Shiawassee River - Chesaning Rock Ramp
Saginaw County, T09N/R03E/S16
Shiawassee River Watershed

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Environment

The Shiawassee River is one of four principle tributaries of the Saginaw River located in southeast Michigan (Figure 1). Originating in Oakland County, the Shiawassee River flows northerly for 110 miles before it joins the Flint, Cass, and Tittabawasee rivers to form the Saginaw River. The Saginaw River flows to Saginaw Bay of Lake Huron.

The Village of Chesaning is located on the Shiawassee River in southern Saginaw County approximately 15 miles upstream of its confluence with the Saginaw River (Figure 1). Chesaning is a semi-rural community with a population of approximately 2,500. Residential housing, small businesses, and recreational park populate the 3 square mile Village limits. Agriculture dominates landuse outside of the Village limits.

History

Chesaning Dam was a centerpiece for the Village and enabled navigation of the Chesaning Showboat in the upstream impoundment giving credence to the Village moniker as "Showboat City". Since 1937, the Village hosted the "Chesaning Showboat Festival" which was key to the community's cultural identity and economic vitality.

Chesaning Dam was built in 1863 for grist mill operations. The dam was a fixed crest "rock-crib" style structure covered with concrete and spanned 211 feet. The dam had a structural height of 9 feet and impounded an estimated 17 acres of water. Michigan Department of Environmental Quality (MDEQ) classified it as a low hazard dam.

Current Status

Although Chesaning Dam had been in need of repair for a number of years, conditions worsened in March 2005 when a center portion collapsed requiring emergency repair (Figure 2). After considering options, the Village decided to replace the existing dam with a rock ramp that would preserve the water level of the upstream impoundment and provide improved natural stream function and fish passage. The Village engaged Wade-Trim Engineering who sub-contracted with Ellen Rivers LLC. for design, engineering, and project oversight.

The impending failure of Chesaning Dam aroused concern from the Michigan Department of Transportation (MDOT) with the structural integrity of the well-traveled M57 bridge over the Shiawassee River. In 2006, to preserve bridge integrity, MDOT installed a channel grade control structure approximately 300 ft. downstream of the bridge. The grade control structure consisted of 184 ft. of steel sheeting embedded 18 ft. into the channel substrate.

After securing a preliminary design and cost estimates ($1.5M), the Village embarked upon a campaign to raise support through donations of money and materials. Community leaders engaged the public in an "Ugly Rock Contest" and encouraged donations of boulders to secure local matching funds. By the end of the campaign, the Village was able to secure $346,000 from local commitments. The Village secured a $900,000 grant from the MDEQ-Clean Michigan Initiative and additional funding was obtained from the United States Fish and Wildlife Service (USFWS), Saginaw Bay Watershed Initiative Network, and other local foundations (Table 1).

In 2008, MDEQ issued the Village of Chesaning a permit (DEQ File 08-73-0045-P) and in 2009, the Chesaning Dam was removed and replaced with a low-slope rock ramp (Figure 2). The Chesaning Rock Ramp is approximately 200 ft. wide by 600 ft. long and consists of seven weirs in a stair-step configuration at an overall 3% slope. Channel morphology at Chesaning was considered incised because "bankfull" flow occurred well below the top of existing banks (S. Verry, Ellen Rivers LLC., personal communication). Thus, design parameters included keeping most of the weir heights at bankfull elevation to decrease the velocity of bank-side water flows and minimize erosion potential. By design, fish passage is encouraged bank-side where stream velocity is reduced. The 3% slope was determined necessary to pass most fish common to the Shiawassee River. In particular, allowing passage of Saginaw Bay spawning Walleye was an objective of the rock ramp. Four additional "J-hook" rock structures were placed downstream to help protect stream banks from erosion.

In August 2011, modifications were made to the Chesaning Rock Ramp to better facilitate fish passage. Modifications included: 1) opening 1 foot gaps between weir stones out to 40 ft. from shore edge on each weir and; 2) the installation of mid-weir veins (40 ft. long with 1 ft. gap) on the upper 4 weirs. Costs associated with these modifications were incurred by Ellen Rivers LLC.

In April 2014, rock displacement on the upper two weirs occurred and was believed to be the result of high flow, ice and debris accumulation during the spring thaw, and undersized boulders (Figure 3). Boulder displacement resulted in an estimated 1.5-2.0 ft. drop in water level in the upstream impoundment (J. Leonardi, MDNR Fisheries, personal observation). Continued boulder displacement in 2015 and 2016 resulted in further de-watering of the upstream impoundment. During summer of 2016, with flow below normal conditions (95 cfs), the upstream impoundment was no longer navigable for typical shaft boat motors.

