Attachment 3

WVIC back-testing the concept of more water at start of winter.

Appendix 7

Preliminary Evaluation of BEPCO 60% Plan

Preliminary Evaluation of BEPCO 60% Plan
April 2011

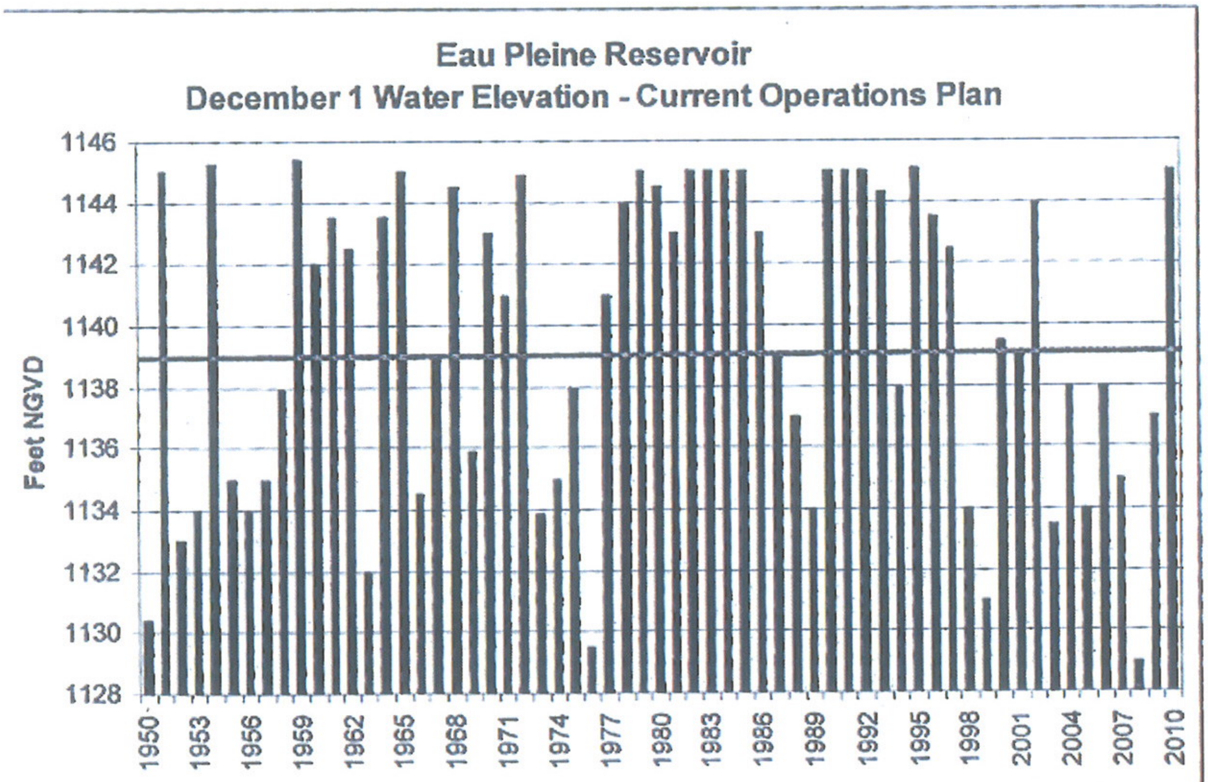
roduction

ıe Big Eau Pleine Citizens Organization (BEPCO) has proposed a revised operation plan for the Eau ɜine Reservoir that they believe will prevent or minimize the occurrence of winter fish kills in the servoir. The plan, which they refer to as the "60% Solution", has two basic components:

- Enter the winter season (December 1) with at lease 60% storage in the reservoir. This storage corresponds to a water elevation of 1139.0 ft.
- Maintain 20% storage at the end of the winter drawdown. This storage corresponds to a water level elevation of 1129.0.

ırrent Operation Plan

VIC operations model was used to analyze the December 1 water level over a 61-year period 1950 ·ough 2010. The graph below illustrates the Eau Pleine water level on December 1 of each year using ɜ current operating plan.



uring the 61-year modeling period, the current operation plan results in water levels being below 1139.0 et (60% storage) on December 1 in 26 years. The water level is at or above 1139.0 feet (60% storage) ı December 1 in 35 years. The lowest water level experienced on December 1 occurred in 2008, near e end of the recent extreme drought, when the water level was 1129.0 feet.

Modified Operation Plans Considered

Two modified operations plans were considered to ensure that the water level on December 1 is at or above 1139.0 feet.

