,000 at lakeside, $422,000 at 1,000 feet (nominal distance), and $409,000 at 2,000 feet. This represents an increase in average prices for properties along the lake of 6.7% versus properties at 1,000 feet from the lake, and an increase of 10.0% versus properties at 2,000 feet from the lake.

The total property value (of land plus buildings) was normalized by house square footage and property acreage to derive a cost per square foot of residential space and of per acre of property. Based on house square footage, there was a small increase in value for houses along the lake versus those at 1,000 and 2,000 feet from the lake (3.0% and 4.5%, respectively). Based on average cost per acre of residential property (including houses and other improvements), there was a 27.1% increase in value for lakeside properties compared to those at 1,000 feet, and a 23.5% increase in lakeside property values compared to those at 2,000 feet. See Table 7.1 for average prices and percentage differences for housing and property values by ring.

Table 7.1. Average price per square foot and per acre, by ring, and percentage premium for lakeside properties

Ring	Average Price	Average Price per House Square Feet	Average Price per Acre
Lakeside	$450,679	$276	$1,996,835
1,000 Feet	$422,445	$268	$1,571,056
2,000 Feet	$409,827	$265	$1,616,258
Lakeside v 1,000'	6.7%	3.0%	27.1%
Lakeside v 2,000'	10.0%	4.5%	23.5%

To determine if these differences are statistically significant, one-way ANOVA tests were conducted to compare the cost per square foot of sampled houses, and cost per acre of sampled properties in each of the three rings. Based on these tests, it was determined that the cost per acre of the properties in each ring were significantly different (p-value = 7.09E-04), while the differences in cost per square foot of residential structures was not significant. Figures 7.2 and 7.3 show, for each of the three rings, the distribution of price per house square foot and the price per acre of land, respectively.

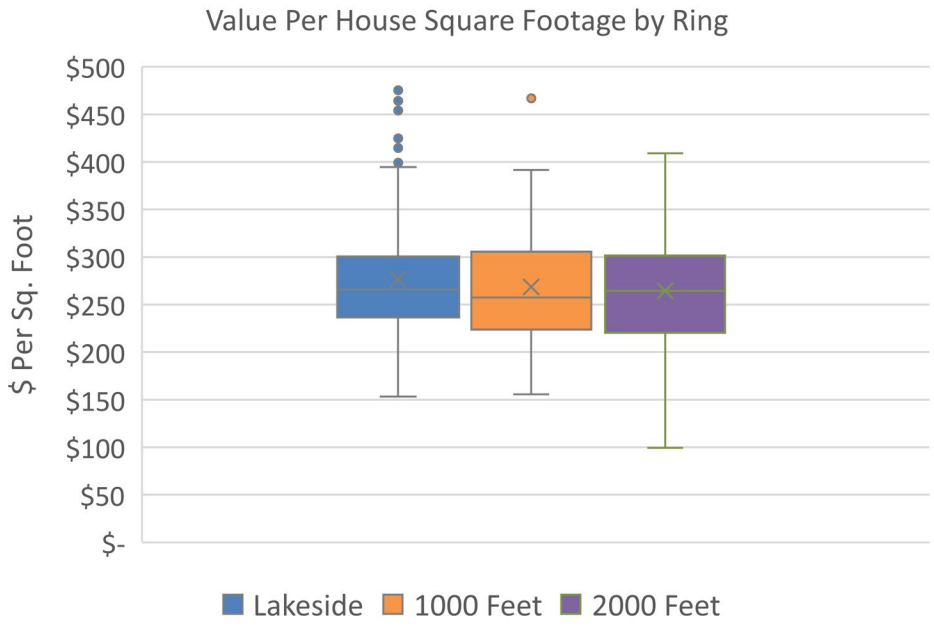


Figure 7.2. Box and whisker plot showing distribution of price per house square footage by ring

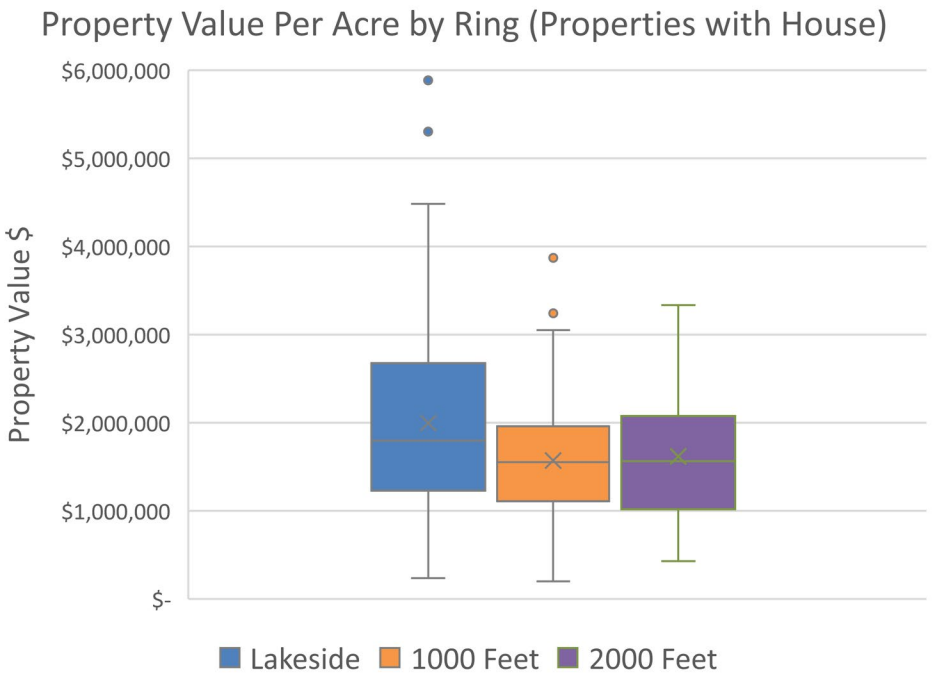


Figure 7.3. Box and whisker plot showing distribution of price per acre of properties by ring

Table 7.2 shows the results of the test for both variables.

Table 7.2. Statistical results (one-way ANOVA) for select housing variables

One-way ANOVA Test	Test Value (F)	P-value	Statistically significant difference among rings (reject null hypothesis)
Average price per square foot of house	1.144	7.09E-04	NO
Average price per acre of property	**7.509**	**0.32050**	**YES**

While many factors potentially affect the value of a property, this research indicates that relationship to Lake Musconetcong does have a significant impact on property values. Housing square footage was not significantly impacted by distance to the lake, implying that the economic impact is based on location alone, independent of the size of a particular residence.

Total Property Value

To determine the total potential effect of Lake Musconetcong on the local real estate economy of the area, the total number of properties for both the lakeshore (133 properties) and those within 1,000 feet of the lake (excluding lakeside properties—736 properties) were multiplied by the average price of properties at 2,000 feet from the lake (i.e., properties for which location relative to the lake

was considered to have negligible influence on price). This number represents the expected value of those properties if Lake Musconetcong did not exist. Using this approach, the 869 residential properties within 1,000 feet would have an estimated total value of approximately $356 million. Applying the average value as inventoried for residential properties along the lakeshore and within 1,000 feet of the lake to all residential properties there, the total estimated value with the presence of the lake is nearly $371 million. This represents a difference of over $14.7 million in real estate value that might be directly attributable to the presence of Lake Musconetcong, see Table 7.3.

Table 7.3. Total estimated real estate value provided by Lake Musconetcong

Proximity to Lake Musconetcong	Number	Average (No Lake)	Average Value (Actual)	Total Value (No Lake)	Total Value (Actual)	Difference
Lakeside	133	$409,827	$450,679	$54,506,981	$59,940,352	$5,433,371
Within 1000' Buffer	736	$409,827	$422,445	$301,632,615	$310,919,200	$9,286,585
Totals	**869**			**$356,139,596**	**$370,859,552**	**$14,719,956**

Summary

This limited case study was undertaken to estimate the value of Lake Musconetcong on real estate values in proximity to the lake. While it is theoretically possible to extrapolate these values beyond Lake Musconetcong, that was not done here. Lake Musconetcong is a much smaller and less heavily used lake than other lakes, such as Lake Hopatcong to the north. The purpose of this study was to provide an example of a single, discrete body of water and the potential effects it has on property values in the area. No attempt was made to apply the values to the entire study area. Refer to Chapter 3, Increased Property Value for an estimate of the total value of clean water and healthy watersheds on housing values in the study area.

To evaluate local impacts of Lake Musconetcong, a conservative approach was taken, assuming that no effects of the lake on values are felt beyond 2,000 feet. Further, to determine the effects on the total value of real estate, the average value for the properties farthest from the lake but still within the 1,000-foot ring was used, and any increased property value beyond the 1,000-foot ring was ignored.

Lake Musconetcong itself is much less widely used for recreation, and the value to boaters is less, than the larger Lake Hopatcong. Lake Musconetcong is relatively shallow, with limited recreational facilities, and is prone to blooms of submerged aquatic vegetation. Certainly, while Lake Musconetcong was shown to be a driver of economic value in the region, other water features in the northern Delaware River tributary watersheds can be expected to have at least a similar or substantially higher value in many cases.

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Appendix A. Employment Codes by Industry

Industry	NAICS Code
Agriculture, Forestry, Fishing and Hunting	11
Crop Production	111
Animal Production	112
Aquaculture	1125
Forestry and Logging	113
Fishing, Hunting and Trapping	114
Fishing	1141
Support Activities for Agriculture and Forestry	115
Mining, Quarrying, and Oil and Gas Extraction	21
Oil and Gas Extraction	211
Mining (except Oil and Gas)	212
Nonmetallic Mineral Mining and Quarrying	2123
Support Activities for Mining	213
Utilities	22
Utilities	221
Electric Power Generation, Transmission and Distribution	2211
Natural Gas Distribution	2212
Water, Sewage and Other Systems	2213
Construction	23
Construction of Buildings	236
Residential Building Construction	2361
Nonresidential Building Construction	2362
Heavy and Civil Engineering Construction	237
Land Subdivision	2372
Highway, Street, and Bridge Construction	2373
Other Heavy and Civil Engineering Construction	2379
Specialty Trade Contractors	238
Manufacturing	31
Food Manufacturing	311
Seafood Product Preparation and Packaging	3117
Beverage and Tobacco Product Manufacturing	312
Textile Mills	313
Textile Product Mills	314
Apparel Manufacturing	315
Apparel Knitting Mills	3151
Leather and Allied Product Manufacturing	316
Wood Product Manufacturing	321
Paper Manufacturing	322
Petroleum and Coal Products Manufacturing	324
Chemical Manufacturing	325
Basic Chemical Manufacturing	3251
Resin, Synthetic Rubber, and Artificial Synthetic Fibers and Filaments Manufacturing	3252
Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing	3253
Pharmaceutical and Medicine Manufacturing	3254
Paint, Coating, and Adhesive Manufacturing	3255
Soap, Cleaning Compound, and Toilet Preparation Manufacturing	3256
Other Chemical Product and Preparation Manufacturing	3259
Plastics and Rubber Products Manufacturing	326
Nonmetallic Mineral Product Manufacturing	327
Cement and Concrete Product Manufacturing	3273
Lime and Gypsum Product Manufacturing	3274
Other Nonmetallic Mineral Product Manufacturing	3279
Primary Metal Manufacturing	331
Fabricated Metal Product Manufacturing	332

Industry			NAICS Code
	Machinery Manufacturing		333
	Computer and Electronic Product Manufacturing		334
		Computer and Peripheral Equipment Manufacturing	3341
		Communications Equipment Manufacturing	3342
		Audio and Video Equipment Manufacturing	3343
		Semiconductor and Other Electronic Component Manufacturing	3344
		Navigational, Measuring, Electromedical, and Control Instruments Manufacturing	3345
		Manufacturing and Reproducing Magnetic and Optical Media	3346
	Electrical Equipment, Appliance, and Component Manufacturing		335
	Transportation Equipment Manufacturing		336
		Motor Vehicle Manufacturing	3361
		Motor Vehicle Body and Trailer Manufacturing	3362
		Motor Vehicle Parts Manufacturing	3363
		Aerospace Product and Parts Manufacturing	3364
		Railroad Rolling Stock Manufacturing	3365
		Ship and Boat Building	3366
		Other Transportation Equipment Manufacturing	3369
	Furniture and Related Product Manufacturing		337
	Miscellaneous Manufacturing		339
Wholesale Trade			42
	Merchant Wholesalers, Durable Goods		423
	Merchant Wholesalers, Nondurable Goods		424
	Wholesale Electronic Markets and Agents and Brokers		425
Retail Trade			44
	Motor Vehicle and Parts Dealers		441
	Furniture and Home Furnishings Stores		442
	Electronics and Appliance Stores		443
		Electronics and Appliance Stores	4431
	Building Material and Garden Equipment and Supplies Dealers		444
	Food and Beverage Stores		445
	Health and Personal Care Stores		446
	Gasoline Stations		447
	Clothing and Clothing Accessories Stores		448
	Sporting Goods, Hobby, Book, and Music Stores		451
	General Merchandise Stores		452
	Miscellaneous Store Retailers		453
	Nonstore Retailers		454
Transportation and Warehousing			48
	Air Transportation		481
		Scheduled Air Transportation	4811
		Nonscheduled Air Transportation	4812
	Rail Transportation		482
		Rail Transportation	4821
	Water Transportation		483
		Deep Sea, Coastal, and Great Lakes Water Transportation	4831
		Inland Water Transportation	4832
		Support Activities for Water Transportation	4883
	Truck Transportation		484
		General Freight Trucking	4841
		Specialized Freight Trucking	4842
	Transit and Ground Passenger Transportation		485
		Urban Transit Systems	4851
		Interurban and Rural Bus Transportation	4852
		Taxi and Limousine Service	4853
		School and Employee Bus Transportation	4854
		Charter Bus Industry	4855
		Other Transit and Ground Passenger Transportation	4859
	Pipeline Transportation		486
		Pipeline Transportation of Crude Oil	4861

Industry	NAICS Code
Information	51
Publishing Industries (except Internet)	511
Motion Picture and Sound Recording Industries	512
Broadcasting (except Internet)	515
Telecommunications	517
Data Processing, Hosting, and Related Services	518
Other Information Services	519
Finance and Insurance	52
Monetary Authorities-Central Bank	521
Credit Intermediation and Related Activities	522
Securities, Commodity Contracts, and Other Financial Investments and Related Activities	523
Insurance Carriers and Related Activities	524
Funds, Trusts, and Other Financial Vehicles	525
Real Estate and Rental and Leasing	53
Real Estate	531
Rental and Leasing Services	532
Lessors of Nonfinancial Intangible Assets (except Copyrighted Works)	533
Professional, Scientific, and Technical Services	54
Professional, Scientific, and Technical Services	541
Management, Scientific, and Technical Consulting Services	5416
Scientific Research and Development Services	5417
Management of Companies and Enterprises	55
Management of Companies and Enterprises	551
Administrative and Support and Waste Management and Remediation Services	56
Administrative and Support Services	561
Travel Arrangement and Reservation Services	5615
Waste Management and Remediation Services	562
Educational Services	61
Educational Services	611
Colleges, Universities, and Professional Schools	6113
Technical and Trade Schools	6115
Educational Support Services	6117
Health Care and Social Assistance	62
Ambulatory Health Care Services	621
Hospitals	622
Nursing and Residential Care Facilities	623
Social Assistance	624
Arts, Entertainment, and Recreation	71
Performing Arts, Spectator Sports, and Related Industries	711
Museums, Historical Sites, and Similar Institutions	712
Amusement, Gambling, and Recreation Industries	713
Other Amusement and Recreation Industries	7139
Accommodation and Food Services	72
Accommodation	721
Traveler Accommodation	7211
RV (Recreational Vehicle) Parks and Recreational Camps	7212
Rooming and Boarding Houses	7213
Food Services and Drinking Places	722
Other Services (except Public Administration)	81
Repair and Maintenance	811
Personal and Laundry Services	812
Religious, Grantmaking, Civic, Professional, and Similar Organizations	813
Social Advocacy Organizations	8133
Business, Professional, Labor, Political, and Similar Organizations	8139
Private Households	814
Public Administration	92
Executive, Legislative, and Other General Government Support	921
Justice, Public Order, and Safety Activities	922
Administration of Human Resource Programs	923

Industry	NAICS Code
Administration of Environmental Quality Programs	924
Administration of Housing Programs, Urban Planning, Community Development	925
Administration of Economic Programs	926
Space Research and Technology	927
National Security and International Affairs	928

Source: U. S. Bureau of Labor Statistics

Appendix B. Survey Research Detailed Methods

This appendix details the survey process at the individual-survey-outing level and provides context for the results gathered on each of seven outings throughout the study year. Summary statistics and survey process details are also outlined by type: recreational, fishing, boating, and hunting.