A primary objective of the Chesaning Rock Ramp was to maintain sufficient water level for the Chesaning Showboat (aka Shiawassee Queen) to navigate the upstream impoundment. In 2013, organizers of the annual Chesaning Showboat Festival went bankrupt and the aging Shiawassee Queen fell into disrepair. In 2015, the Shiawassee Queen was dismantled and the objective of maintaining impoundment water level was no longer critical. The demise of the Chesaning Showboat Festival was short-lived as the Village re-organized their annual summer celebration as "River Days" emphasizing the success of the Chesaning Rock Ramp. In addition, the Village renamed its library as "River Rapids Library" further embracing the rock ramp structure. Communications with the Village indicate the community is pleased with the Chesaning Rock Ramp:

"The community has embraced the rock ramp. It is a tranquil and relaxing place and people are using the area for recreation such as fishing and wading in the river. There is a huge increase in use." - J. Sedlar, President, Village of Chesaning.

An evaluation component for projects like the Chesaning Rock Ramp is often neglected. Communities typically do not have available resources to perform specific evaluations. As invested supporters of the project, both the Michigan Department of Natural Resources (MDNR), Fisheries Division and the USFWS had a strong desire to determine if fish passage was occurring at the rock ramp. The two agencies collaborated to perform a basic evaluation of fish passage. In addition, Central Michigan University and Michigan State University embarked upon evaluations of the Chesaning Rock Ramp (B. Murry, unpublished data, Stoller 2013).

Analysis and Discussion

The Shiawassee River is classified as a large warmwater stream supporting over 61 species of fish. Recreational anglers target species including Smallmouth Bass, Northern Pike, Channel Catfish, and a variety of catostomid (sucker) species. The Shiawassee River also supports seasonal spawning runs of Lake Huron species including Walleye, Quillback, and catostomid species. Until the installation of the Chesaning Rock Ramp, the Chesaning Dam served as the first barrier to Lake Huron migrations of fish.

The basic study design developed by MDNR Fisheries and the USFWS included sampling both upstream and downstream of the rock ramp during the spring and summer seasons for the period 2010-2016. Direct current electrofishing boats were used for sampling. Prior to dam removal (September 2009), the USFWS conducted an electrofishing survey of the upper impoundment (Table 2). Extensive review of fisheries records for the Shiawassee River determined similar species composition both upstream and downstream of Chesaning Dam. Each of the species collected by the USFWS in 2009 were common upstream and downstream. However, during the course of evaluation of the rock ramp, 4 species of fish (Walleye, Quillback, Freshwater Drum, Gizzard Shad) were identified in the downstream reach and never documented upstream of Chesaning Dam. Two species (Walleye and Quillback) occurred in abundance downstream and were used as indicator species to evaluate fish passage. Walleye were of particular importance since a spawning run from Saginaw Bay was known to congregate downstream of Chesaning Dam.

In conjunction with MDNR Fisheries Division and the USFWS, Central Michigan University (CMU) and Michigan State University (MSU) provided additional data support. In April 2013, CMU deployed 460 floy tags to a variety of fish downstream of the rock ramp. Tag data would provide conclusive evidence of passage for species known to be common to both upstream and downstream reaches. From 2014-2016, MDNR Fisheries jaw tagged Walleye downstream of the rock ramp as part of a separate Saginaw Bay Walleye study (Fielder 2015). In 2014, a total of 1000 Walleye were tagged. A total of 469 Walleye were tagged in 2015 and 127 Walleye were tagged in 2016.

Downstream monitoring for the period 2010-2016 was primarily conducted to: 1) determine relative abundance of fish; 2) gauge the progression of spring spawning migrations, and; 3) deploy tags on various species of fish. Reproductive biology of specific species often reflected catch. Common White Suckers and Walleye generally congregated downstream of the rock ramp shortly after ice-out when water temperatures approached 38-44F. Redhorse (sp.) and Quillback appeared in greatest numbers when water temperatures approached 45-50F. Sampling typically began at the base of the rock ramp and extended downstream 1.2 miles to the remnants of the collapsed Peet Dam (Figure 4).