- Plan 1 – Reduce the flow goals at the Wisconsin Rapids flow control point. Since water levels in the Eau Pleine Reservoir respond to flow goals at Wisconsin Rapids, reducing the Wisconsin Rapids flow goals during summer and fall result in higher water levels in the Eau Pleine Reservoir. This technique requires flow goals to be reduced every year by an amount that will prevent the Eau Pleine water level from falling below 1139.0 on December 1 in the driest year on record.
- Plan 2 – Maintain the current Wisconsin Rapids flow goals, but limit the Eau Pleine summer and fall drawdown level to 1139.0 feet. This is modeled by setting the minimum index level to elevation 1139.0 during the summer and fall period.

For both operating plans tested, the operation of the 20 northern reservoirs was not modified. As such, water levels in the 20 northern reservoirs and the flow of the Wisconsin River at Merrill remain the same as the current operating plan.

After a preliminary evaluation, it was determined that Plan 2 resulted in extremely low Wisconsin River flows in late summer and throughout fall during dry years. These low flows would significantly degrade Wisconsin River water quality. As such, this plan was not developed and analyzed in detail.

Plan 1 Results

Plan 1 used lower flow goals at Wisconsin Rapids. In even the driest years on record, the Eau Pleine water level does not begin to decline until about July 1. As such, reduction in the current flow goals for the period April through June would provide little or no benefit to the December 1 Eau Pleine water level and thus the flow goals for these months were not modified. Since Eau Pleine water levels can decline significantly starting in July, and since in dry years there may be no significant runoff events throughout the July through November period, flow goals must be reduced for the entire July through November period to ensure the 1139.0 feet water level on December 1 of the driest years. Flow goals for the July through November period were tested by multiple trials using WVIC's operations model to achieve a water level of 1139.0 feet or higher on December 1. It was determined that the July through November flow goals must be reduced approximately 150 cfs to achieve the desired result.

The primary benefits provided by the Eau Pleine Reservoir that can be quantified are hydropower, water quality enhancement on the Wisconsin River, and recreation on the Eau Pleine Reservoir. While flood control is also a benefit of the reservoir, limitations in the operations model prevent it from being used to make an accurate determination of flood reduction benefits.

- Hydropower – Over the 61-year modeling period the loss in hydropower production at the 12 hydroelectric power dams located downstream because of the reduced Wisconsin Rapids flow goals varies from a minimum of 1.1 million KWh (wet years) to a maximum of 11.2 million KWh (dry years). The average annual loss in hydropower production averaged 6.0 million KWh over the 61-year period.

- Wisconsin River Water Quality – Low flow augmentation provided by the Eau Pleine Reservoir increases the ability of the Wisconsin River to assimilate waste. Waste loads in the Wisconsin River come from two sources, non-point agricultural runoff and point loading from industrial and municipal waste discharge. Methodologies were developed during licensing in 1993 to asses the benefit to industrial dischargers. However, WVIC was never able to develop a methodology to evaluate the benefit for municipal or non-point loads. The effect on industrial loading was evaluated as follows in the 1993 methodology. If the change in operation reduced the allowable waste discharge by less than 3%, then the value of waste load reduction was calculated based on increased operating cost for existing treatment facilities. If the reduction in allowable waste load was greater than 3%, then the value of waste load reduction was based on the addition of tertiary treatment facilities.

This plan reduces the allowable waste load for the downstream industrial dischargers by about 1%. As such, additional tertiary treatment would not be required. The estimated increase in operating cost for existing treatment facilities would increase by an average of $54,000 per year.

- Eau Pleine Reservoir Recreation – During the 1993 licensing process a methodology to evaluate the recreation value of reservoir water levels was developed. Since that time, recreation uses have changed significantly and it is beyond the scope of this evaluation to update the recreation valuation methodology to 2010 dollars. Instead, the recreation benefit can be qualitatively evaluated using the following data:

	August 31 Water Level			September 30 Water Level		
	Lowest	Highest	Average	Lowest	Highest	Average
Current Operation	1132.0	1145.4	1140.9	1132.0	1145.4	1140.3
Modified Operation	1140.0	1145.4	1142.6	1139.5	1145.4	1142.3

The recreation value of the Eau Pleine Reservoir decreases as water levels decrease because the reservoir becomes less accessible and is more difficult to navigate and use for recreation. To asses the effect on recreation, the model was used to characterize water levels at the end of August and the end of September. As shown in the table above, the Modified Operation Plan results in average water levels that are 1.7 feet higher at the end of August and 2.0 feet higher at the end of September when compared to the current operation. These increases in average years will provide a minor to moderate increase in recreation value. In extremely dry years, the water levels under the Modified Operation Plan will be 8.0 feet higher at the end of August and 7.5 feet higher at the end of September when compared to the current operation. These increases in drought years will provide a significant increase in recreation value.