Table B.1. Field survey date and location in the Musconetcong River Watershed

Survey	Location	Date	Day of Week	Time spent (hr)
1	• Musconetcong Watershed Association • Shurts Rd fishing access • Asbury Mill • Asbury-West Portal Rd • River Rd 1 • A frame fishing access • Person/Lime Kiln Rd • Bloomsbury fishing access • Bloomsbury Water Co • Unnamed Finesville access • Riegelsville boat ramp • Hampton Borough Park • New Hampton bridge • Changewater Rd • Butler Park • Point Mountain trailhead • Penwell fishing access • Stephensburg fishing access • East Ave • Alumni field • Stephens State Park • Newburgh Rd, Hackettstown fish/wildlife • River Rd 2 • Valley Rd	April 30 & May 1, 2022	Sat/Sun	6.0
2	• Valley Rd • Shurts Rd • Asbury-West Portal Rd • Hampton Borough Park • Asbury Mill • New Hampton bridge • Penwell fishing access • Stephensburg fishing access • Waterloo Field • Tilcon Lake • Morris Canal N • Saxton Lake • Saxton Falls • Stephens State Park • Sober Rd	May 27 & June 4, 2022	Fri/Sat	4.5

Survey	Location	Date	Day of Week	Time spent (hr)
	• A Frame fishing access • Bloomsbury fishing access • Hughesville fishing access • Waterloo Valley Rd • Kings Highway			
3	• Lake Hopatcong	June 28, 2022	Tue	1.0
4	• Merrill Creek boat ramp • Merrill Creek Visitors Center	July 15, 2022	Fri	3.0
5	• Tilcon Lake • Stephens MTB • Sussex Branch Trailhead • Waterloo Village	September 30, 2022	Fri	2.5
6	• Sussex trailhead • Point Mountain trailhead • Lake Musconetcong	October 19, 2022	Wed	2.0
7	• Point Mountain trailhead • Stephens State Park • Stephens MTB • Sussex Branch trailhead • Penwell access	November 19, 2022	Sat	2.0

Recreation: Survey questions for recreation postcards (Figure B.1):

1. What zip code do you reside in?
2. How many hours do you plan to spend on this trip?
3. How many years have you been coming to this trail area?
4. How much did you spend in whole dollars on this trip (including clothing, gear, gas, guide fees, admission or other fees, food, lodging, etc.)?
5. What activities will you pursue on this trip? (Walking, hiking, cycling, climbing, picnicking, bird-watching, viewing other wildlife, other).

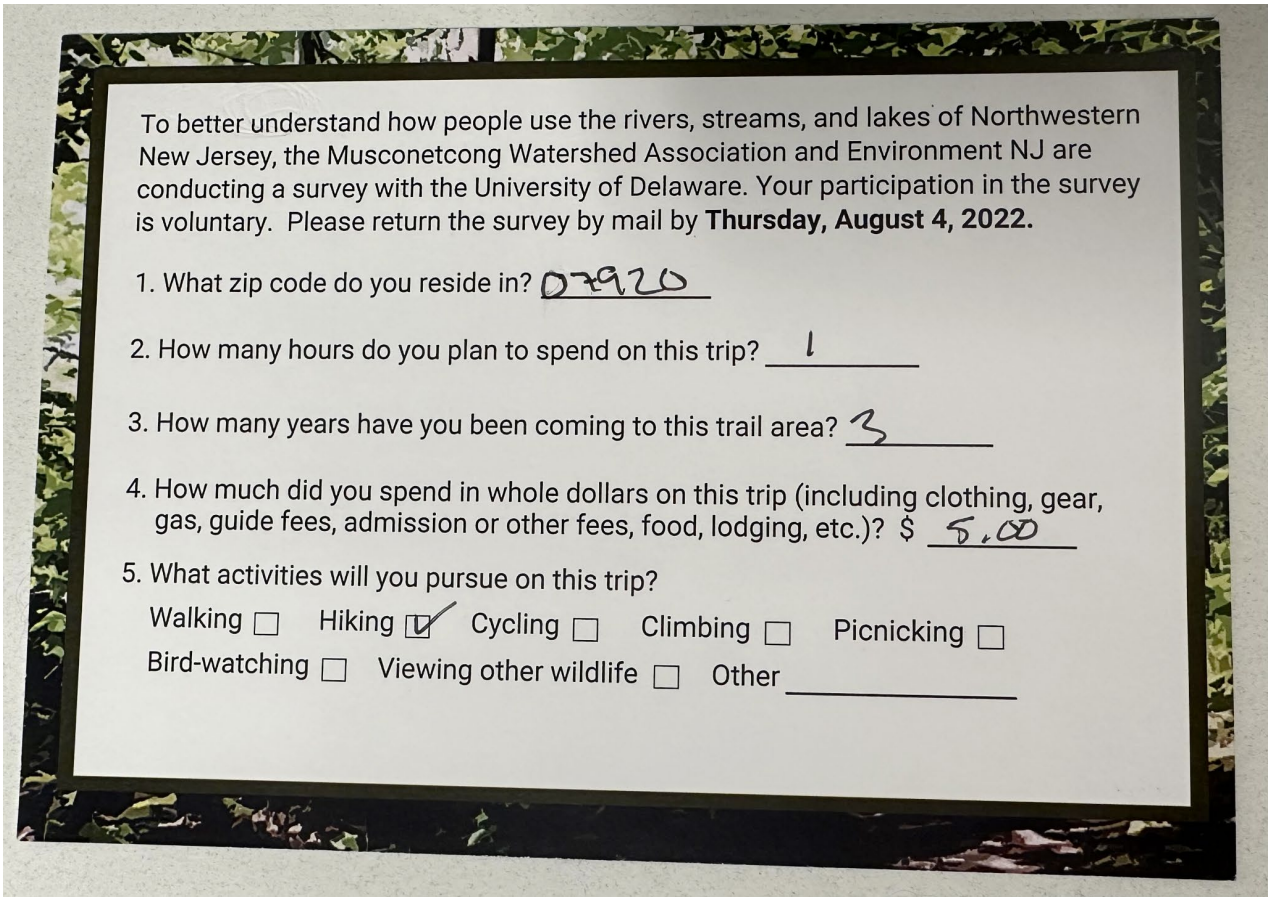
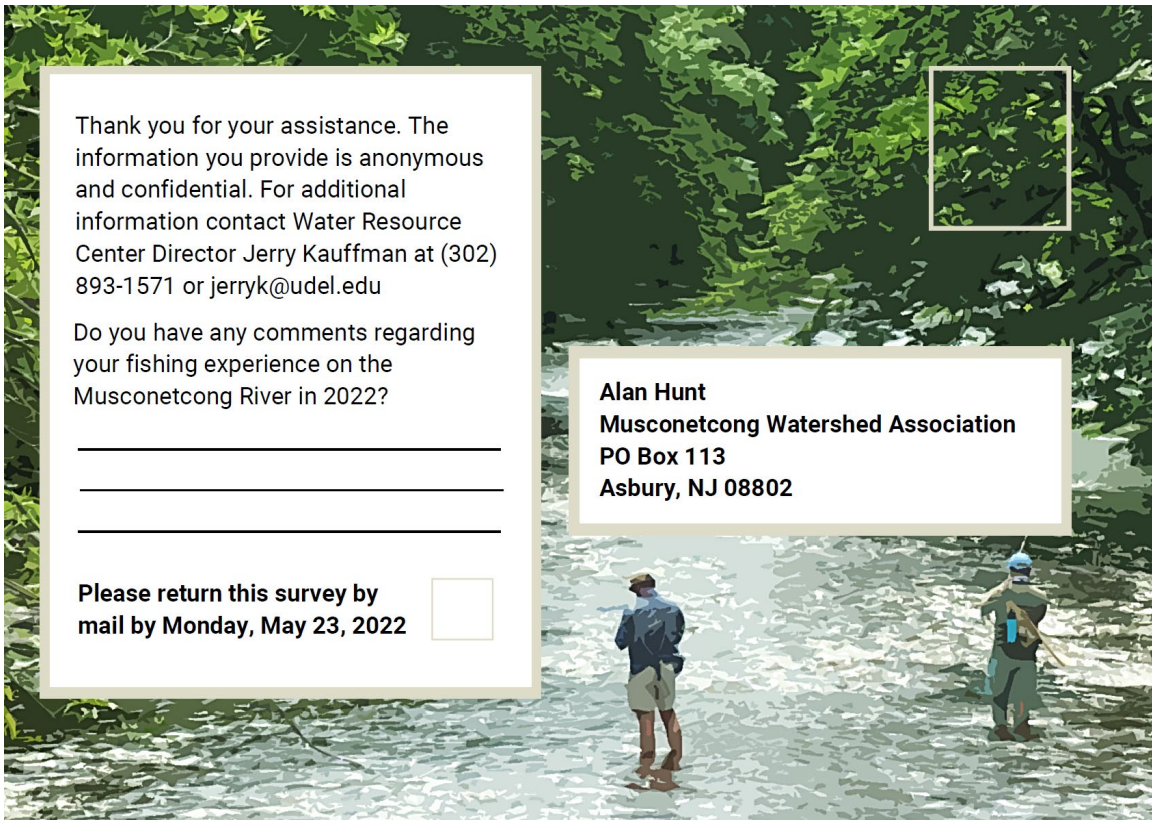


Figure B.1. Recreation survey postcard for Musconetcong River Watershed

Fishing: Survey questions for fishing postcards (Figure B.2):

1. What zip code do you reside in?
2. How many hours do you plan to fish on this trip?
3. How many years have you fished on the Musconetcong River?
4. How much did you spend in whole dollars on this trip (including tackle, gas, guide fees, ramp fees, food, lodging, etc.)?
5. What species do you plan to fish for on this trip? (Rainbow Trout; Brown Trout; Brook Trout; Smallmouth Bass; Largemouth Bass; Crappie; Chain Pickerel; Sunfish; other; no specific target, just out to have a good time).
6. Are you shoreline or boat fishing?
7. Do you prefer a fly rod or spinning rod?



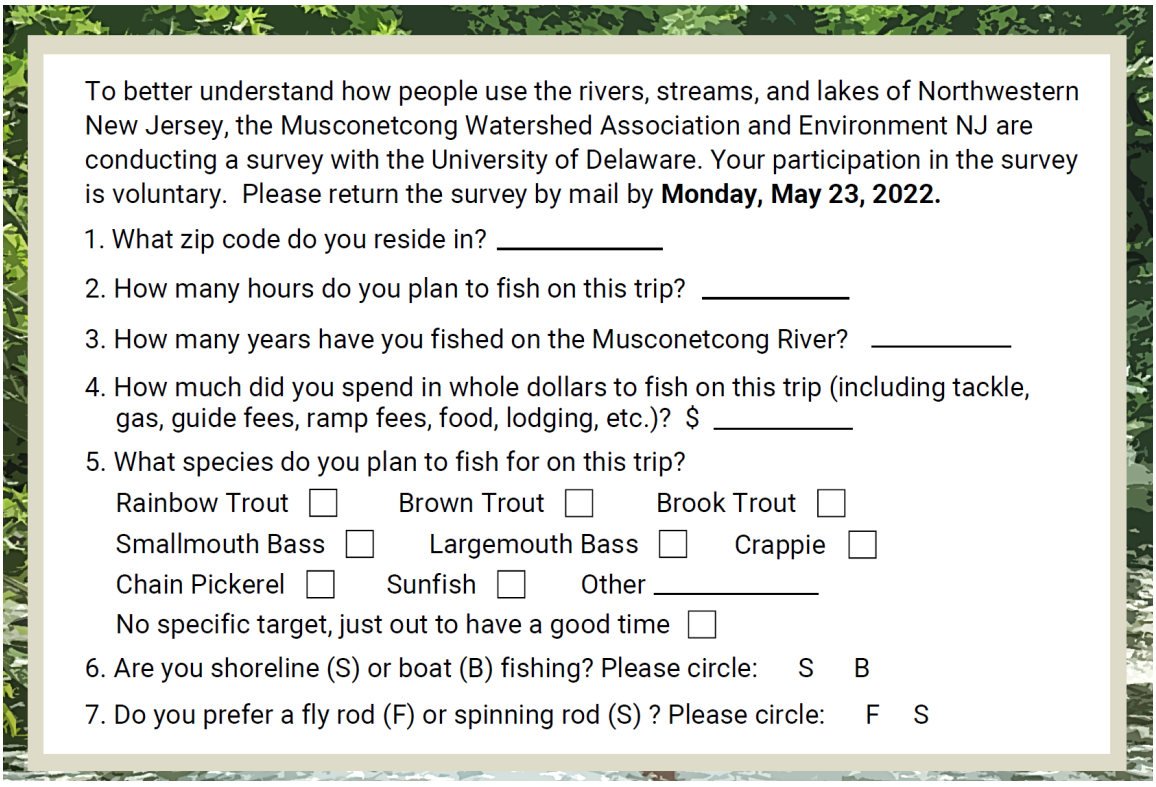


Figure B.2. Sample fishing survey postcard for the Musconetcong River Watershed.

Boating: Survey questions for boating postcards (Figure B.3):

1. What zip code do you reside in?
2. How many hours do you plan to spend on your trip today?
3. How many years have you been coming to this lake/reservoir?
4. How much did you spend in whole dollars on this trip (including clothing, gear, gas, guide fees, ramp or admission fees, food, lodging, etc.)?
5. What activities will you pursue on this trip? (Kayaking, canoeing, sailing, motor boating, paddleboarding, rowing, tubing, wading, swimming, fishing, other).
6. If you are fishing, what species do you plan to fish for? (Largemouth bass; Smallmouth bass; Hybrid striped bass; White bass; Bluegill; Channel catfish; Brown bullhead catfish; Black crappie; Musky; Tiger musky; Yellow perch; Chain pickerel; Northern pike; Atlantic salmon; Sunfish; Lake trout; Rainbow trout; Brown trout; no particular species, just out to have a good time).

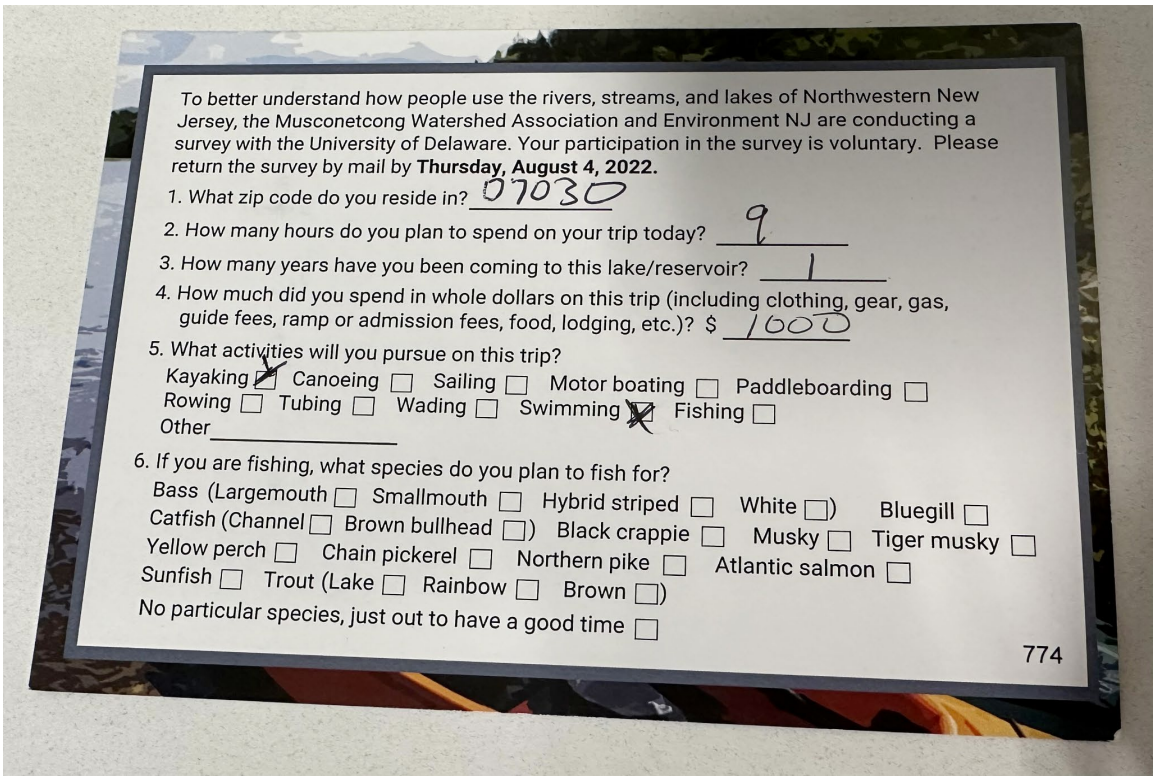
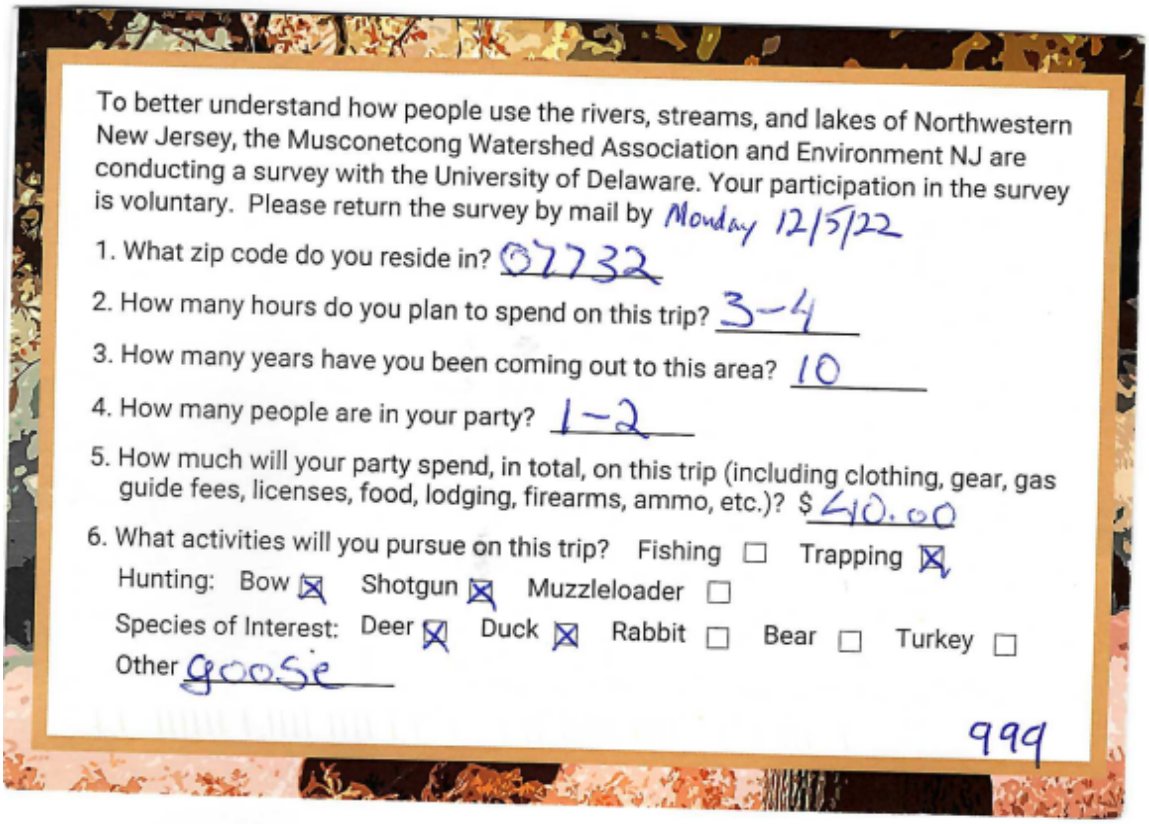


Figure B.3. Completed boating survey postcard for Musconetcong River Watershed.