Although only arbitrarily tracked, Walleye catch per unit effort (CPUE) downstream during the peak of the spawning run was typically 200-300 fish/hour. CPUE for Common White Suckers during their peak was 300-400 fish/hour. Reliable CPUE for Quillback was not tracked but likely exceeded 200 fish/hour. It was sufficient to note the Shiawassee River experienced fairly significant spawning runs of Walleye, Quillback, and Common White Suckers. It is believed the magnitude of the Saginaw Bay Walleye spawning run in the Shiawassee River is in the realm of 10,000-15,000 fish (J. Leonardi, MDNR Fisheries, personal observation).

Upstream spring sampling for the period 2010-2016 yielded substantially fewer Walleye and Quillback (Table 3). Sampling typically started approximately 2.5 miles upstream and extended downstream to the rock ramp (Figure 4). The low abundance of Walleye collected upstream in 2010 and 2011 prompted Ellen Rivers LLC. to modify the rock ramp structure by widening the gaps of the weir boulders. Increased Walleye numbers were observed in 2012 and 2013 suggesting improved passage. Walleye passage appeared greatest in 2014 when 87 fish were collected in 0.76 hours of electrofishing. However, 2014 was also the year when boulder displacement on the upper weirs was observed. Quillback abundance upstream appeared relatively consistent and in lesser abundance compared to downstream. Quillback abundance upstream was greatest in 2015 but believed to have corresponded better with sampling during their preferred spawning water temperatures.

The capture of tagged fish provided conclusive documentation of passage (Table 3). Seven Walleye tagged downstream in 2014 were captured upstream in the same year. In addition, 5 redhorse (sp.) tagged downstream were captured upstream during the study period.

Cursory summer sampling upstream of the Chesaning Rock Ramp for the period 2010-2015 found indicator species not only passed the rock ramp but remained upstream into the summer period (Table 3). The impoundment upstream of Chesaning Rock Ramp now supports a small year-round population of Walleye and Quillback.

In 2010, sampling within the rock ramp weirs was performed using electrofishing gear. Sampling was conducted in both spring and summer. Electrofishing within the weirs proved to be difficult due to current and boulder substrate. Sampling was completed within weirs 1, 2, 3, and 5 (1=furthest downstream). Weir sampling resulted in the capture of 17 species of fish (Table 4). As evidenced by weir sampling, the Chesaning Rock Ramp was functioning as habitat for a variety of fish species. Of particular note was the capture of 12 Walleye during the spring sampling and 51 Smallmouth Bass during the summer sampling.

During the spring sampling period, with the exception of 2014, Walleye passage was less than anticipated. Discussions between study collaborators examined collection methods, rock ramp design, and spring flow conditions for possible explanations.

It was suggested that Walleye may quickly pass the rock ramp (perhaps at night) and move upstream out of the sample area. This suggestion was counter argued for a number of reasons; 1) given the abundance of Walleye downstream of the rock ramp, one would expect to capture more than just a few Walleye in a 2.5 mile sample area; 2) no Walleye were observed in a prime Walleye spawning riffle located just downstream of Ditch Road; 3) in 2012, eleven of the 123 walleye collected downstream of the rock ramp on April 4 displayed tags that were inserted on March 23 suggesting a reluctance to pass

despite being released 12 days earlier immediately downstream of the rock ramp, and; 4) a lack of angler observations of Walleye upstream of the rock ramp.

Collaborators discussed the rock ramp design and whether or not the slope and weir attributes were adequate to facilitate the passing of Walleye. Concern about slope and boulder gaps (too narrow) led to ramp modifications in 2011. The 2011 modifications did result in a slight increase in Walleye abundance upstream and the natural displacement of boulders in 2014 resulted in the highest abundance observed during the study period. However, spring sampling in 2015 and 2016 did not indicate significant Walleye passage (Table 3).

Collaborators discussed the role Shiawassee River spring flow may play on Walleye passage. The Shiawassee River is extremely flashy. Summer and early fall flow is typically only a few hundred cubic feet per second (cfs). Spring flow and heavy rainfall event flow can increase to over 3,000 cfs. A United State Geological Survey (USGS) gaging station located approximately 15 miles upstream of Chesaning provided baseline flow measurements during spring sampling (Figure 5). At 2,000 cfs, the Chesaning Rock Ramp is fully inundated (Figure 6). The role of Shiawassee River spring flow with Walleye passage appeared inconclusive. In a typical year, Walleye ascend the Shiawassee River in mid-March and remain until late April. Weir inundating flow during the Walleye spawning period occurred in 4 of the 6 sample years yet, only in 2014 was significant Walleye passage observed. Shiawassee River spring flow in 2014 (during the Walleye spawning period) was above normal and it is reasonable to conclude higher flow resulted in greater Walleye passage. However, some Walleye passed during low flow in 2015. In addition, Quillback abundance upstream was greatest during the low flow conditions in 2015.