Summary

Two modified operation plans were initially considered. The second plan had significant drawbacks and thus only the first plan was more fully developed. The modified plan reduced hydropower production by an average of 6.0 million KWh annually, increased the operation cost of downstream treatment facilities, and increased the recreation value of the Eau Pleine Reservoir by raising late summer water levels an average of 1.7 to 2.0 feet.

This report does not address the ability of the modified operation to prevent fish kills. It simply evaluates the effect of the proposed "60% solution" on hydropower, Wisconsin River water quality, and reservoir recreation. The potential for the modified operation to prevent fish kills will be considered separately.

Preliminary Evaluation of BEPCO 60% Plan
May 2011 Update

Introduction

After meeting with BEPCO representatives, WVIC performed additional modeling of the "60% Solution". The revised modeling reduced Wisconsin Raids target flows by 50 cfs in July, 100 cfs in August, 150 cfs in September and 200 cfs in October and November. The revised flow goals essentially achieved the BEPCO objective of 60% storage in the Eau Pleine Reservoir on December 1. The revised goals also reduced the hydropower loss. The hydropower losses are illustrated in the three attached graphs. Hydropower loss was summarized for "Reservoir Years" rather than calendar years and winter and summer-fall losses were separated to make the results more understandable.

The loss in hydropower averaged 1.7 million KWh during the summer-fall period and 2.4 million KWh during the winter period. The total annual hydropower loss averaged 4.2 million KWh.

Discussion

The "60% Solution" contains two components, limited summer-fall drawdown and limited winter drawdown.

Summer-Fall Drawdown

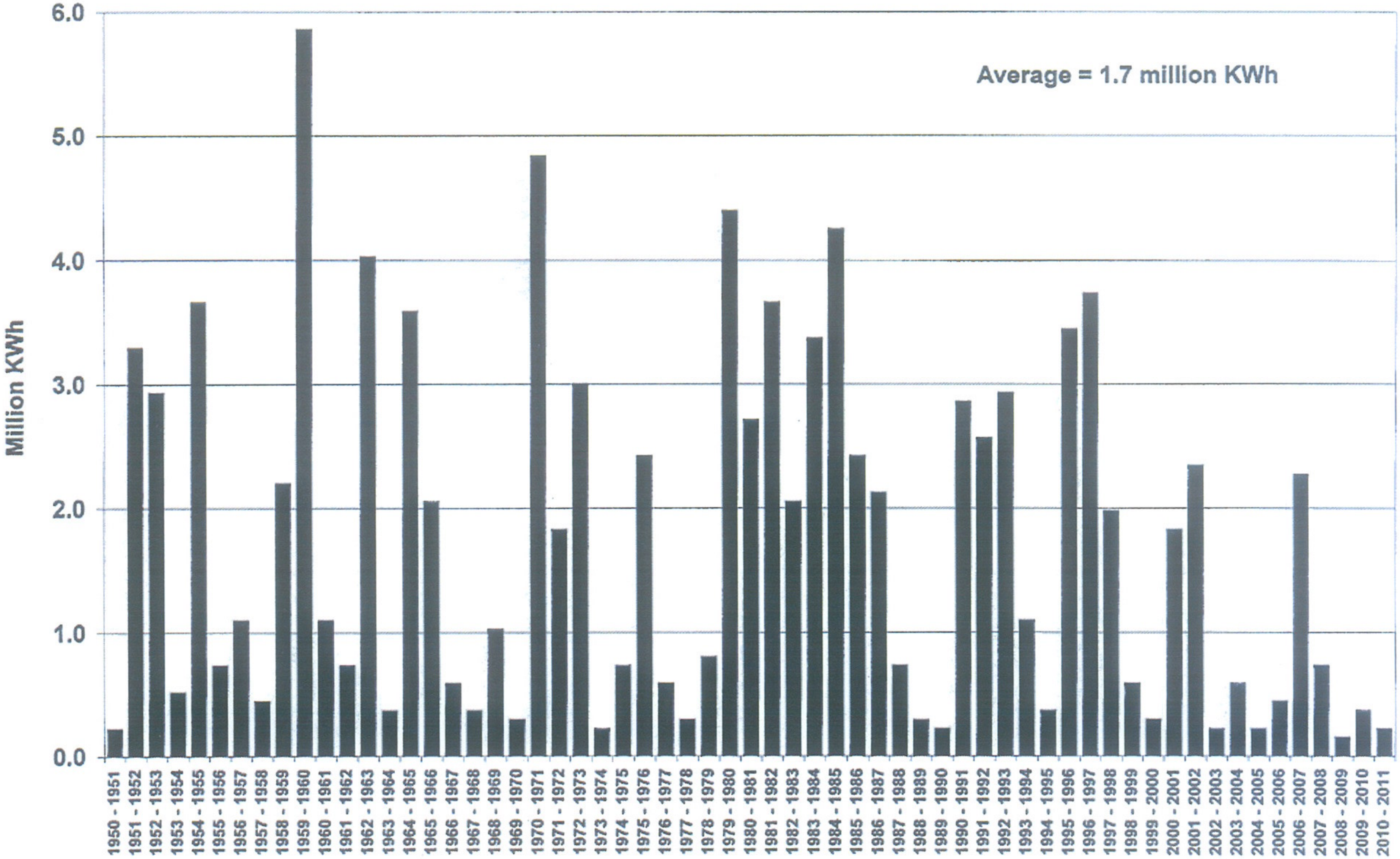
While WVIC understands BEPCO's concerns regarding the effect of summer-fall drawdowns on winter water quality and recognizes the potential benefit to the fishery in drought years of higher fall water levels, WVIC does not believe that ensuring 60% storage on December 1 is required in all circumstances. Rather, WVIC proposes to add additional trigger levels to the Drought Management Plan that will allow WVIC and resource agencies to modify water level operation during drought conditions. Three new trigger events have been proposed in the Drought Management Plan. This will allow WVIC more operational flexibility while helping to protect the fishery.