Hunting: Survey questions for hunting postcards (Figure B.4):

1. What zip code do you reside in?

2. How many hours do you plan to spend on this trip?
3. How many years have you been coming out to this area?
4. How many people are in your party?
5. How much will your party spend, in total, on this trip (including clothing, gear, gas, guide fees, licenses, food, lodging, firearms, ammo, etc.)?
6. What activities will you pursue on this trip? (Fishing, trapping, bow hunting, shotgun hunting, muzzleloader hunting). Species of interest? (Deer, duck, rabbit, bear, turkey, other).


To better understand how people use the rivers, streams, and lakes of Northwestern New Jersey, the Musconetcong Watershed Association and Environment NJ are conducting a survey with the University of Delaware. Your participation in the survey is voluntary. Please return the survey by mail by Monday 12/5/22

1. What zip code do you reside in? 07732
2. How many hours do you plan to spend on this trip? 3-4
3. How many years have you been coming out to this area? 10
4. How many people are in your party? 1-2
5. How much will your party spend, in total, on this trip (including clothing, gear, gas guide fees, licenses, food, lodging, firearms, ammo, etc.)? $ 40.00
6. What activities will you pursue on this trip? Fishing ☐ Trapping ☒
   Hunting: Bow ☒ Shotgun ☒ Muzzleloader ☐
   Species of Interest: Deer ☒ Duck ☒ Rabbit ☐ Bear ☐ Turkey ☐
   Other Goose

999

Figure B.4. Completed hunting survey postcard for Musconetcong River Watershed.

Figure B.5. Recreation areas along Musconetcong River National Wild & Scenic River (NPS)

Results

Survey Outing 1: The first survey outing recorded angler responses and was completed over two days, Saturday, April 30, and Sunday, May 1, 2022, with 6 total hours of direct surveying and 60 total respondents. The results from Survey 1 are from multiple fishing access points within the Musconetcong River Watershed (Table B.2). The map provided shows the recreation areas visited for Survey 1 (Figures B.5). Anglers traveled from 46 different zip codes to fish within the Musconetcong River Watershed with the highest number of anglers arriving from their home ZIP code 08865, Phillipsburg, N.J. (Figure B.6). Most respondents spent 3–5 hours fishing during their trip, but time spent ranged from 1–10 hours (Figure B.7). Most respondents have spent less than 10 years fishing the area along the Musconetcong River with some respondents spending as much as 51–60 years fishing the area (Figure B.8). The total dollar amount spent by anglers ranged from $10 to $200, most anglers spent less than $20 on their trip (Figure B.9). The mean from n = 60 responses on this outing was 4 hours fished, 16 years of fishing experience, and $69.00 spent per visit. Nearly all respondents were fishing from shore with spinning rods used as the most common tackle (Figure B.10).

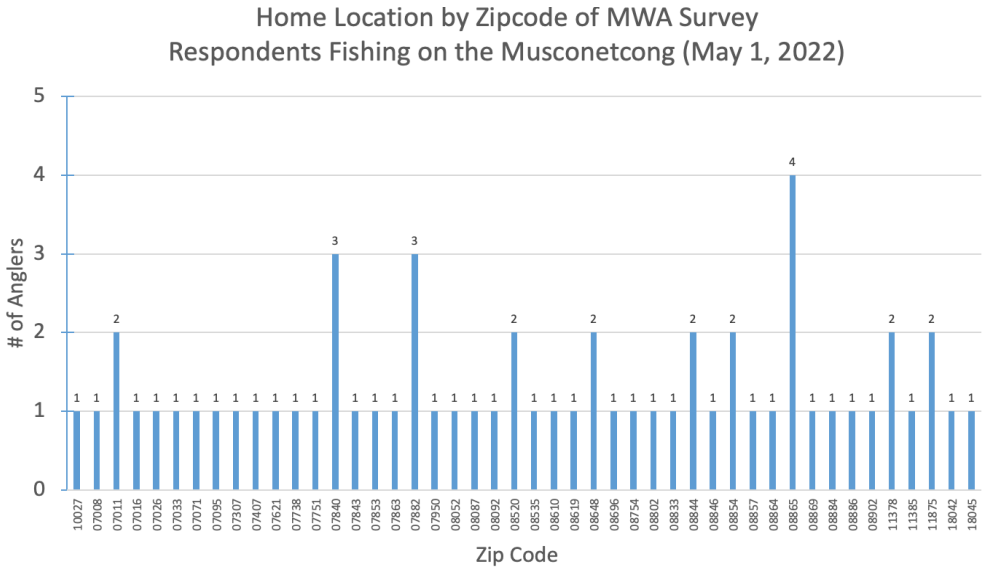


Figure B.6. Home ZIP code of anglers along the Musconetcong River (April 30–May 1, 2022).

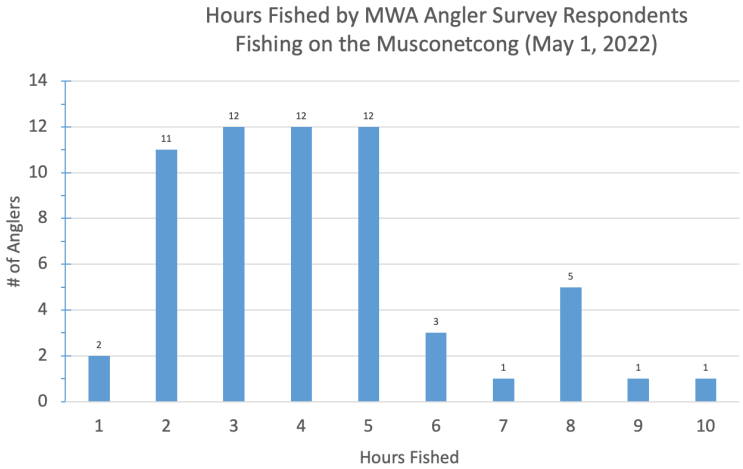


Figure B.7. Hours fished by anglers along the Musconetcong River (April 30–May 1, 2022).

Table B.2. Fishing field survey data along the Musconetcong River (April 30–May 1, 2022).

Response No.	Card No.	ZIP Code	Hours	Years Fished	Spent ($)	Species	Shore (S) or Boat (B)	Fly (F) or Spin (S) or Both (B)
1	26	07853	6	18	500	Rainbow	S	S
2	32	07950	4	40	20	Rainbow	S	S
3	45	08087	3	30	90	Rainbow	S	S
4	46	08092	3	1	80	Rainbow	S	S
5	47	10027	4	6	10	Rainbow	S	S
6	48	07407	10	20	80	Rainbow	S	S
7	49	08052	5	1	200	Rainbow	S	S
8	50	11378	4	2	40	Rainbow	S	S
9	51	11378	5	1	100	Rainbow	S	S
10	52	07071	2	2	60	Rainbow	S	S
11	53	11385	4	6	80	Rainbow	S	S
12	54	07621	8	2	250	Rainbow	S	S
13	55	07011	8	3	150	Rainbow	S	S
14	56	11875	5	20	30	Rainbow	S	S
15	57	11875	5	20	30	Rainbow	S	S
16	58	07011	9	40	30	Rainbow, Brown, Brook	S	S
17	59	08846	4	2	10	Rainbow	S	S
18	61	07095	1	40	12	Rainbow	S	S
19	62	08648	5	1	20	Rainbow	S	F
20	64	08754	4	10	50	Rainbow	S	F
21	65	07016	4	15	30	Rainbow	S	S
22	66	08833	3	10	20	Rainbow	S	S
23	67	08864	6	10	30	Rainbow	S	S
24	68	07738	5	60	20	Rainbow	S	F
25	69	08857	3	3	20	Rainbow	S	S
26	70	08854	2	5	200	Rainbow	S	S
27	71	07751	6	3	20	Rainbow	S	F
28	72	07863	5	40	20	Rainbow	S	S
29	73	07840	2	4	40	Rainbow	S	S
30	74	07840	2	3	30	Rainbow	S	S
31	75	07840	8	30	15	Rainbow	S	S
32	76	07882	2	3	75	Rainbow	S	S
33	77	07307	4	40	100	Rainbow	S	F/S
34	99	08619	5	20	60	Rainbow	S	S
35	100	07008	8	3	75	Rainbow	S	S
36	101	08535	8	3	75	Rainbow	S	S
37	102	07882	2	10	5	Rainbow	S	S
38	103	08865	4	15	10	Rainbow	S	S
39	104	08865	5	15	10	Rainbow	S	S

Response No.	Card No.	ZIP Code	Hours	Years Fished	Spent ($)	Species	Shore (S) or Boat (B)	Fly (F) or Spin (S) or Both (B)
40	105	08902	2	25	15	Rainbow	S	S
41	106	08854	3	30	80	Rainbow	S	S
42	107	08865	4	10	10	NS	S	S
43	110	08869	4	3	25	Rainbow	S	S
44	111	18045	3	3	20	Rainbow, Brown	S	F
45	112	08520	3	2	30	NS	S	S
46	113	08520	3	2	30	NS	S	S
47	114	07033	3	10	10	Other	S	S
48	121	07882	2	1	5	Rainbow	S	S
49	123	08802	5	30	10	Other	S	S
50	124	08610	5	12	30	Rainbow	S	F
51	125	08886	7	40	25	Rainbow	S	S
52	126	07026	2	4	40	Rainbow, Brown	S	F/S
53	130	07843	5	37	20	Rainbow, Brown, Brook	S	S
54	131	08865	4	1	50	Rainbow, Brown, Brook	S	F
55	132	08884	3	35	5	Rainbow	S	S
56	133	08648	3	49		Rainbow, Brown	S	S
57	134	08696	3	10	40	Rainbow, Brown	S	S
58	143	18042	1	57	60	Other	S	S
59	144	08844	2	30	800			S
60	145	08844	2	7		Rainbow, Brown	S	S
n = 60		**Mean:**	**4**	**16**	**69**			

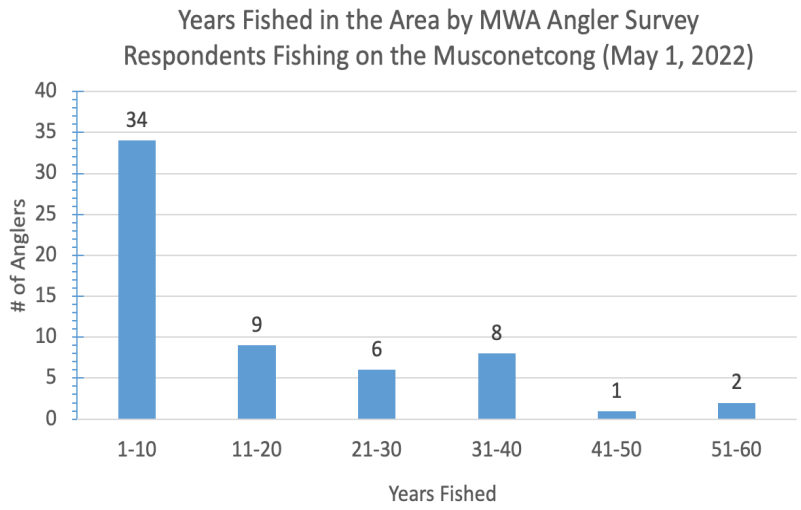


Figure B.8. Years anglers spent fishing along the Musconetcong River (April 30–May 1, 2022)

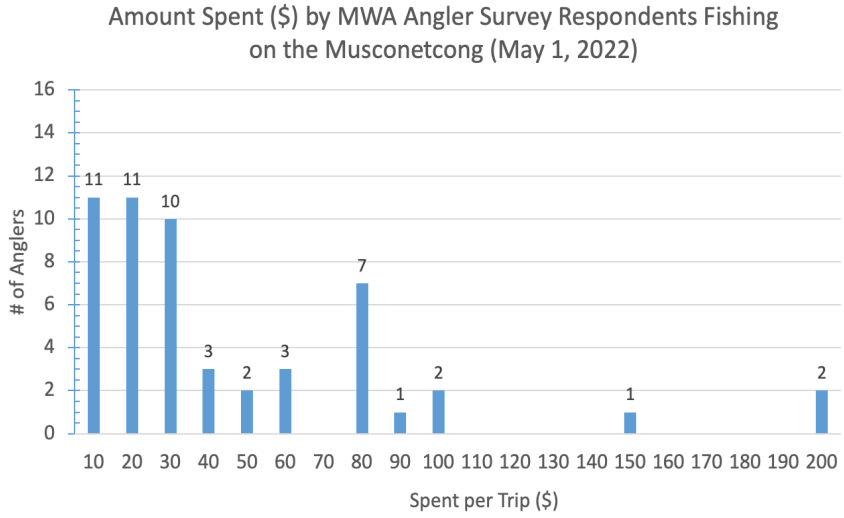
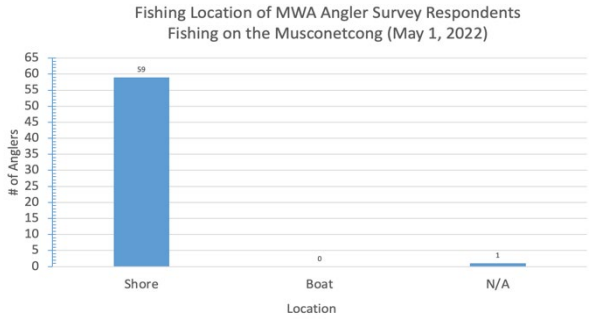


Figure B.9. Amount spent by anglers on the Musconetcong River (April 30–May 1, 2022)



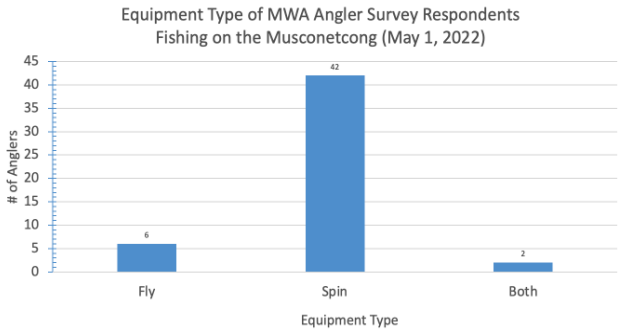


Figure B.10. Angler location and equipment on Musconetcong River (April 30–May 1, 2022)

Survey Outing 2: The second survey outing recorded angler responses on May 27 and June 4, 2022, with 4.5 total hours of direct surveying and 35 total respondents. The results from Survey 2 are from anglers at multiple fishing access points within the Musconetcong River Watershed (Table B.3). Anglers traveled from 26 different ZIP codes to fish within the Musconetcong River Watershed with the highest number of anglers arriving from Hackettstown and Kenvil, N.J. (Figure B.11). The most common response reported for time spent fishing was 4 hours, while some anglers spent up to 10 hours fishing during their trip (Figure B.12). The amount of time that anglers have fished the area ranged from 0–60 years (Figure B.13). Anglers spent between $10 and $120 on their trip, with most spending $10 (Figure B.14). The majority of respondents were shore fishing (Figure B.15) and using spinning rods (Figure B.16). The maps show the number of interviews at each location (Figure B.17) and spending trends by anglers at respective survey interview locations (Figure B.18) during Survey 2. The mean from n = 35 responses on this outing was 4 hours fished, 17 years of fishing experience, and $36.00 spent per visit.