Collaborators also recognized the inherent behavioral tendencies of fish species to pass rock ramp structures. Fish species are not equally suited to pass physical and velocity barriers in rivers. Some species (salmon) are more adapted than other (Walleye). Collaborators agreed that Common White Suckers, Quillback, and redhorse (sp.) were more likely to pass than species such as Walleye.

Fish passage at the Chesaning Rock Ramp was evaluated 2010-2016. In that time, a great deal has been learned about how rock ramps perform in general and specifically in the case of the Chesaning Rock Ramp and the Shiawassee River. The following conclusions are presented:

The Chesaning Rock Ramp has successfully resulted in fish passage. Indicator species (Walleye, Quillback, Gizzard Shad, Freshwater Drum) have been found upstream where they previously were not documented. Other species (e.g. Common White Suckers, redhorse species) likely pass but since existing populations were present upstream passage could not be evaluated.

River discharge (flow) likely influences fish passage. During low flow, the Chesaning Rock Ramp is still considered a partial barrier to fish passage but improved compared to a dam where no passage occurs.

The original design of the Chesaning Rock Ramp was not effective in passing Walleye. It was believed the gaps between the boulders of the upper two weirs were too narrow. Improved Walleye passage was observed after the gaps were manually widened in 2011 and more improved after the natural displacement of the upper weir boulders observed in 2014.

The capture of 87 Walleye in a single effort in 2014 demonstrates Walleye passage occurs. However, Walleye passage likely fluctuates between years and is influenced by timing (i.e. having sufficient flow aligned with photoperiod and water temperature critical to Walleye reproduction).

Quillback appear to pass the Chesaning Rock Ramp with lesser difficulty.

Stoller (2013) suggests the Chesaning Rock Ramp has improved summer Shiawassee River fish assemblage characteristics patterns with higher similarity to a free-flowing river than to a dammed river.

The structural integrity of the upper two weirs of the Chesaning Rock Ramp did not endure spring flow and ice/debris conditions. The natural displacement of the upper boulders suggests they were undersized in the original design. The forces of spring flow along with ice jams and wood debris accumulation has great potential to displace large boulders.

Summer sampling indicates small year-round populations of Walleye and Quillback have developed upstream of the rock ramp.

Ice jams and wood debris accumulation continue to collect upstream of the Chesaning Rock Ramp but have passed downstream during high flow events. The manual removal of wood debris may be a concern for future rock ramps.

Water levels have dropped 1.5-2.0 ft. in the upper impoundment largely due to the natural displacement of the upper weir boulders. Under summer low flow conditions, the navigability of the upstream impoundment for motorized boats may be prohibitive.

The rock ramp provides additional riffle habitat and is being used by a variety of fish species. In particular, Smallmouth Bass appeared to be inhabiting the rock ramp during the summer period.

Rock ramps are a compromised alternative to full dam removal. As such, rock ramps can still be a physical barrier to some fish under certain river conditions (i.e. low flow).

Improvements to natural stream function and fish passage with rock ramps are likely determined by design and the unique physical properties of the river. A 3% slope appears to be a maximum slope to consider for Walleye passage.

Management Direction

Rock ramps are becoming a popular alternative to dams in Michigan and throughout the country. Although this study was basic in design and specific to fish passage, it provides some valuable information on rock ramp performance. Future rock ramps should consider evaluation components addressing channel morphology and natural stream function as well as fish passage.

The Shiawassee River is on an accelerated pace for dam removals (Table 5). Removal of the Corunna Dam and the Shiawassee Town Dam are scheduled within two years. There are 3 low head dams in the City of Owosso but each has a 12 ft. vertical slot cut in them which allows for some level of fish

passage. The City of Owosso is currently discussing potential modifications of these structures. Although the Peet Dam has collapsed, there is potential for clearing the rubble to better facilitate fish passage and is recommended. As it stands, the Chesaning Rock Ramp has improved fish passage and along with the scheduled plans for other dam removals, connectivity and natural stream function will be greatly improved in the mainstem Shiawassee River.