Winter Drawdown

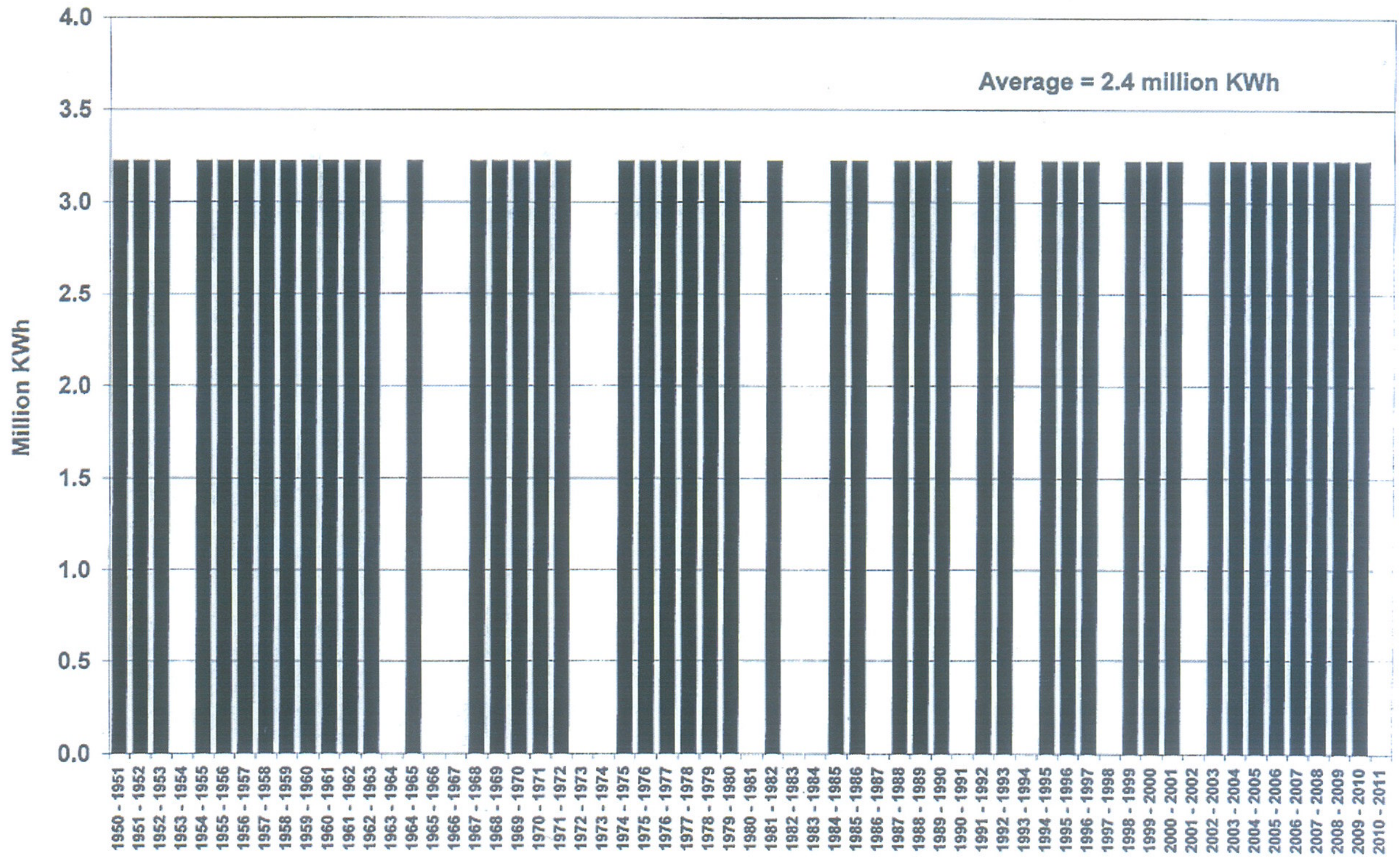
WVIC also understand BEPCO's concerns regarding the effect of the extent of the winter drawdown on winter water quality and recognizes the potential benefit to the fishery of a higher minimum level. However, WVIC does not believe that 20% storage is required. Instead, WVIC proposes to limit the winter drawdown to at least 10% of capacity. As such, WVIC proposes to raise the minimum allowable water level in the Eau Pleine Reservoir from the current 1118.0 feet NGVD to 1125.00 feet NGVD.