Table B.3. Fishing field survey data along the Musconetcong River (May 27 and June 4, 2022)

Response No.	Card No.	ZIP Code	Hours	Years Fished	Spent ($)	Species	Shore (S) or Boat (B)	Fly (F) or Spin (S) or Both (B)
61	6	07874	7	15	50	Rainbow, Brown, Brook	S	F
62	7	07840	4	1	10	Rainbow	S	S
63	8	07836	3	25	10	Largemouth, Chain Pickerel	S	S
64	9	07860	2	2	20	Largemouth	S	S
65	10	07874	4	10	80	Largemouth	B	S
66	11	07874	4	10	70	Rainbow	B	S
67	14	07840	4	10	25	Rainbow, Other	S/B	S
68	20	07892	4	6	5	Other	B	S
69	24	08562	5	33	120	Rainbow	S	S
70	25	07828	2	2	10	Rainbow	S	S
71	33	08804	3	4	5	Rainbow, Sunfish	S	S
72	36	08865	4	30	30	Rainbow, Other	S	S

Response No.	Card No.	ZIP Code	Hours	Years Fished	Spent ($)	Species	Shore (S) or Boat (B)	Fly (F) or Spin (S) or Both (B)
73	37	08848	5	35	10	Rainbow, Brown, Brook	S	F
74	79	07047	5	2	25	Rainbow	S	F
75	80	07030	5	2	50	Rainbow	S	F
76	81	07302	4	3	70	Rainbow	S	F
77	82	07833	4	53		Rainbow	S	S
78	83	07006	4	5	10	Rainbow	S	S
79	151							
80	161	08620	10	55	20	Rainbow	S	F
81	162	08827	2	4		Rainbow, Brook	S	S
82	163	07095	5	2	60	Rainbow	S	S
83	164	07095	5	2	60	Rainbow	S	S
84	165	08857		5	100	Rainbow	S	S
85	166	08859	2	3	100	Rainbow		
86	167	08826	2	50	10	Rainbow	S	S
87	168	08846	4	3	20	Brown	S	S
88	169	08827	5	15	40	Rainbow	S	S
89	202	07841	1	55	10	Rainbow	S	S
90	203	07840	3	20	10	Rainbow	S	S
91	204	08301	4	30	30	Rainbow	S	S
92	205	07866	4	20	35	Rainbow	S	B
93	208	07860	3	20	20	Rainbow	S	F
94	209	07843	2	15	10	Rainbow	S	F
134	109	08807	6	43	30	Rainbow, Brown, Brook	S	F
n = 35		**Mean:**	**4**	**17**	**36**			

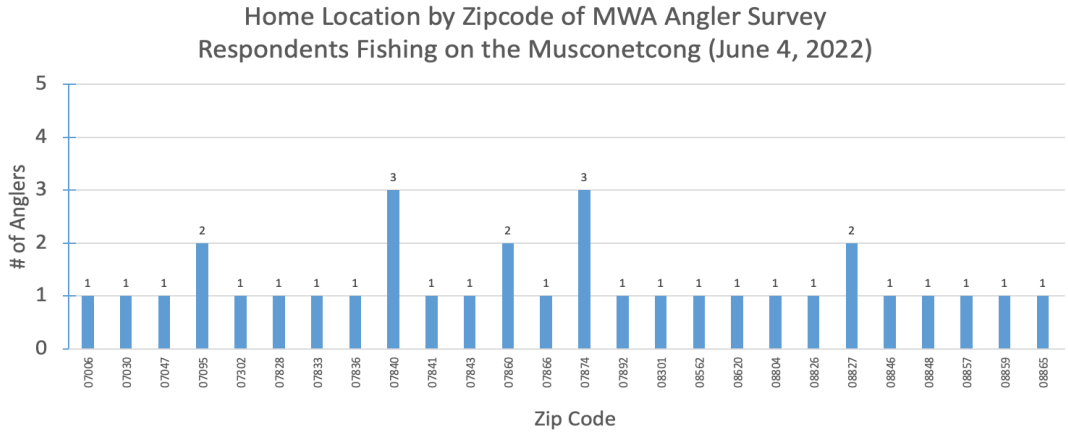


Figure B.11. Home ZIP code of anglers along the Musconetcong River (May 27 and June 4, 2022)

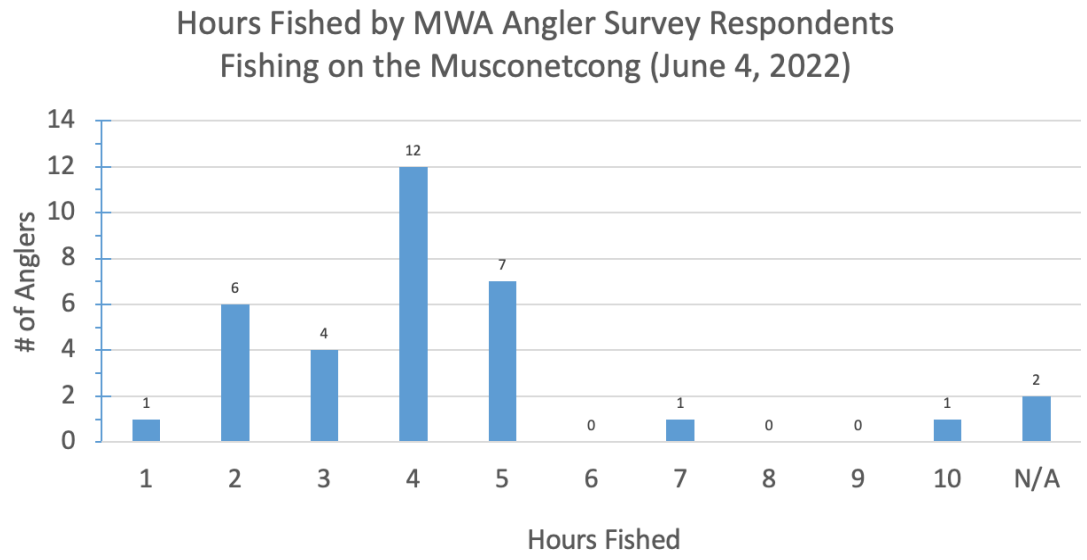


Figure B.12. Hours fished by anglers along the Musconetcong River (May 27 and June 4, 2022)

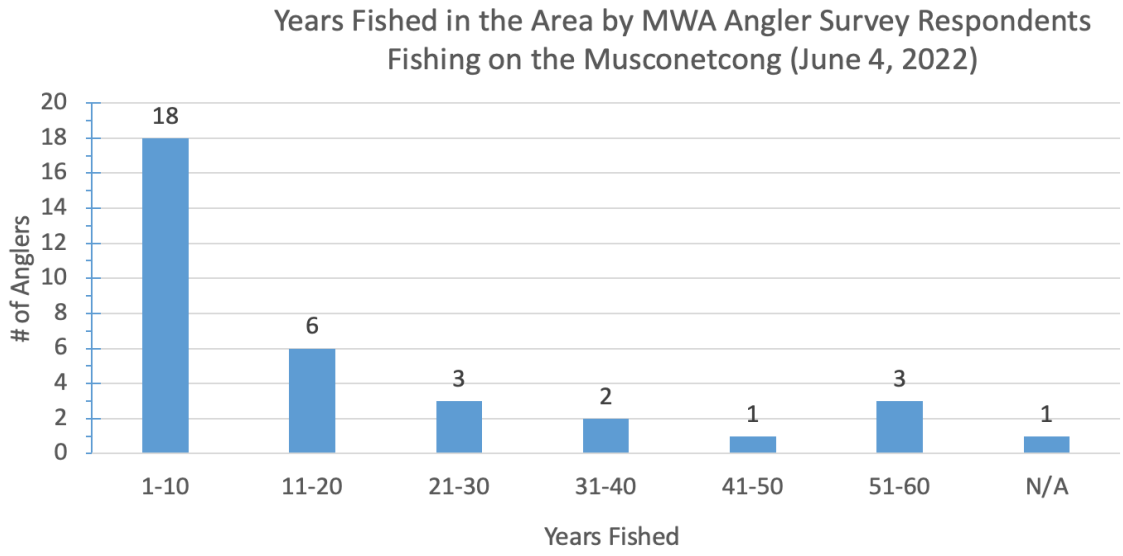


Figure B.13. Years anglers spent fishing on the Musconetcong River (May 27 and June 4, 2022)

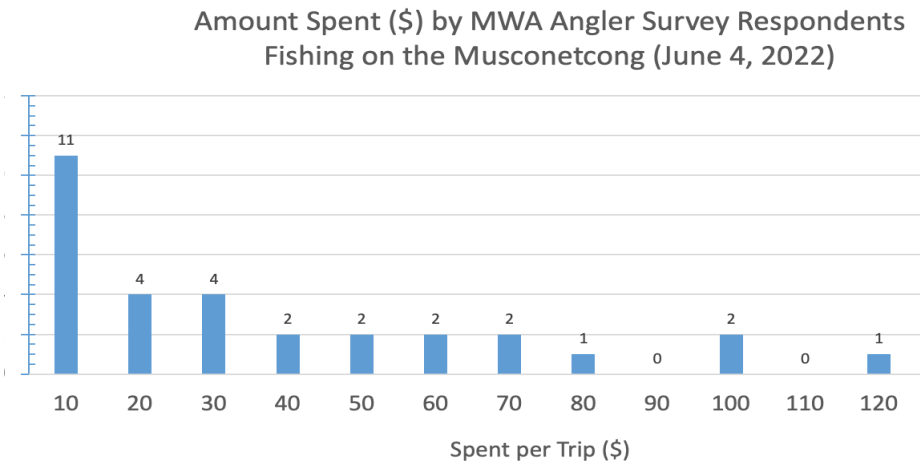


Figure B.14. Amount spent by anglers on the Musconetcong River (May 27 and June 4, 2022)

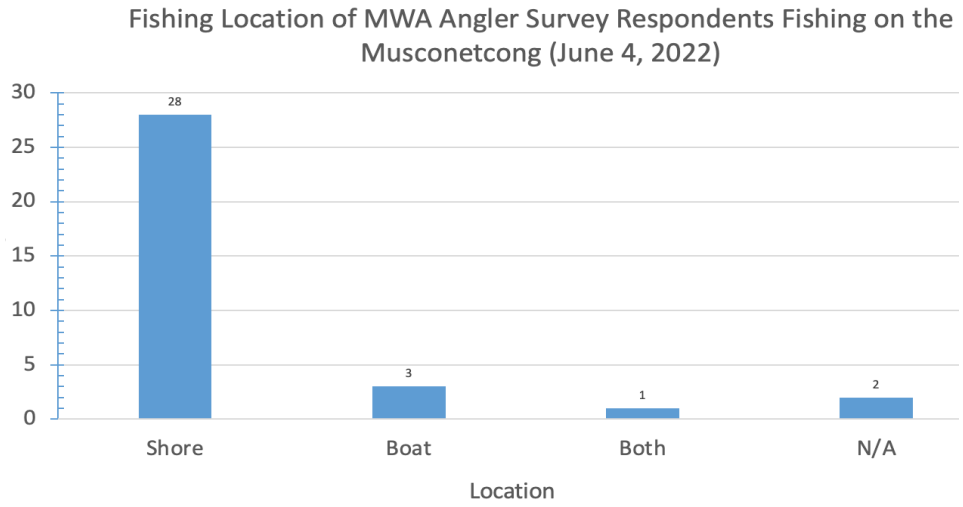


Figure B.15. Fishing location of anglers along the Musconetcong River (May 27 and June 4, 2022)

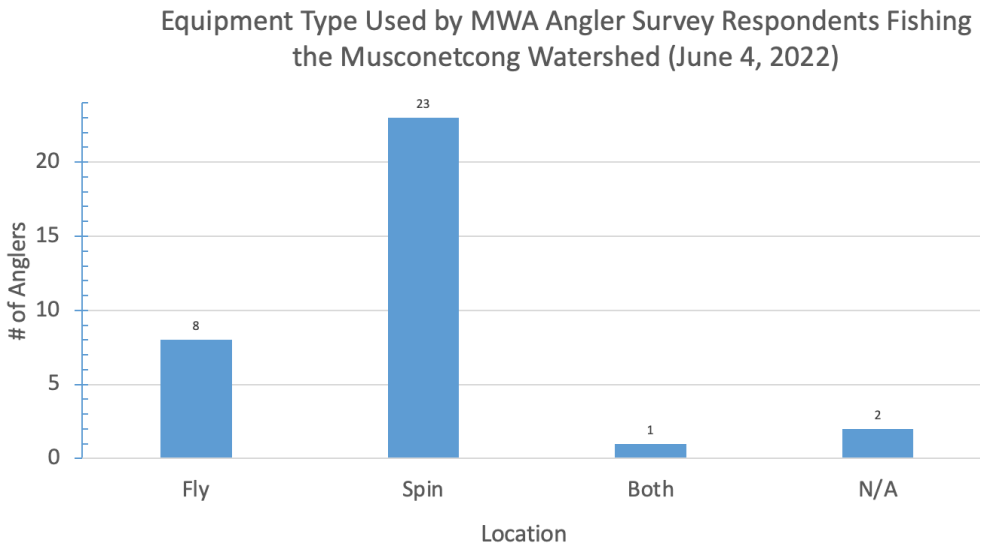


Figure B.16. Equipment used by anglers along the Musconetcong River (May 27 and June 4, 2022)

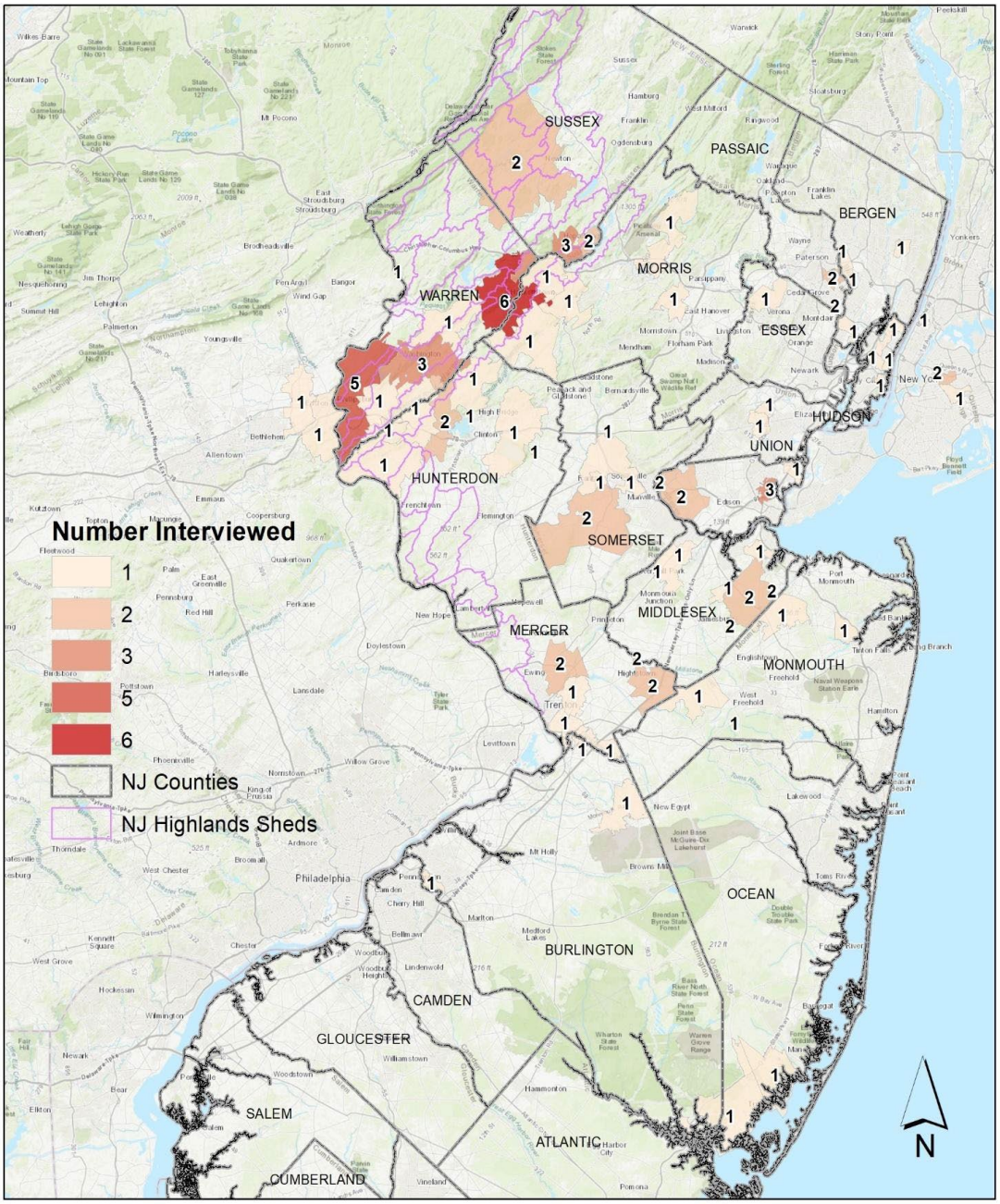


Figure B.17. Number of anglers by ZIP code interviewed on Musconetcong River (April 30, May 1, June 4, and September 30, 2022)

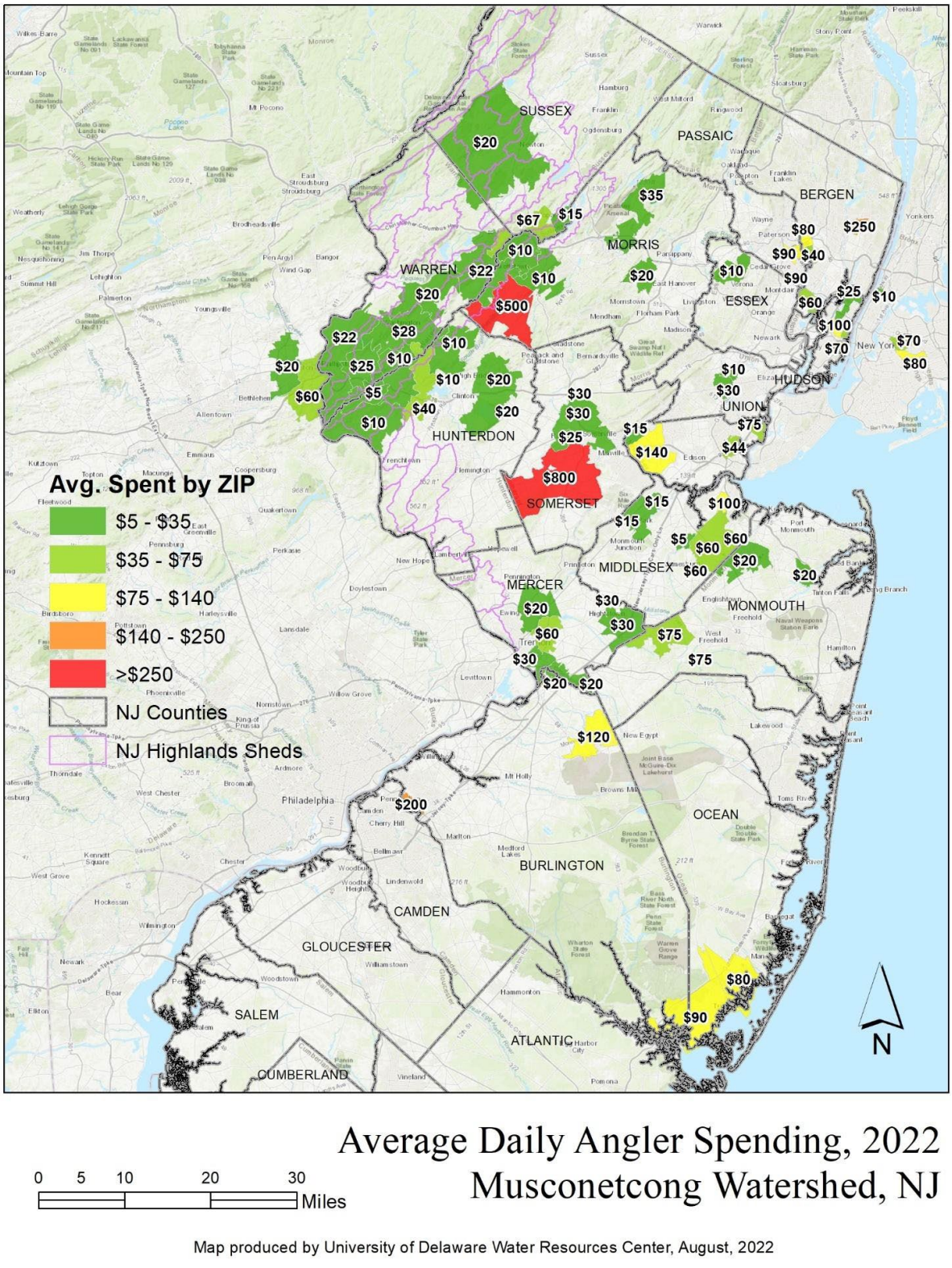


Figure B.18. Angler spending by ZIP code on Musconetcong River (April 30, May 1, June 4, and September 30, 2022)

Survey Outing 3: The third survey outing took place on Tuesday, June 28, 2022, and involved 1.5 hours of direct contact with respondents. The results from Survey 3 are from respondents at multiple recreation access points along the Musconetcong River (Table B.4). Respondents traveled from 20 home ZIP codes for their activity, most (5) from 07843 or Hopatcong, N.J. (Figure B.19). Most respondents (6) planned to spend two hours for their activity, but time spent ranged from 1–9 hours total (Figure B.20). Years spent in the area ranged from 0 (first time visiting) to 70 years (Figure B.21), and money spent on activities ranged from $0–$300+, with most respondents (9) spending $10 or less (Figure B.22). The map shows home locations of survey respondents during Survey 3 (Figure B.23). The mean from n = 27 responses on this outing was 4 hours per visit, 15 years visited, and $148.00 spent per visit.