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References

Fielder, D.G. 2015. Vital statistic of Walleyes in Saginaw Bay (Study 230436). Annual and final reports to the U.S. Department of Interior, Wildlife and Sportfish Restoration Program. Project Number F-81-R-16. Michigan Department of Natural Resources, Alpena Research Station, Alpena, MI.

Stoller, J.B. 2013. Effects of a rock ramp structure on summer fish assemblage in the Shiawassee River. Michigan State University, East Lansing. Publication Number 1546451.

Table 1. Funding sources for the Chesaning Rock Ramp.

Funding Agency	Grant Amount
MDEQ Clean Michigan Initiative	$900,000
USFWS Economic Stimulus Funding	$99,400
Saginaw Bay Watershed Initiative	$50,000
Partners for Fish and Wildlife –Shiawassee National Wildlife Refuge (USFWS) General Fund	$5,000
Local Commitment	$346,000
Total	**$1,410,400**

Table 2. Catch and effort summary of USFWS survey of Chesaning Impoundment, September 9, 2009.

Species	Number caught	CPUE (#/hour)	% of catch
Golden redhorse	46	69	84
Greater redhorse	3	4	5
Common carp	3	4	5
Smallmouth bass	1	1	2
Yellow bullhead	1	1	2
Spotfin shiner	1	1	2

Table 3. Numbers of indicator species collected upstream of Chesaning Rock Ramp, 2010-2016 (hours electrofished in parenthesis).

Sample Year (Hours)	**Walleye**	**Quillback**	**Gizzard Shad**	**Freshwater Drum**	**Tagged redhorse**
2010					
4 Spring efforts (2.56)	1	4	0	0	0
1 Summer effort (1.00)	2	1	5	1	0
2011					
3 Spring efforts (2.85)	4	12	0	0	0
1 Summer effort (1.00)	1	2	8	0	0
2012					
4 Spring efforts (5.50)	15	13	1	0	3
1 Summer effort (0.80)	9	17	4	1	0
2013					
4 Spring efforts (6.60)	29[1]	12	1	0	2
1 Summer effort (1.20)	1	7	0	0	0
2014					
1 Spring effort (0.76)	87[2]	7	0	0	0
1 Summer effort (1.20)	2	3	0	0	0
2015					
1 Spring effort (0.78)	7	50	0	0	0
1 Summer effort (0.90)	5	1	0	1	0
2016					
3 Spring efforts (2.19)	2	5	0	0	0

[1] 2 walleye with 2013 CMU floy tags (tagged downstream of rock ramp).

[2] 7 walleye with 2014 metal jaw tags (tagged downstream on April 7 and 10, 2014.

Table 4. Relative abundance of fish (percent of catch) collected within the Chesaning Rock Ramp weirs.

Species	Spring, 2010	Summer, 2010
Blackside darter		1
Bluegill		<1
Bluntnose minnow	3	
Central stoneroller		
Channel catfish		3
Common carp		
Common shiner	10	12
Creek chub		
Emerald shiner		
Gizzard shad		7
Green sunfish		
Horneyhead chub		7
Johnny darter		
Logperch		<1
Longear sunfish		5
Mimic shiner	5	
Northern hog sucker	3	3
Northern pike		
Pumpkinseed		
Quillback		
Rainbow darter	<1	2
Redhorse, golden	8	4
Redhorse, greater		
Redhorse, shorthead		<1
Redhorse, silver		
Rock bass	5	22
Round goby		<1
Sand shiner		
Smallmouth bass	5	28
Spotfin shiner	3	5
Stonecat		
Striped shiner		
Walleye	20	
White sucker	36	<1
Yellow perch		
Total fish caught	**61**	**183**

Table 5. Barriers on the mainstem Shiawassee River.

Barrier	Estimated distance from confluence (miles)	Maintenance schedule
Peet Dam (collapsed)	13	None
Chesaning Rock Ramp	15	Occasional debris removal
Parshallburg Dam (collapsed)	20	None
Owosso Low Head Dams (3)	37	Modifications in discussion
Corunna Dam	41	Removal scheduled 2017
Shiawassee Town Dam	53	Removal scheduled 2016
Byron Millpond Dam	72	None

Figure 1. Location of Chesaning, MI in the Shiawassee River watershed. (Map source = The Nature Conservancy).