WVIC will also continue to monitor water quality in the reservoir over the winter season and modify winter operation, if required, to optimize water quality and the operation of the aeration system. This will be documented in the Fish & Wildlife Management Plan.

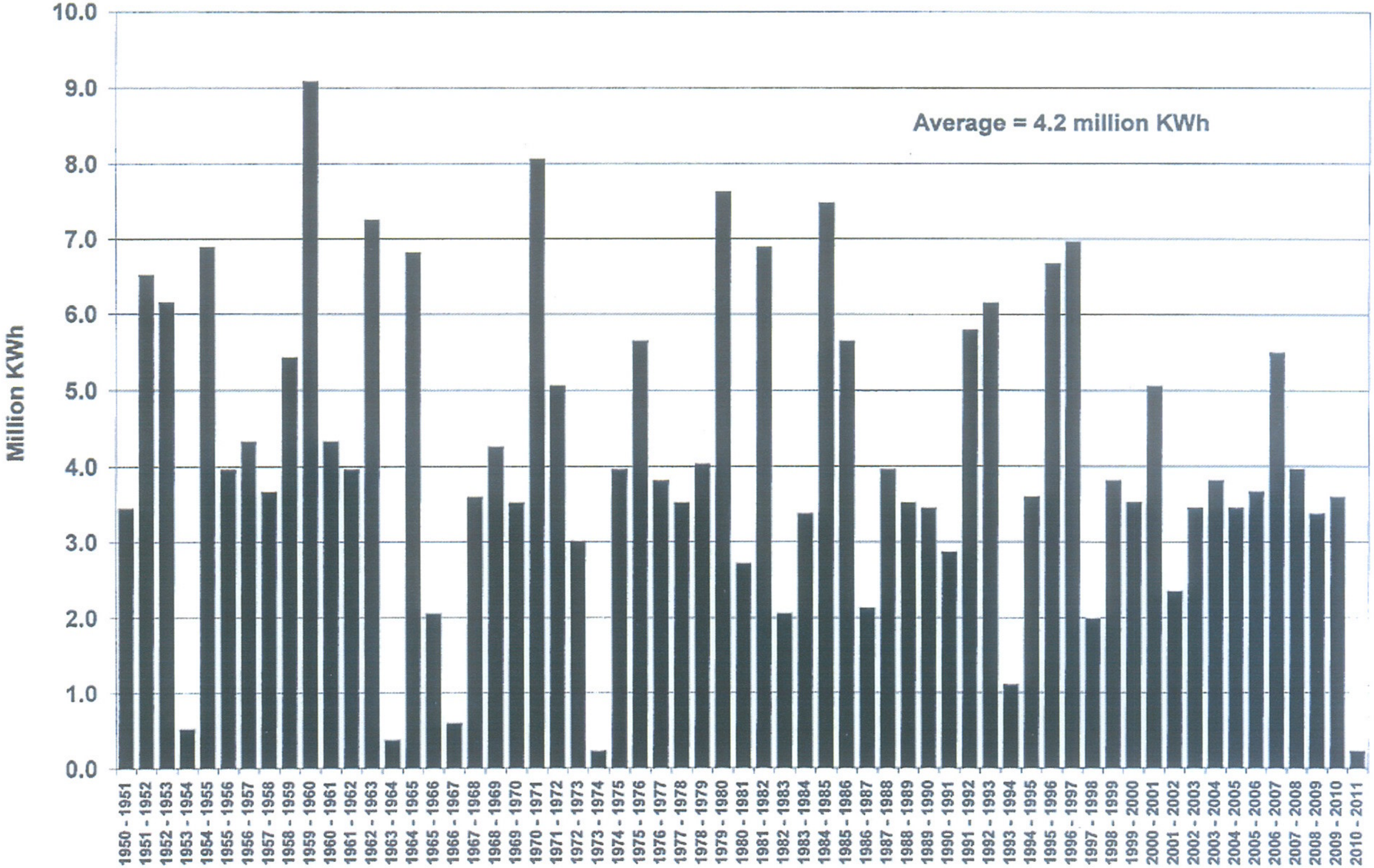
Eau Pleine Lost Hydropower Production Loss
Summer-Fall Loss Only for 60% Plan
Revised Flows Goal Parameters
Reservoir Year April 1 to April 1