Table B.4. Recreation field survey data along the Musconetcong River (June 28, 2022)

Response	Card No.	ZIP	Hours	Years Visited	Spent ($)	Activity Pursued
95	314	07843	4	30	150	Tubing, Boating
96	315	07847	1	70	5	Wildlife Viewing
97	316	NR	NR	NR	NR	NR
98	317	07011	4	55	35	BBQ, Walking
99	318	11374	8	5	100	Relaxing
100	319	07174	5	30	300	Fishing
101	320	07419	1	1	0	Checking for Grandchildren
102	321	07540	3	18	0	Picknicking
103	322	07874	2	18	0	Wildlife Viewing
104	323	NR	NR	NR	NR	NR
105	324	07874	2	3	0	Wildlife Viewing
106	339	07843	2	6	50	Walking, Picknicking
107	340	07093	3	2	60	Sunbathing
108	341	07420	3	30	30	Wildlife Viewing, Sunbathing
109	342	07803	3	5	5	Wildlife Viewing, Sitting
110	343	07801	3	4	5	Wildlife Viewing, Sitting
111	344	07013	6	7	200	Picknicking
112	345	07107	4	20	250	Walking, Picknicking
113	346	11835	6	0	200	Picknicking
114	347	07522	2	15	30	Walking, Wildlife Viewing
115	348	07843	2	2	15	Walking, Wildlife Viewing
116	349	07843	2	1	5	Walking, Playground
117	724	07028	6	20	100	Fishing
118	749	07843	1	42	0	Sailing
119	757	07875	8	2	75	Motor boating, Fishing
120	773	07030	8	1	500	Kayaking, Swimming
121	774	07030	9	1	1000	Kayaking, Swimming
n = 27		**Mean:**	**4**	**15**	**148**	

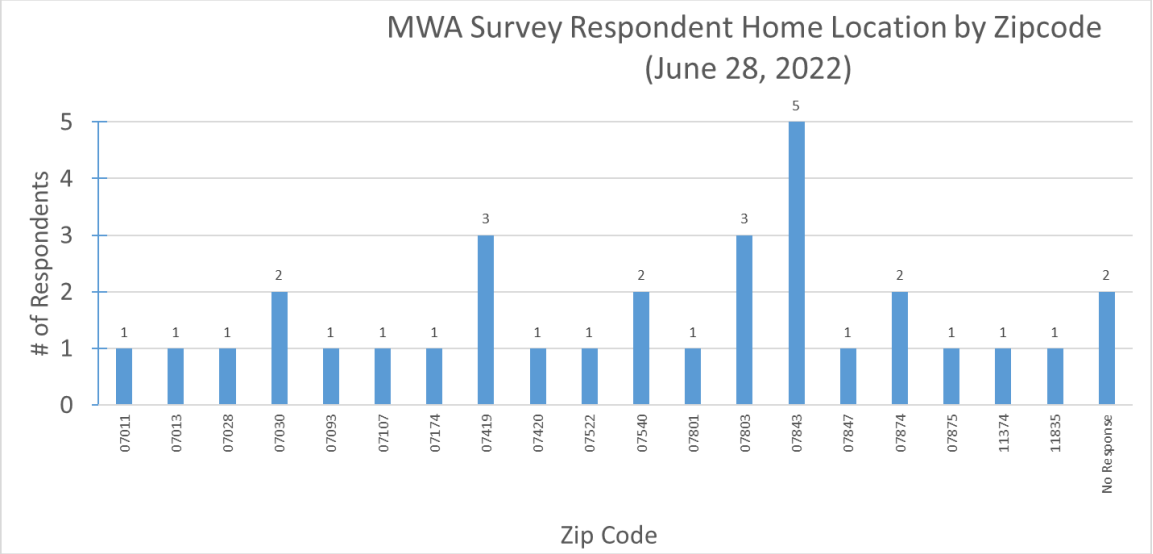


Figure B.19. Home ZIP code of recreation respondents on the Musconetcong River (June 28, 2022)

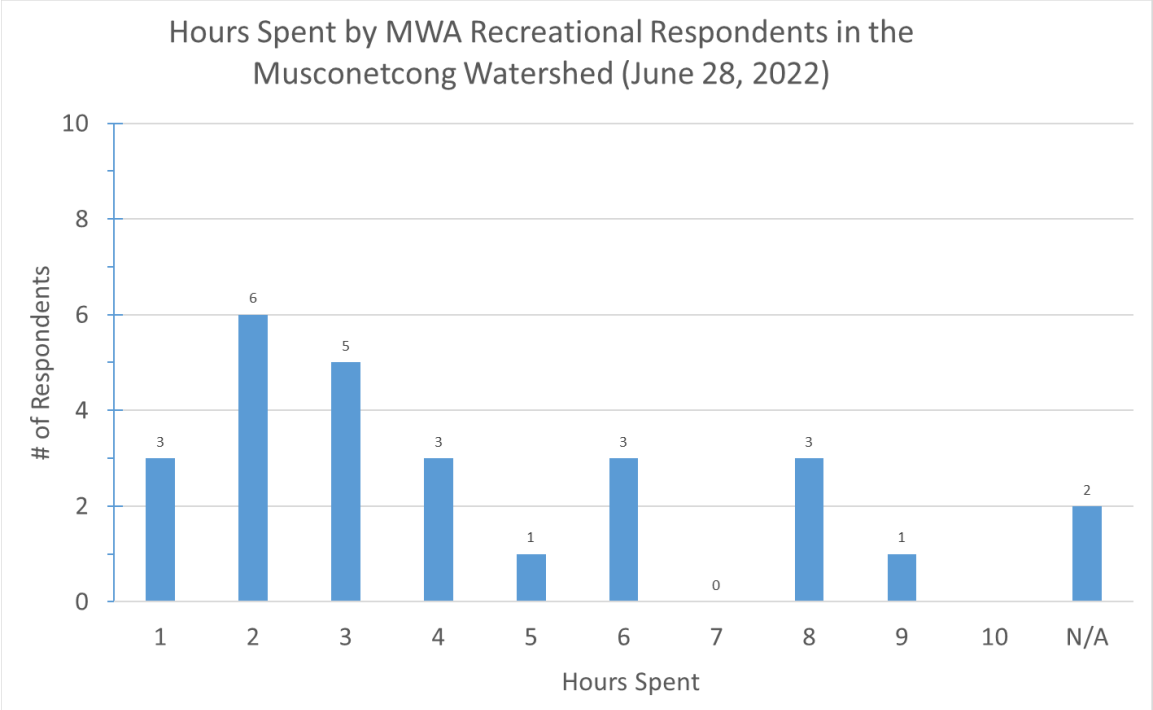


Figure B.20. Hours spent by recreation respondents on the Musconetcong River (June 28, 2022)

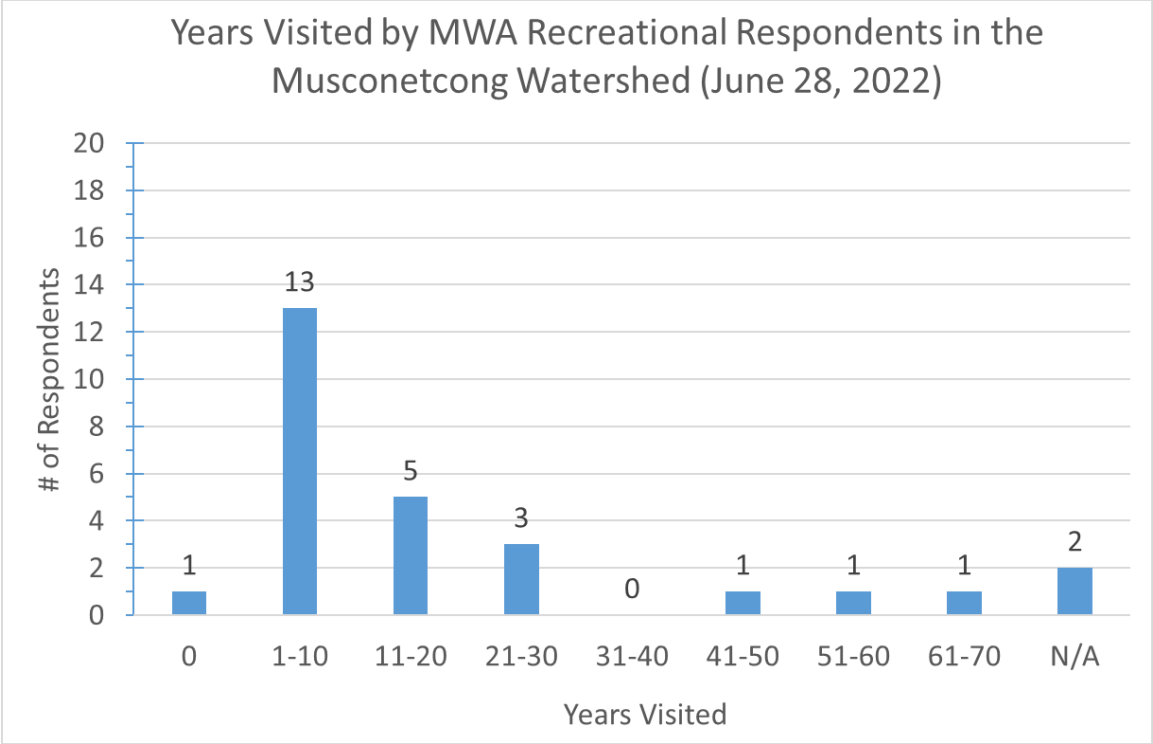


Figure B.21. Years visited by recreation respondents on the Musconetcong River (June 28, 2022)

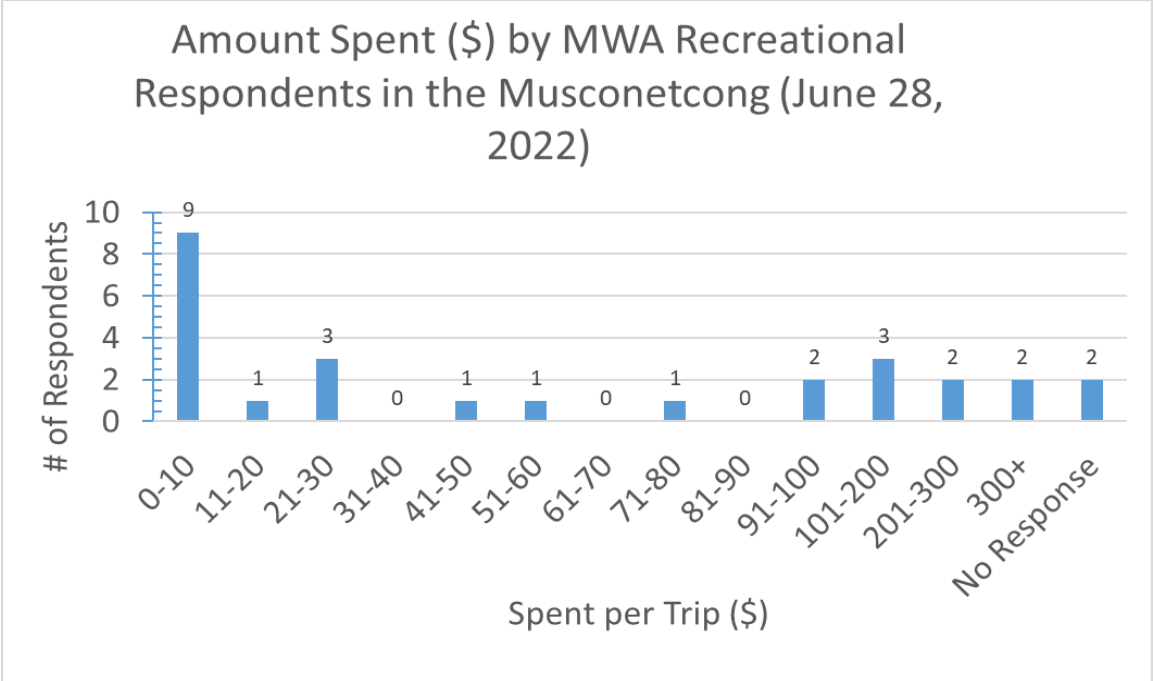


Figure B.22. Money spent by recreation respondents on the Musconetcong River (June 28, 2022)

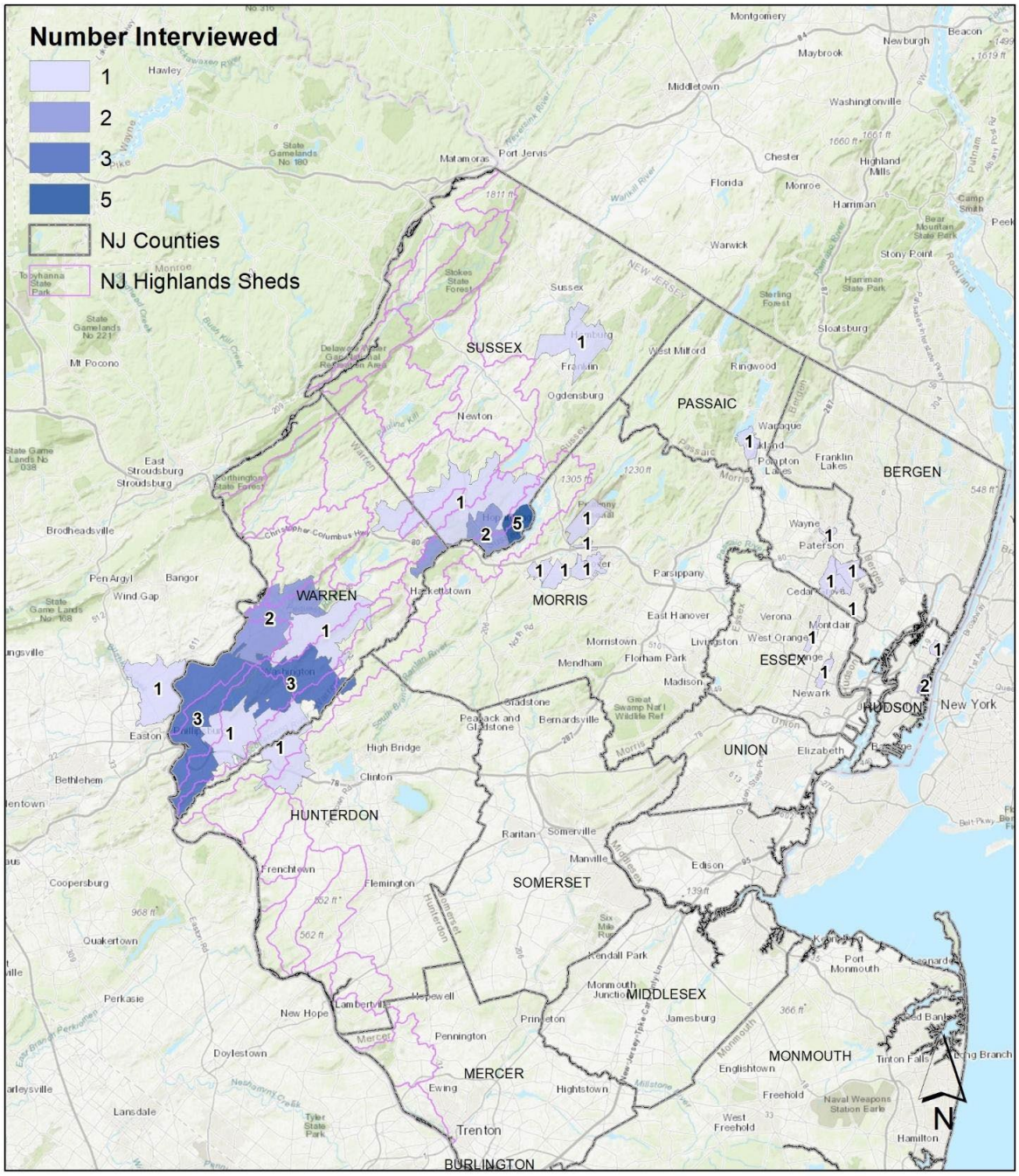


Figure B.23. Number of recreation visitors interviewed by ZIP Code on Musconetcong River (June 28, 2022)

Survey Outing 4: The fourth survey outing took place on Friday, July 15, 2022, and involved 3 hours of direct contact with respondents. The results from Survey 4 are from respondents at Merrill Creek Reservoir (Table B.5). Respondents reported traveling from eight different home ZIP codes (Figure B.24) and the most common (4 responses) time spent on this day was two hours (Figure B.25). Most respondents (8) reported visiting this area for 1–10 years (Figure B.26) and reported spending ranged from $0 to $25+ (Figure B.27). Data from check-in sheets at Merrill Creek Reservoir provided data ranging from March to July 2022 on three additional subjects: size of group, type of boat, and boating intention (Figure B.28). The mean from n = 13 responses on this outing was 3 hours per visit, 10 years visited, and $135.00 spent per visit.