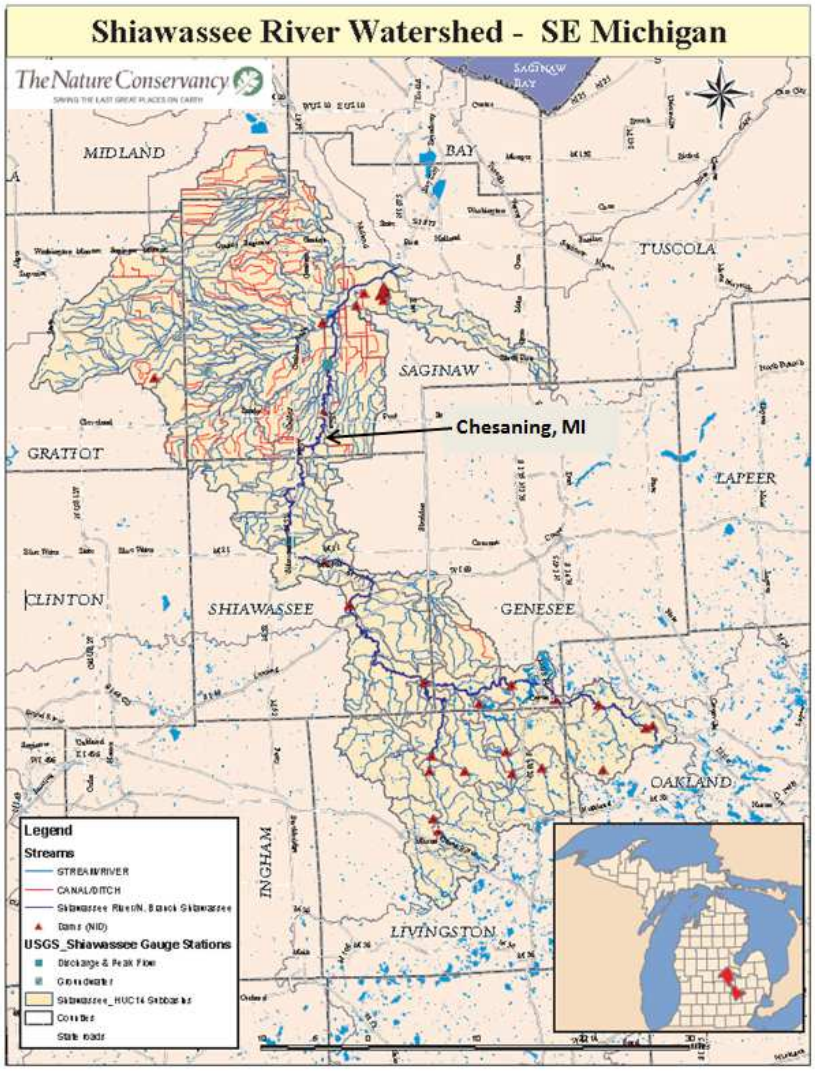


Figure 2. Photographs of the breached Chesaning Dam and the 2009 Chesaning Rock Ramp.

Chesaning Dam breached 2005

Chesaning Rock Ramp, 2009

Figure 3. Photographs illustrating boulder displacement on the upper 2 weirs of the Chesaning Rock Ramp.