Eau Pleine Lost Hydropower Production Loss
Winter Loss Only for Limiting Drawdown to 1129 vs. 1125
Reservoir Year April 1 to April 1



Eau Pleine Lost Hydropower Production Loss
Total Loss 60% Plan and Limiting Drawdown to 1129 vs. 1125
Reservoir Year April 1 to April 1



Attachment 4. Email with WVIC on DCP triggers.

Dorshorst, Ken

From: Ken Dorshorst <kendorshorst@gmail.com>
Sent: Monday, June 13, 2016 11:39 AM
To: Dorshorst, Ken
Subject: Fwd: Drought Contingency Plan

Begin forwarded message:

> **From:** Ken Dorshorst <kendorshorst@gmail.com>
> **Subject: Drought Contingency Plan**
> **Date:** June 12, 2016 8:53:58 AM CDT
> **To:** Peter Hansen <hansen@wvic.com>
> **Cc:** Andrew Johnson <andrew.johnson@co.marathon.wi.us>, John Kennedy <john@kennedydiesel.com>, Kurt Schoen <kurt@schoen-eng.com>, Matt Krueger <mkrueger@wisconsinrivers.org>, Steven R Pelton <Steve.Pelton@ministryhealth.org>, Ken Dorshorst <kendorshorst@gmail.com>
>
> Peter: This is a step closer. What I am looking for is the exact dates when each trigger is hit and the exact elevation. And then also the river flow target at Wisconsin Rapids on those dates. This will tell us better how the triggers could have worked. It will better lay our what options are still available at the time, especially relative to reducing the Wisconsin River flow. The trigger dates can then be compare to targeting 60% full on December 1 which is what the best data we have strongly suggests is needed to protect the fishery.
>
> Take 2012 for example which is the only fish kill in the past 5 years. At the time of the first consultation in late August there was discussion to lower the Wisconsin River flow that was already at the minimum 1300 cfs. Apparently nothing was done. Again on October 5 this was discussed. The river flow was still at minimum 1300. The Big Eau Pleine was then 48% full. The resource agencies would not agree to lowering the river flow as this would adversely affect Wisconsin River quality. So nothing was done. There was a fish kill.
>
> The points are: these triggers are probably too late. Then consultations take a lot of time making it even later before any action might take place. The goals are murky. If the river flow is below 1300, the agencies will likely never allow it to be dropped lower. A proactive approach, i.e. lowering the Wisconsin River flow targets sooner by integrating into the operating rule curves to have more water in the BEP into winter, would have allowed keeping the Wisconsin River flow up to 1300 protecting it, and kept enough water in the BEP reservoir to protect its fishery.
>
> This is what we showed in 2011 with our "2008 rerun" example. WVIC (Sam Morgan) reviewed our proposal and ran it through your WIRSOM model, backtesting it for 60 years, and said it was feasible. But it costs hydropower in some years when you hold that water back in the reservoir in a dry summer and then it rains enough to more than refill the reservoir in the fall. Thats the downside. Its hydropower VS fish kill risk.

Ken Dorshorst
BEPCO

Begin forwarded message:

From: Peter Hansen <hansen@wvic.com>
Subject: RE: Drought Contingency Plan
Date: June 8, 2016 6:32:42 PM CDT
To: Ken Dorshorst <kendorshorst@gmail.com>

Ken – I have added approximate timelines in each box in yellow which indicates when a trigger in the drought contingency plan would have been reached. I also provided elevation data for the Eau Pleine as it relates to Index Levels and the dates the reservoir was below those elevations for each year. As far as what actions would be used and back testing, that is difficult to answer. Ultimately it is our responsibility to notify the DNR and the Fish and Wildlife Service that we have met a trigger. Our thinking is that this table could be a guide to consult from based on past experiences and the results of the winters following each of these years. We feel that we have adequately reviewed the revised triggers and the updated table provides additional data to help the Agencies with decision making during the consultation process.