Table B.5. Recreation field survey data at Merrill Creek Reservoir (July 15, 2022)

Response	Card No.	ZIP Code	Hours	Years Visited	Spent ($)	Activities Pursued | Trails
121	390	07821	4	3	25	hiking, bird-watching, picnicking
122	391	08886	2	8	15	hiking, picnicking, educational program
123	392	07882	4	5	5	hiking, picnicking, educational program
124	407	08865	2	6	10	walking, hiking, viewing other wildlife
125	408	08865	1	6	5	walking, hiking
126	410	07882	1	1	0	
127	787	07823	3	2	10	motor boating, fishing
128	788	08802	2.5	25	5	kayaking
129	789	07863	6	27	20	motor boating, fishing
130	790	07882	2	20	20	kayaking
131	791	07823	1.5	0	10	kayaking
132	792	08865	2	20	10	kayaking
133	828	18040	3	2	0	fishing
n=13		**Mean:**	**3**	**10**	**135**	

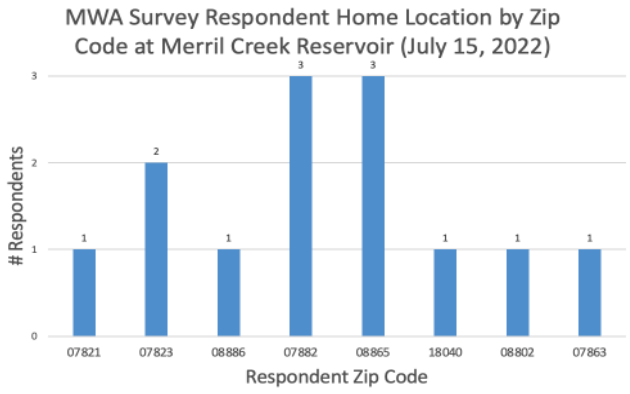


Figure B.24. Home ZIP code of recreation respondents at Merrill Creek Reservoir (Jul 15, 2022)

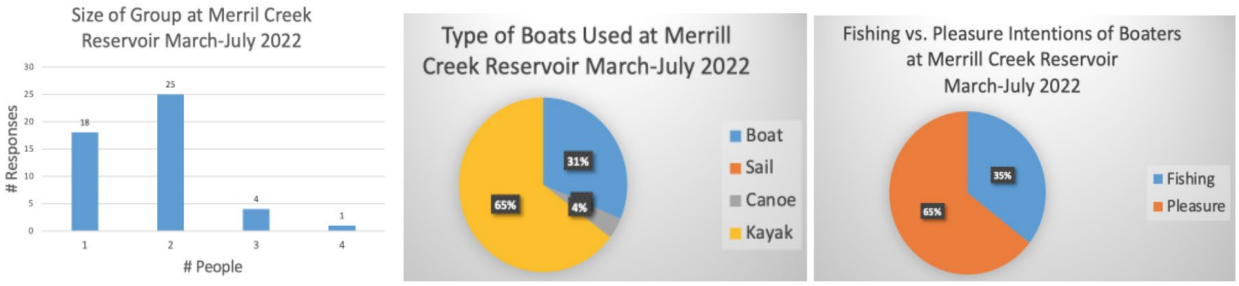


Figure B.25. Data from check-in records at Merrill Creek Reservoir (Jul 15, 2022)

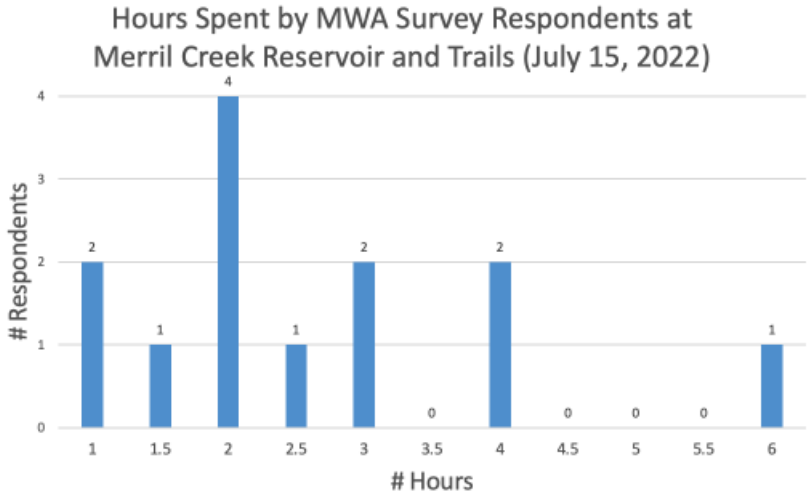


Figure B.26. Hours spent by recreation respondents at Merrill Creek Reservoir (July 15, 2022)

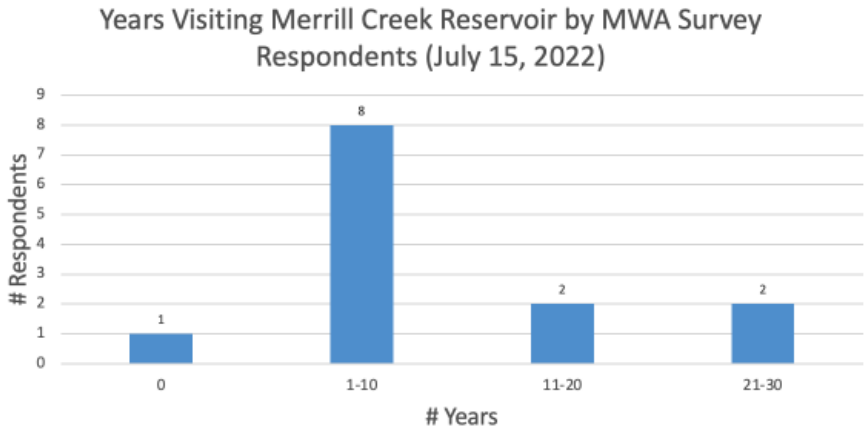


Figure B.27. Years visited by recreation respondents at Merrill Creek Reservoir (July15, 2022)

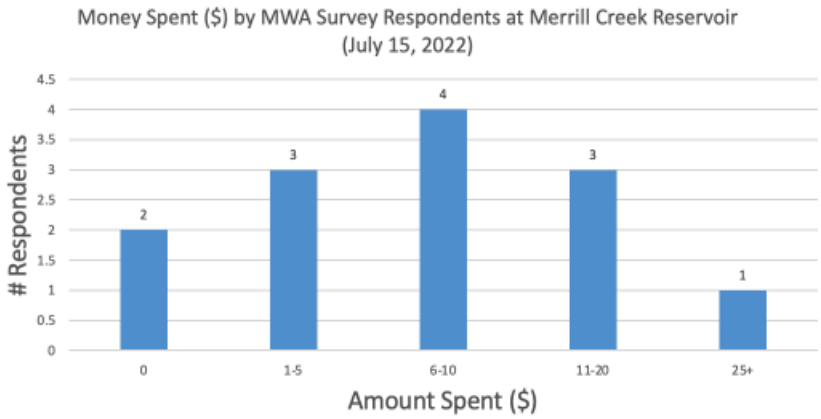


Figure B.28. Money spent by recreation respondents at Merrill Creek Reservoir (July 15, 2022)

Survey Outing 5: The fifth survey outing took place on Friday, September 30, 2022, and involved 2.5 hours of direct contact with respondents. The results are from surveying at two locations during Survey 5: Sussex Branch Trail and Lake Musconetcong (Table B.6). Respondents on this outing reported traveling from 12 different zip codes (Figure B.29), spending between 0.5 hours to 3+ hours for their activity (Figure B.30), and the large majority (11 respondents) have been visiting the area for five years or less (Figure B.31). Most respondents (4) spent $10 or less on this outing, but spending ranged from $0–$200 (Figure B.32). The mean from n = 12 responses on this outing was 2 hours per visit, 4 years visited, and $60.00 spent per visit.

Table B.6. Recreation survey data at Lake Musconetcong & Sussex Branch Trail (September 30, 2022)

Response	Card No.	ZIP Code	Hours	Years Visited	Spent ($)	Activities Pursued | Trails
134	352	18045	2	0	30	Hiking
135	353	07874	1.5	7	5	Hiking, Other-photography
136	355	07860	1	2	5	Walking , Other-pets
137	356	07850	0.5	15	15	Walking
138	357	07840	1.5	4	2	Hiking
138	358	07871	1.5	10	2	Hiking
140	359	19801	0.5	1	200	Hiking
141	360	07828	1	6	50	Hiking, Other-Dog walk
142	361	07047	2.5	1	40	Other-kids program
143	362	80634	4	1	100	Cycling
144	374	65604	12	1	300	
Response	**Card No.**	**ZIP Code**	**Hours**	**Years Visited**	**Spent ($)**	**Boating/Water Activities**
145	725	07843	2	1	25	Fishing
n=12		**Mean:**	**2**	**4**	**60**	

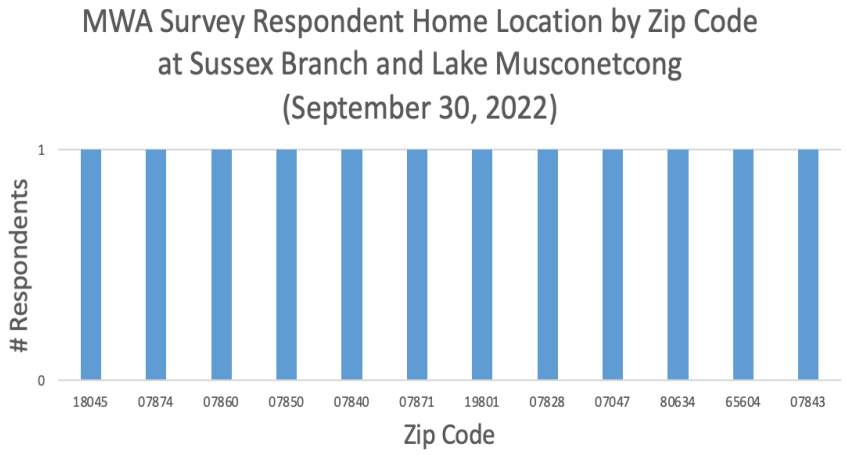


Figure B.29. Home ZIP code of recreation visitors at Sussex Branch Trail and Lake Musconetcong (September 30, 2022)

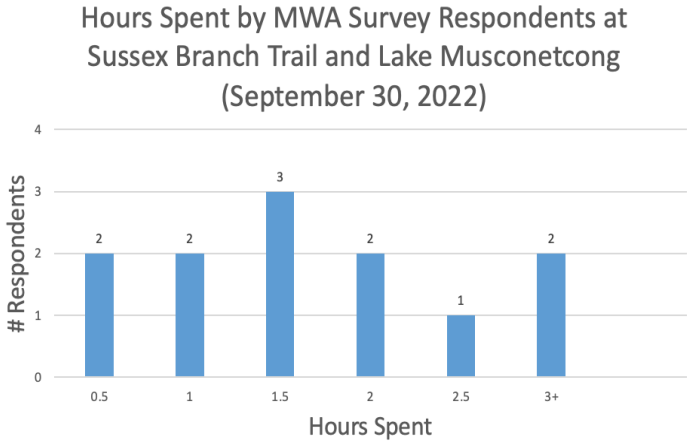


Figure B.30. Hours spent by recreation visitors at Sussex Branch Trail and Lake Musconetcong (September 30, 2022)

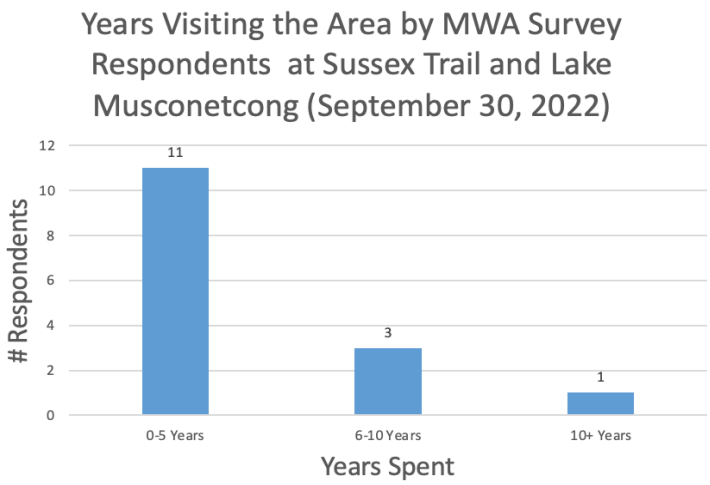


Figure B.31. Years visited by recreation visitors at Sussex Branch Trail and Lake Musconetcong (September 30, 2022)

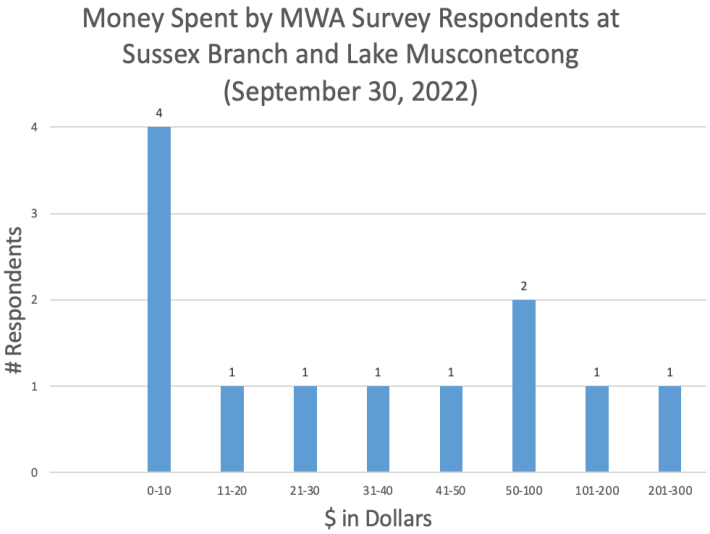


Figure B.32. Spending by recreation visitors at Sussex Branch Trail and Lake Musconetcong (September 30, 2022)

Survey Outing 6: The sixth survey outing took place on Wednesday, October 19, 2022, and involved 2 hours of direct contact with respondents. The results from the survey outing featured two locations: Sussex Branch and Point Mountain trail areas (Table B.7). Respondents reported visiting from 23 different home ZIP codes (Figure B.33), 65% spent one or two hours for their activity (Figure B.34), and most have been visiting the area for 5 years or less (10 respondents) or between 5–10 years (6) with three people reporting visiting these areas for over 50 years (Figure B.35). Money spent by respondents in the sixth survey outing ranged from $0–$600, with most people (13) reporting $5 or less (Figure B.36). The mean from n = 29 responses on this outing was 2 hours per visit, 15 years visited, and $55.00 spent per visit.