April 2011

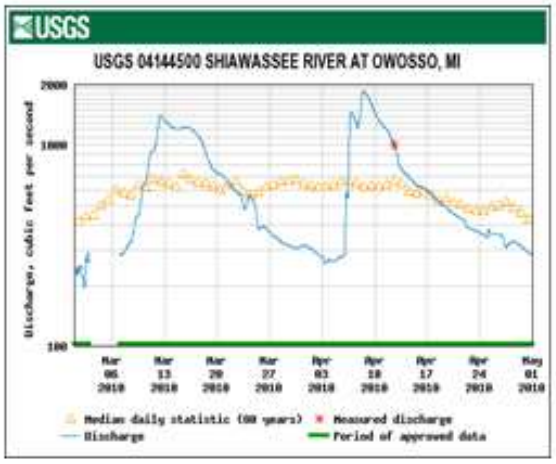
August 2014

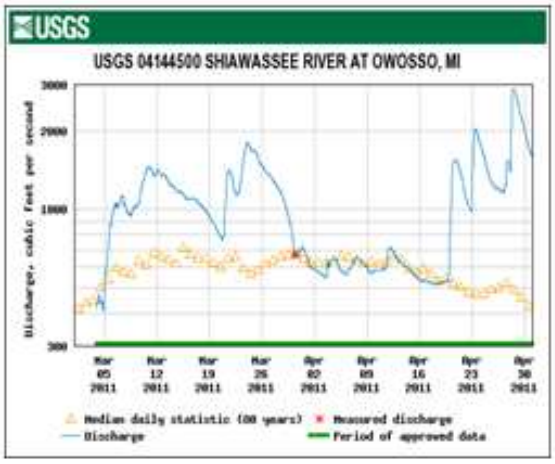
April 2015

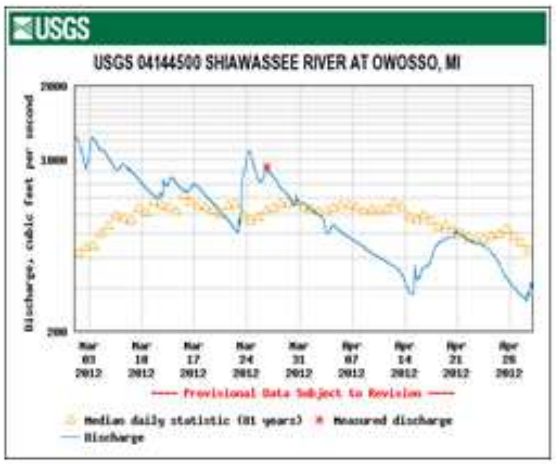
July 2016

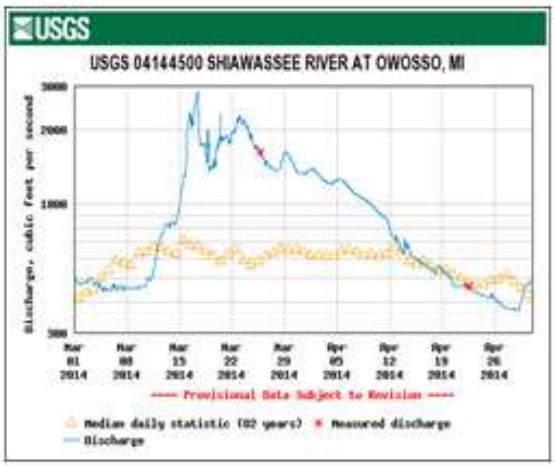
Figure 4. Chesaning Rock Ramp sampling area, 2010-2016.

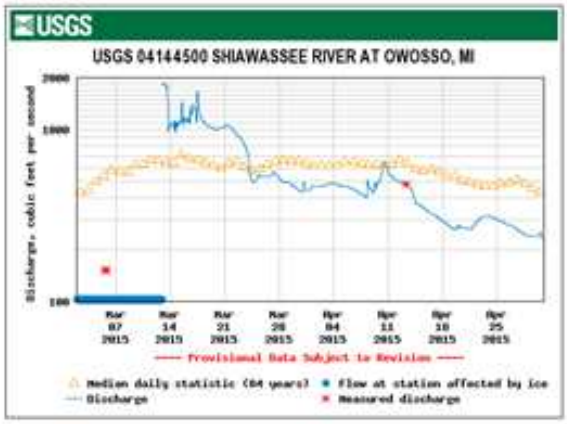
Figure 5. Shiawassee River spring discharge at Owosso during the walleye spawning period, 2010-2016.











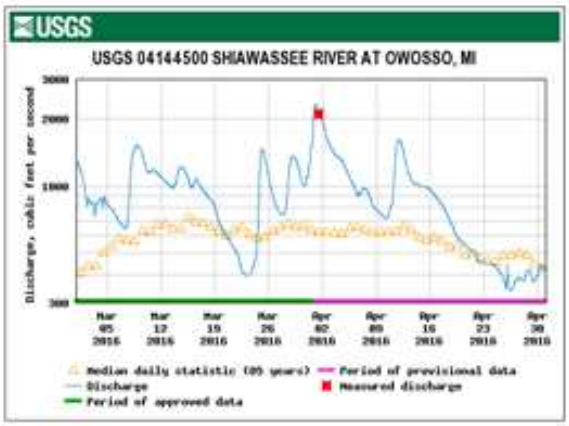


Figure 6. Photos of the Chesaning Rock Ramp at three different discharge values.

Photo taken April 1, 2010 (330 cfs)

Photo taken April 8, 2010 (1,680 cfs)

Photo taken April 15, 2010 (650 cfs)