YEAR	DEC. 1ST <60%	CUMULATIVE PRECIP (>-6")	NATURAL FLOWS (<900 & 1300)	INDEX LEVE
		2 Year (24 consecutive months) Running Average	Two consecutive weeks	6/1-8/31 < & 9/1-11 fe
1996	NO	6.65	NO	N
1997	NO	2.29	NO	N
1998	NO	-9.36 (October)	YES (July - December)	YES (8/1-8/31)
1999	YES	-6.2 (Year)	YES (September - November)	YES (10/2
2000	YES	4.35	NO	N
2001	NO	4.55	YES (July - August)	N
2002	NO	8.53	NO	N
2003	NO	2.11	YES (July - October)	YES (8/10-8/ 11/
2004	YES	-5.88	YES (July - October)	N
2005	YES	-2.67	YES (July - September)	YES (7/25-8/31
2006	YES	-4.45	YES (June - September)	YES (7/
2007	YES	-9.03 (May)	YES (June - September)	YES (7/16-8/31
2008	YES	-9.72 (Year)	YES (July - December)	YES (7/31-8/31
2009	YES	-9.68 (Year)	YES (July - December)	YES (8/5-8/31 &
2010	YES	2.70	YES (April - May)	N
2011	NO	6.07	YES - MERRILL ONLY	N
2012	NO	-6.145 (November)	YES (June - October)	YES (8/1

2013	YES	0.04	YES (Late July - early September)	N
2014	NO	12.71	NO	N
2015	NO	10.63	NO	N

Peter Hansen, P.E. / Vice President of Operations
715-848-2976 Ext. 311
www.wvic.com

From: Ken Dorshorst [mailto:kendorshorst@gmail.com]
Sent: Sunday, May 29, 2016 9:35 AM
To: Peter Hansen <hansen@wvic.com>
Cc: Kurt Schoen <halfthepaddle@gmail.com>; John Kennedy <john@kennedydiesel.com>; Andrew Johnson <andrew.johnson@co.marathon.wi.us>; Matt Krueger (mkrueger@wisconsinrivers.org) <mkrueger@wisconsinrivers.org>; Steven R Pelton <Steve.Pelton@ministryhealth.org>; Ken Dorshorst <kendorshorst@gmail.com>
Subject: Fwd: Drought Contingency Plan

Thank you for the information regarding the DCP triggers. However a lot of questions we have asked before remain unanswered regarding the potential effectiveness of the triggers to significantly lower the risk of fish kills. The information you relayed says there will be a lot of consultations, but no definitive actions.

On what dates in which years would these triggers have been hit?

How much water would be in the BEP reservoir at each of those points?

What are the possible actions for the Big Eau Pleine, given where water levels were?

What was the extent of the backtesting done to give confidence that these trigger can be effective at stopping fish kills?

Ken Dorshorst
BEPCO

Begin forwarded message:

From: "Dorshorst, Ken" <KDorshorst@appletoncoated.com>
Subject: FW: Drought Contingency Plan
Date: May 4, 2016 11:51:26 AM CDT
To: 'Ken Dorshorst' <kendorshorst@gmail.com>

From: Peter Hansen [mailto:hansen@wvic.com]
Sent: Wednesday, May 04, 2016 10:33 AM
To: Dorshorst, Ken <KDorshorst@appletoncoated.com>
Cc: 'Ken Dorshorst' <kendorshorst@gmail.com>
Subject: RE: Drought Contingency Plan

Ken - Per your request, we have reviewed the drought contingency plan's three triggers relating to the requirements on starting consultations. I only reviewed going back to 1996 as this was when our new license was issued and we were not recording natural flows for Wisconsin Rapids as well as index levels previous to the license update. Based on the review we propose the following changes in yellow to the DCP language:

- WVIC will track the cumulative precipitation departure from normal. If the 24-month running average cumulative precipitation deficit reaches 6 inches, WVIC will consult with WDNR and USFWS to consider reducing flow goals to Q(7,10) earlier than specified. During this consultation process, WVIC and the resource agencies will also consider limiting winter drawdowns in all WVIC reservoirs to facilitate a more complete spring refill. Any changes in flow goals or reservoir drawdowns will remain in effect until all parties agree they can be lifted.

- WVIC will track the natural flows of the Wisconsin River at Merrill and Wisconsin Rapids. Natural flow is defined as the river flow that would occur without reservoir storage or release. If after two consecutive weeks the natural river flow falls below 900 cfs at Merrill or 1,300 cfs at Wisconsin Rapids, WVIC will consult with WDNR and USFWS to consider reducing flow goals earlier than specified.

- If the index level in any of the five large reservoirs (Rainbow, Willow, Rice, Spirit, or Eau Pleine) falls below level 3 during the period June through November, WVIC will consult with WDNR and USFWS to consider reducing flow goals earlier than specified.