Table B.7. Recreation survey data at Sussex Branch and Point Mountain trail areas (October 19, 2022)

Response	Card No.	ZIP Code	Hours	Years Visited	Spent ($)	Activities Pursued | Trails
146	375	07879	1	6	50	Hiking, Other-Photography
147	376	07078	2.5	25	25	Hiking
148	377	08833	2	2	20	Cycling
149	378	07825	2	53	30	Hiking
150	379	07054	2	10	25	Hiking
151	380	07836	2	32	25	Hiking
152	381	07866	2.5	20	25	Hiking
153	382	07416	1	1	15	Picnicking
154	383	07860	2	30	5	Walking
155	384	07801	2	10	5	Walking, Hiking
156	385	07843	1	5	5	Walking
157	386	07853	3	15	5	Hiking
158	387	07874	1	7	2	Other-Running
159	388	07885	1	5	5	Other-Running
160	393	07801	1	1	0	Hiking
161	394	07840	2	10	0	Hiking
162	395	08807	2.5	5	505	Fishing *same as #171
163	396	07869	2	1	180	Hiking
164	397	08810	3	3	5	Hiking
165	398	NR	NR	NR	NR	NR
166	401	07869	3	0	3	Hiking
167	402	07840	1	5	0	Walking, Viewing wildlife
168	403	07882	1	15	0	Walking, Hiking, Other-running
169	404	08822	2	10	100	Walking, Hiking, Other-birding
170	405	08802	2	30	15	Walking, Hiking, Picnicking
171	406	07882	3	50	1	Walking, Hiking
172	794	08807	2.5	5	505	Fishing
173	806	07865	1.5	70	8	Fishing
174	808	08525	3	15	30	Fishing
n=29		**Mean:**	**2**	**15**	**56**	

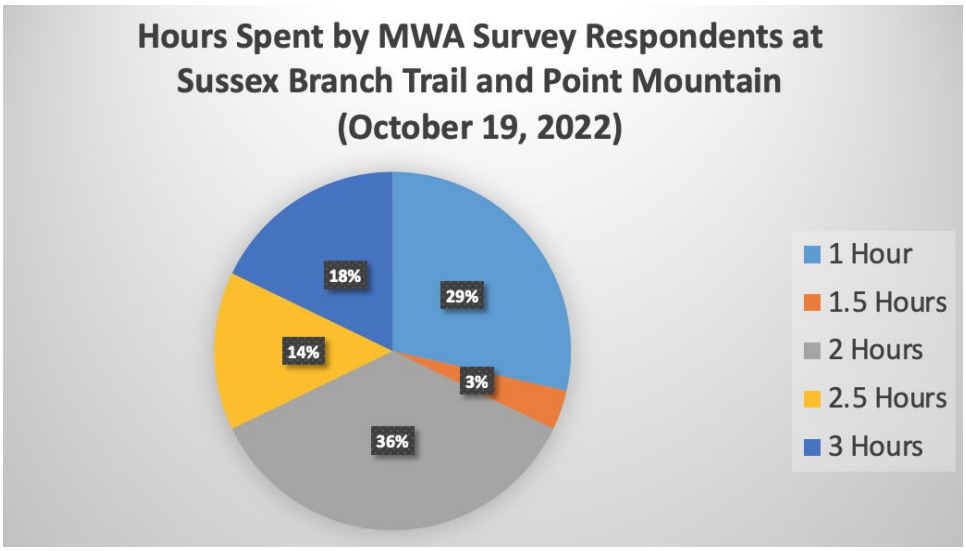


Figure B.33. Hours spent by recreation visitors at Sussex Branch Trail and Point Mountain (October19, 2022)

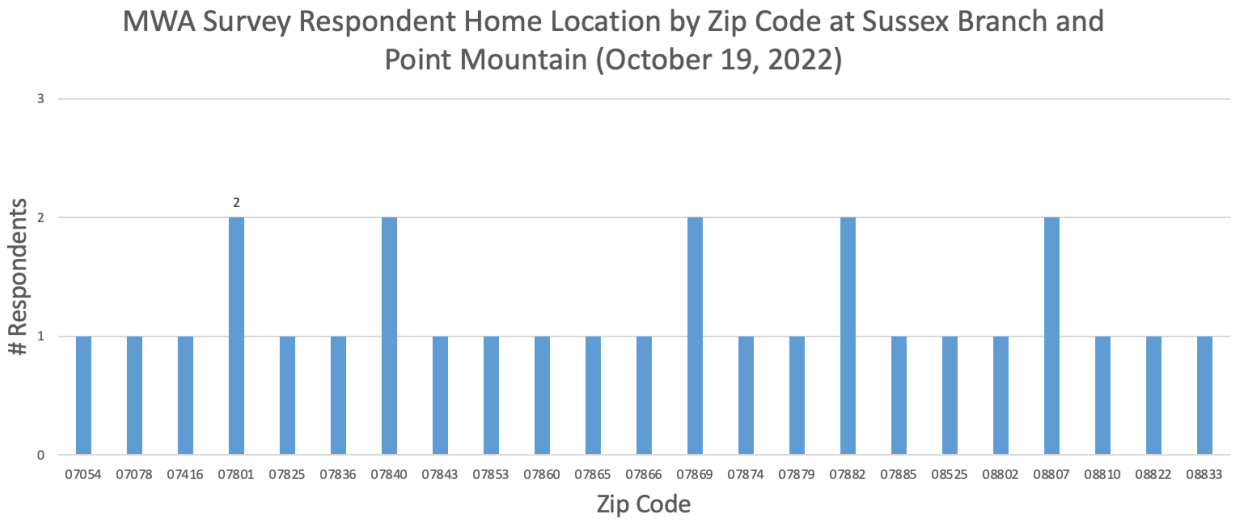


Figure B.34. Home ZIP code of recreation visitors at Sussex Branch Trail and Point Mountain (October19, 2022)

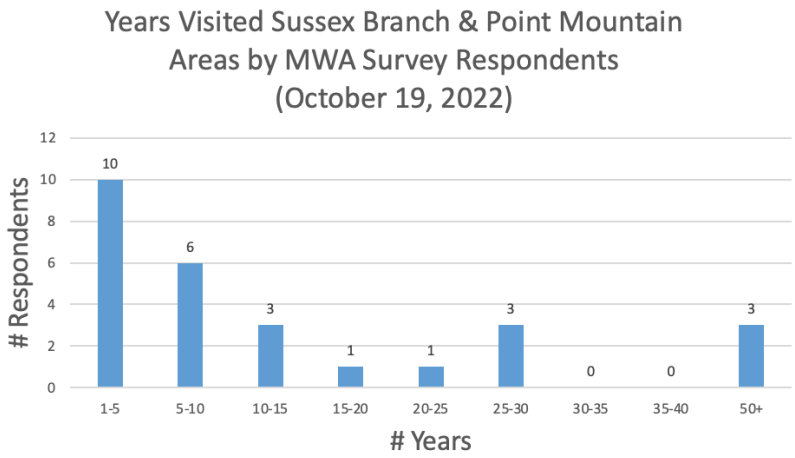


Figure B.35. Years visited by recreation visitors at Sussex Branch Trail and Point Mountain (October19, 2022)

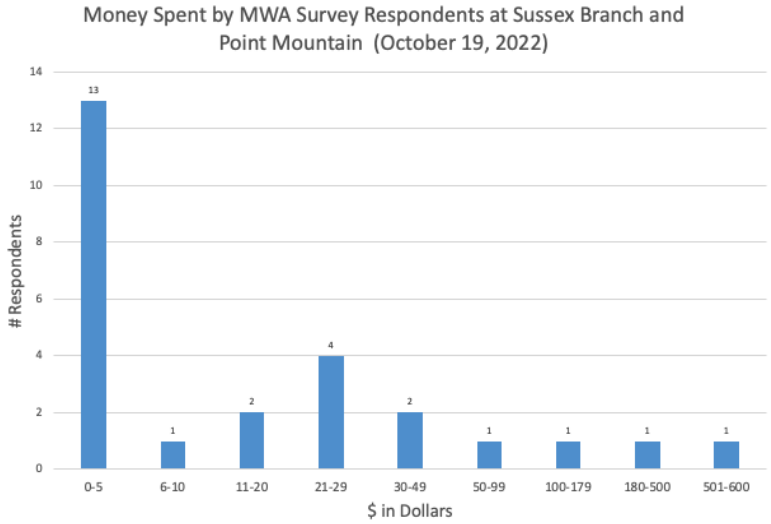


Figure B.36. Money spent by recreation visitors at Sussex Branch Trail and Point Mountain (October19, 2022)

Survey Outing 7: The seventh survey outing took place on Saturday, November 19, 2022, and involved 2 hours of direct contact with respondents. The results from this survey outing include responses collected at several locations: Point Mountain trailhead, Stephens State Park, Stephens MTB, Sussex Branch trailhead, and Penwell access (Table B.8). Respondents reported visiting from 24 different home locations (Figure B.37), typically spending 3 or less hours for their visit (Figure B.38), and most (21 respondents) report visiting the area for 1–5 years (Figure B.39). Spending reported in Survey 7 ranged from $0–$50+ and most respondents spent $5 or less (Figure B.40). The mean from n = 28 responses on this outing was 3 hours per visit, 7 years visited, and $23.00 spent per visit.

Table B.8. Recreation survey data along Musconetcong River Watershed (November 19, 2022)

Response No.	Card No.	ZIP Code	Hours	Years Visited	Spent ($)	Activities Pursued | Trails
175	501	07921	2	1	15	Hiking
176	500	07850	2	3	30	Hiking
177	494	07828	2	4	5	Hiking
178	491	07054	2	1	10	Walking, Hiking
179	485	07840	1	30	10	Walking, Hiking
180	478	07920	1	3	5	Hiking
181	471	08827	1	1	15	Hiking
182	465	07871	1	1	5	Hiking
183	464	11419	3	1	25	Hiking
184	463	07856	1	2	12	Hiking
185	462	07866	3	20	5	Cycling
186	461	07857	2	3	1	Hiking
187	460	07940	2	1	10	Hiking
188	459	07945	3	1	5	Hiking
189	458	07874	3	30	1	Hiking
190	456	07920	1	3	5	Hiking
191	477	07882	3	5	20	Walking, Hiking, Climbing, Viewing wildlife
192	451	18104	6	1	120	Hiking, Birdwatching, viewing other wildlife
193	399	07750	48	10	200	Other-Fishing
194	435	08865	4	4	5	Hiking, Other-Leading educational hike
Response No.	**Card No.**	**ZIP Code**	**Hours**	**Years Visited**	**Spent ($)**	**Activities Pursued | Boating/Water Activities**
195	807	07960	3	5	25	Fishing
Response No.	**Card No.**	**ZIP Code**	**Hours**	**Years Fished**	**Spent ($)**	**Species**
196	200	08844	6	15	50	Rainbow Trout, Brown Trout
197	201	07921	6	3	50	Rainbow Trout, Brown Trout
Response No.	**Card No.**	**ZIP Code**	**Hours**	**Years Hunted**	**$ spent by party**	**# in party**
198	998	08827	2	1	200	3
199	997	07730	3	2	35	1
200	999	07732	4	10	40	2
201	991	07882	1	4	0	1
202	992	08826	2	25	0	1
n=28		**Mean=**	**3**	**7**	**23**	**1.6**

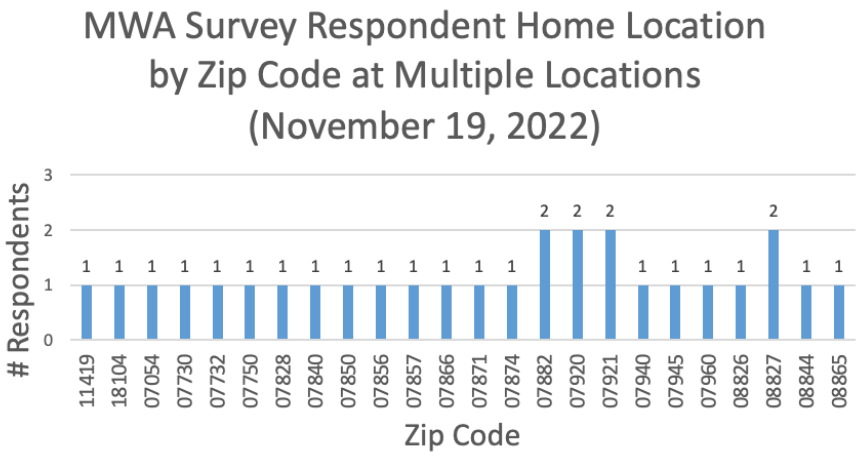


Figure B.37. Home ZIP code of recreation visitors along the Musconetcong River (November 19, 2022)

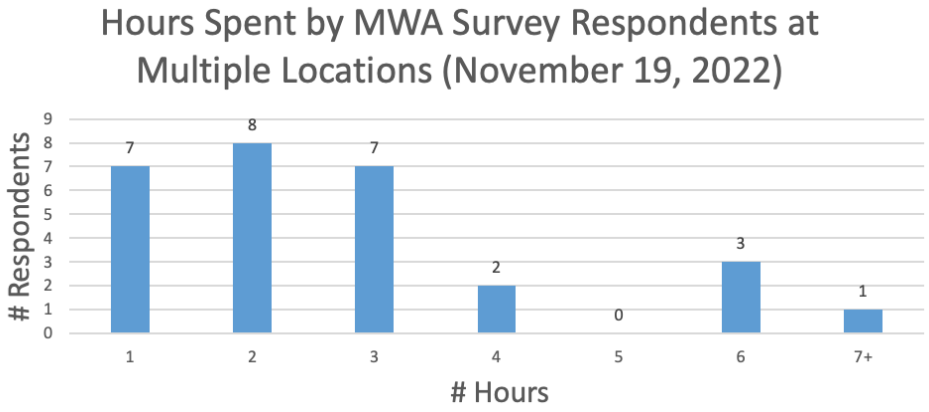


Figure B.38. Hours spent by recreation visitors along the Musconetcong River (November 19, 2022)

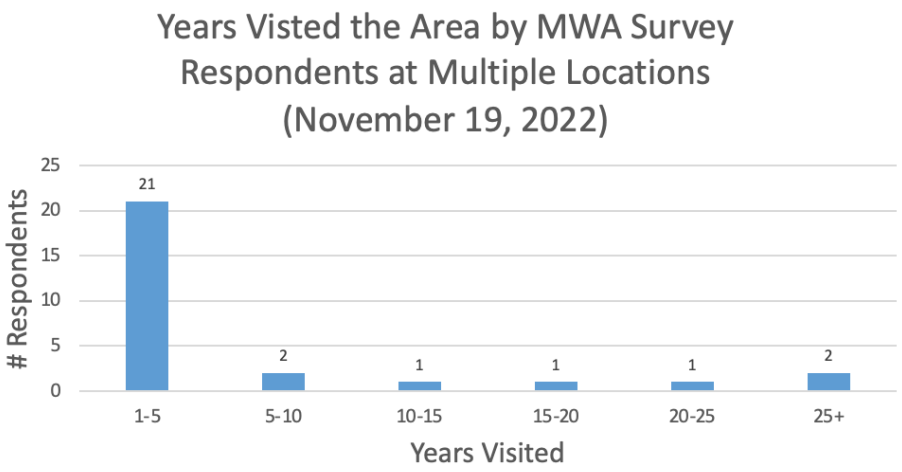


Figure B.39. Years visited by recreation visitors along the Musconetcong River (November 19, 2022)

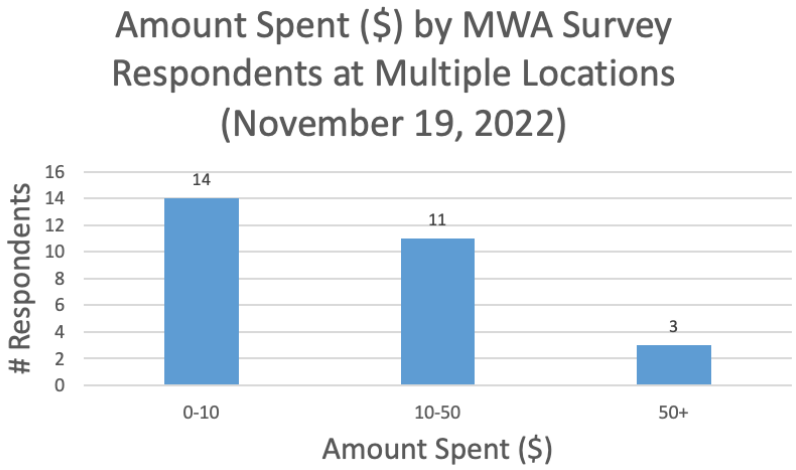


Figure B.40. Money spent by recreation visitors along the Musconetcong River (November 19, 2022)

Recreation Surveys: For the purposes of this survey, recreation activities included: hiking, walking, cycling, bird watching, viewing other wildlife, picnicking, and other. Hiking and walking were reported most often, seen in Figure B.41. Activities reported in the "Other" category included: botany, kids programs, sunbathing, sitting, dog walking/pets, swimming, photography, running, educational program, and relaxing. The average time spent on these recreational activities was 3 hours, with longer outliers of 12 and 48 hours reported. The mean amount of money spent on these activities was $45.11, with a standard deviation of $85.72. The median amount spent was $10, and the mode was $5. Figure B.42 shows the findings related to spending on recreation, with 37 people spending less than $10 and another 30 respondents spending between $10 and $50 total.

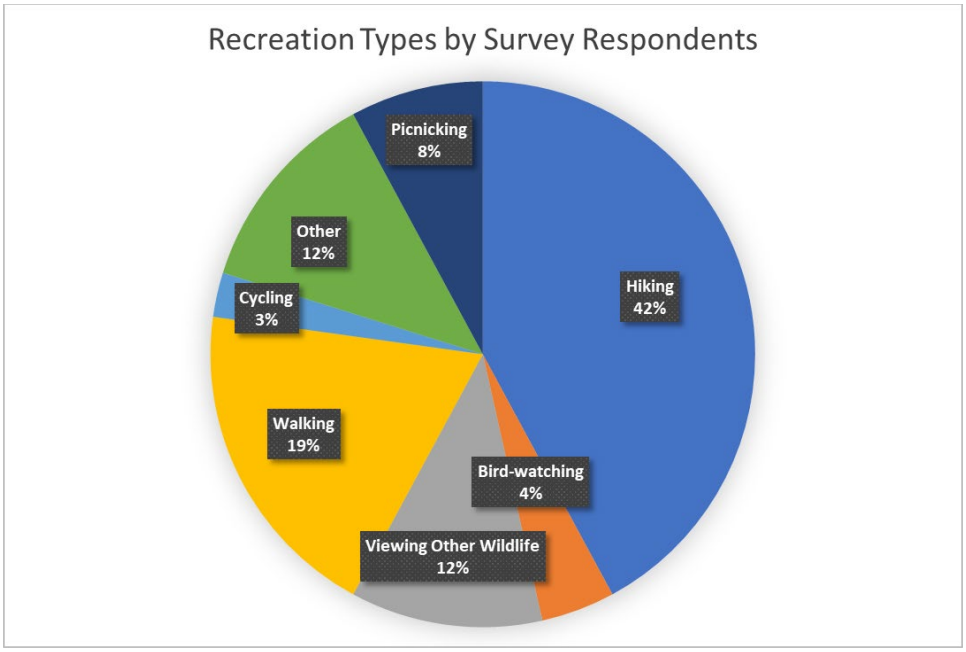


Figure B.41. Recreation activity by visitors along the Musconetcong River (2022)

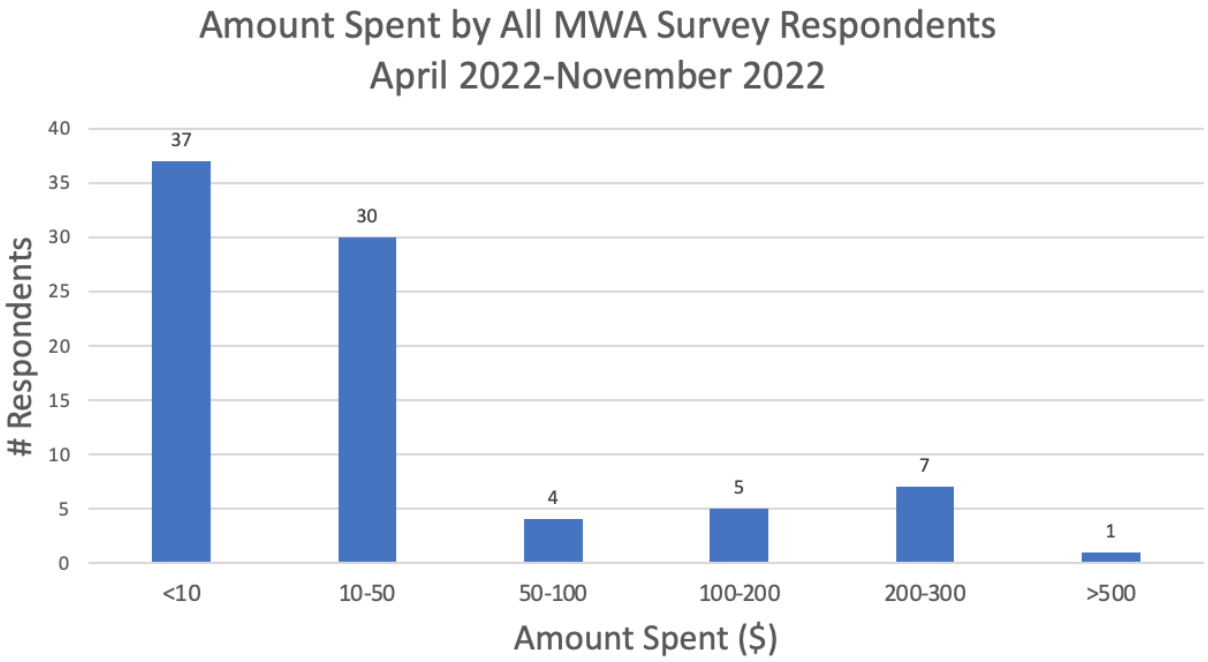


Figure B.42. Amount respondents spent on recreation along the Musconetcong River (2022)

Fishing Surveys: The angler survey was designed to collect data on the value of fishing activity in the watershed. The average amount spent by survey respondents was $56.99 with a standard

deviation of $99.94. The median amount spent was $30, and the most commonly reported spending amount was $10. Major outliers in spending were $500 and $800 by one respondent each. The most popular species sought after by respondents was rainbow trout, as seen in Figure B.43. Figure B.44 shows 96% of anglers who completed the survey fished from the shore and 79% of anglers report using spin-style fishing rods. The average time reported by survey respondents and the mode were both four hours. The largest outlier was 10 hours, reported by two respondents. The number of years fishing in the watershed ranged from one to sixty years.

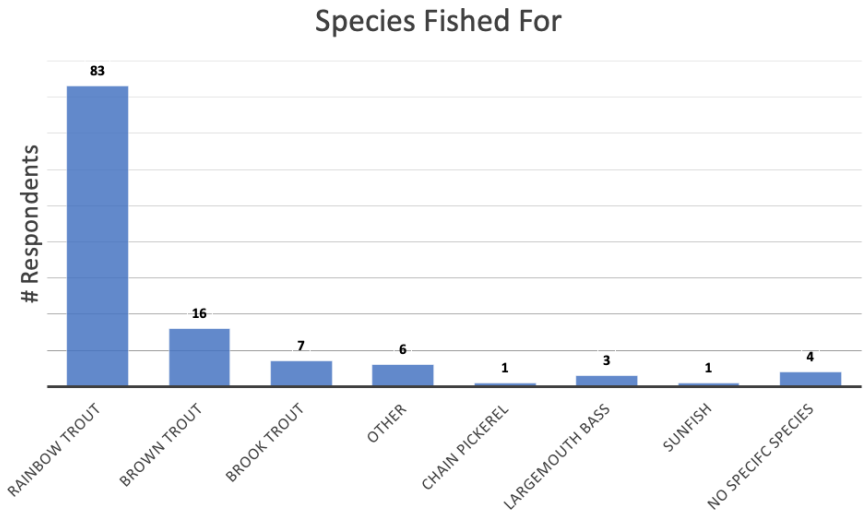


Figure B.43. Fish species caught by anglers along the Musconetcong River (2022)

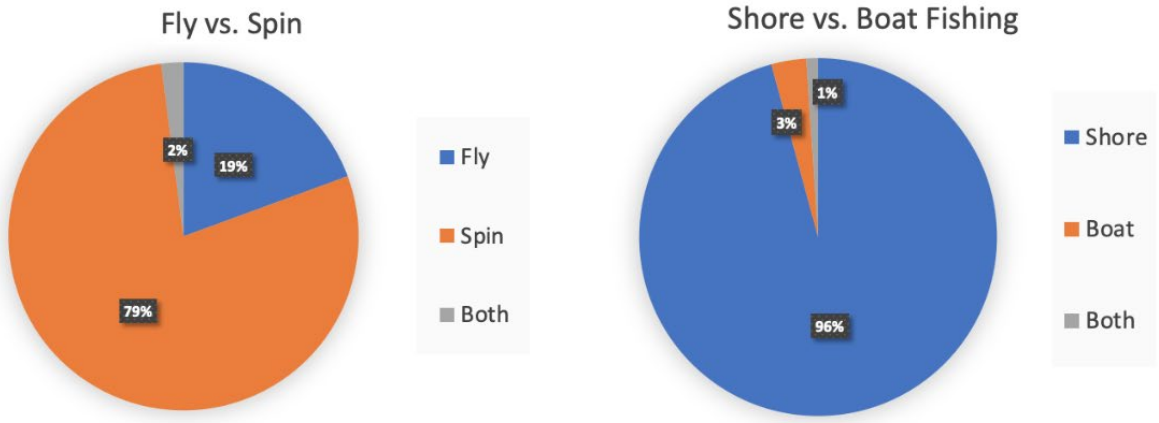


Figure B.44. Fishing style and location by survey respondents along Musconetcong River (2022)

Boating Surveys: The average amount spent by respondents on boating activities was $137.82, with a standard deviation $265.80. The median amount spent was $20 and the mode spent was $10. Outliers for the amount spent included $500 and $1,000 each reported once. The average time spent on boating activities was 4 hours, with a range of one to nine hours. The range of years visiting the watershed for boating activities was zero, or first time visiting, to 70 years. The most commonly reported amount of years spent in the area was one year. The most popular boating activities were fishing and kayaking, seen in Figure B.45, and the most common species desired by these anglers was the "Other" category. The species included in this category were: Catfish, Musky, Yellow Perch, Chain Pickerel, Bluegill, and Sunfish.

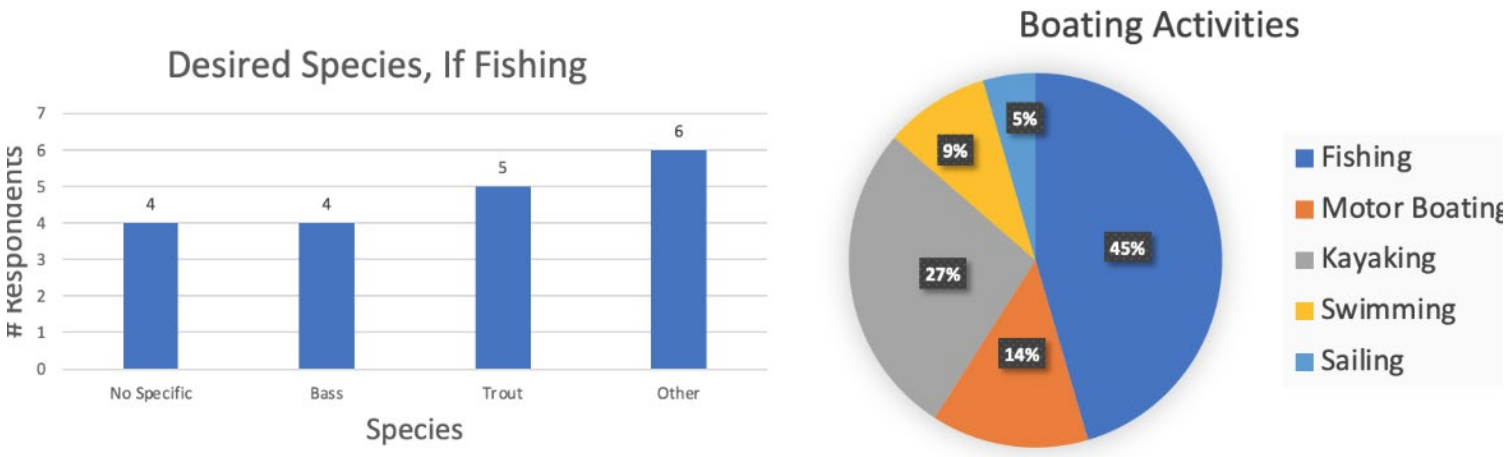


Figure B.45. Boating and fish species by survey respondents along the Musconetcong River (2022)

Hunting Surveys: All hunting surveys were administered or left at Musconetcong Wildlife Management Area in Bethlehem and Franklin Townships in one of three parking areas: Valley Road, Shurts Road, and River Road. The average amount of money spent by hunters who responded to the survey was $91.67, with a standard deviation of $76.63. The spending reported ranged from $35 to $200, and the number of people in the hunting party ranged from one to three. The average time spent hunting by respondents was three hours, and the average number of years reported hunting in this area was 4.3 years. One respondent reported 10 years. Figure B.46 shows the type of game being hunted in the area, and Figure B.47 shows 60% of respondents were using shotguns.

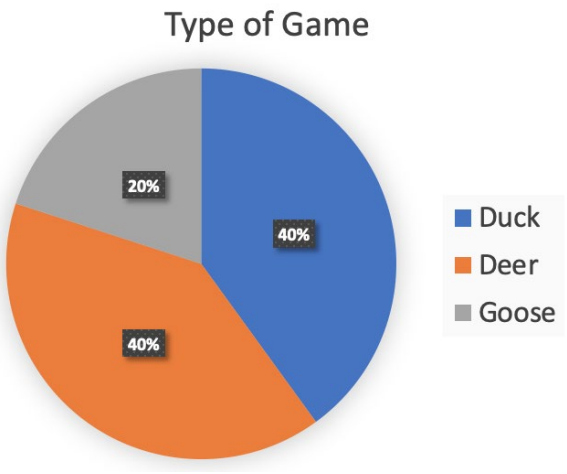


Figure B.46. Game hunted by survey respondents along the Musconetcong River (2022)

Figure B.47. Hunting equipment by survey respondents along the Musconetcong River (2022)

Overall: The major focus of the survey process was to gauge the spending of participants utilizing the watershed for various activities. Figure B.48 shows the full results of spending trends across all survey types, identifying $0–$25 as the most common spending range overall and $25–50 as the next most common spending range with 40 responses. Figure B.49 shows fishing as the survey type most frequently completed, making up 49% of total responses.

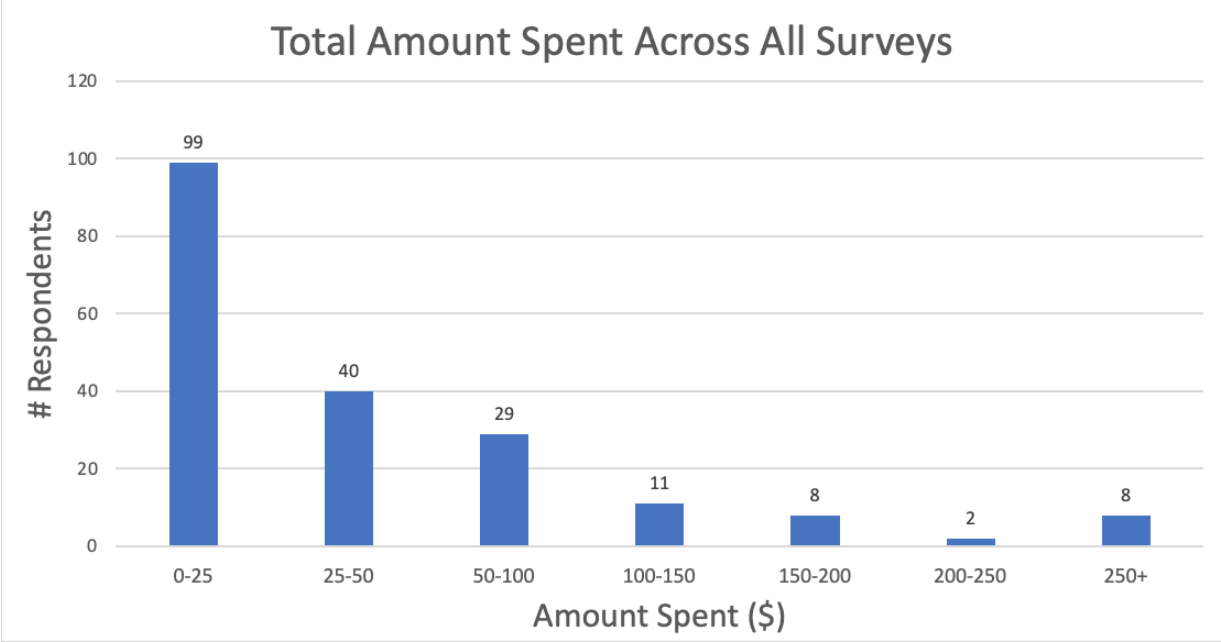


Figure B.48. Spending for recreation, fishing, boating, and hunting on Musconetcong River (2022)

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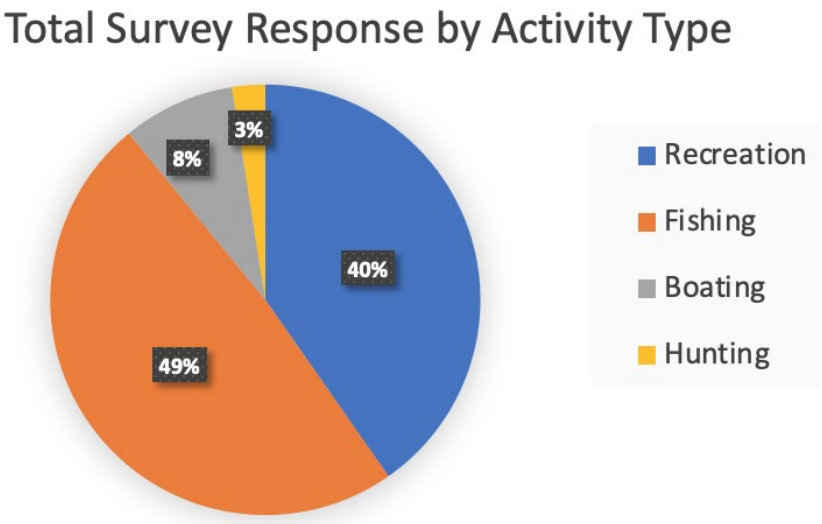

Figure B.49. Recreation, fishing, boating, hunting responses along Musconetcong River (2022)

Discussion

The most common responses across all survey types were from anglers, and most respondents spent $25 or less. Of those respondents who completed the boating survey, 45% reported fishing

activity. Many respondents reported spending "nothing" or "zero dollars," explaining that they live within minutes of the point of contact and did not need any new resources for their activity. Some respondents, especially in the recreation category, even reported walking from their home to the water, trailhead, etc. Some respondents reported just one or a few dollars in gas as the only spending related to their activity, suggesting that the watershed resources are heavily enjoyed and utilized by locals. The bigger spending reports were usually by anglers responding to the fishing survey, especially in the prime fishing weeks of spring and summer. The respondent spending the most amount of money relating to their activity in the watershed was a pair of kayakers who had just purchased their boats to enjoy a day during the June 28th survey session. While hunting made up only 1% of completed surveys, this activity had the second highest average spending after fishing. Based on the results, hiking trails and stocked streams for fishing were the significant resources sought out by survey respondents.

Conclusions

Individuals, families, and groups of friends have been coming to the Musconetcong Watershed for decades and continue to return here, spending their time and money on various activities in the woods and waterways. Due to the immense monetary, sentimental, and intrinsic value attributed to the land, water, and relative resources of the area, it should remain protected from pollution and overdevelopment. The 204 recreational visitors to the Musconetcong River watershed spent $23 to $148 per day for 2 to 4 hours per visit and have been visiting the watershed for 4 to 17 years (Table B.9).

Table B.9. Summary statistics of recreation use survey in Musconetcong River watershed (2022)

Survey	Date (2022)	Type	n	Mean Visit (hr/day)	Mean Years Visiting (yr)	Mean Spending ($/day)
1	April 30, May 1	Angling	60	4	16	69
2	May 27, June 4	Angling	35	4	17	36
3	June 28	Recreation/Lake	27	4	15	148
4	Jule 15	Merrill Cr. Res.	13	3	10	135
5	September 30	Recreation/Trails	12	2	4	60
6	October 19	Recreation/Trails	29	2	15	55
7	November 19	Recreation/Hunting	28	3	7	23
			204	**2–4**	**4–17**	**23–148**

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