YEAR	DEC. 1ST <60%	CUMULATIVE PRECIP (>-6")	NATURAL FLOWS (<900 & 1300)	INDEX LEVEL BELOW 3
		2 Year (24 consecutive months) Running Average		
1996	NO	6.65	NO	NO
1997	NO	2.29	NO	NO
1998	NO	-9.36	YES	YES
1999	YES	-6.27	YES	YES
2000	YES	4.35	NO	YES
2001	NO	4.55	YES	NO
2002	NO	8.53	NO	NO
2003	NO	2.11	YES	YES
2004	YES	-5.88	YES	NO
2005	YES	-2.67	YES	YES
2006	YES	-4.45	YES	YES
2007	YES	-9.03	YES	YES
2008	YES	-9.72	YES	YES
2009	YES	-9.68	YES	YES
2010	YES	2.70	YES	NO
2011	NO	6.07	YES - MERRILL ONLY	NO
2012	NO	-6.15	YES	YES
2013	YES	0.04	YES	NO
2014	NO	12.71	NO	NO
2015	NO	10.63	NO	NO

Peter Hansen, P.E. / Vice President of Operations
715-848-2976 Ext. 311
www.wvic.com

From: Dorshorst, Ken [mailto:KDorshorst@appletoncoated.com]
Sent: Thursday, March 17, 2016 5:46 PM
To: Peter Hansen <hansen@wvic.com>
Cc: 'Ken Dorshorst' <kendorshorst@gmail.com>
Subject: FW: Drought Contingency Plan

Page 3. I am pretty sure this statement should be in red italics. "Low water levels in reservoirs that could adversely affect the reservoir fishery."

In regards to the three new trigger points, was there backtesting done? I have lots of questions as to the effectiveness of the new triggers in the DCP at stopping fish kills on the BEP. Is there data that has been analyzed to give us confidence that the new triggers will work to stop fish kills? If so can you share it? I would think you would want to go back to 1981 when the aerator was installed. On what dates in which years would these triggers have been hit? How much water would be in the BEP reservoir at each of those points? What are the possible actions that a consultation could have resulted in given where water levels were? Would there have been enough to have the reservoir 60% full at the start of winter? History says that the chances of a fish kill are about 50-50 with a winter starting level below 60% full.

Thank you,
Ken Dorshorst
BEPCO

Attachment 5

The Big Eau Pleine Dissolved Oxygen Model

What is it?

The ***Big Eau Pleine Dissolved Oxygen Model*** uses size and shape of the reservoir, weather, river flow and water level in a computer simulation to project how oxygen concentrations vary under the ice in the Big Eau Pleine. The model was developed by researchers at the University of Wisconsin-Stevens Point and the University of Wisconsin-Extension along with a technical committee of individuals from BEPCO, DNR, WVIC, Marathon County and the River Alliance. The Model used the Army Corps of Engineers CE-QUAL-W2 modeling system. The figure below shows how the model segments the reservoir and calculates the dissolved oxygen concentration throughout the reservoir.

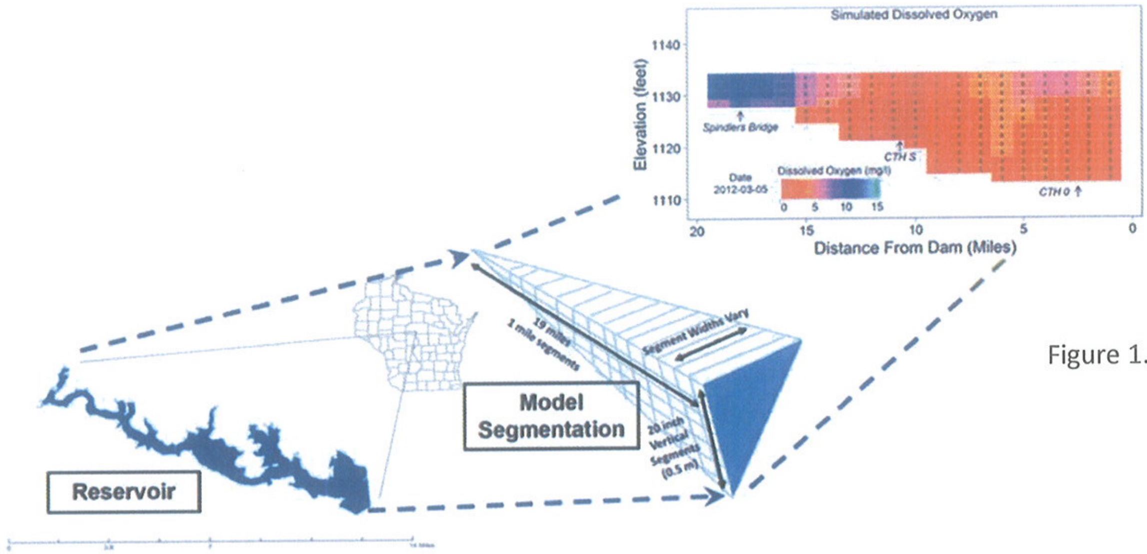


Figure 1.

Why did we do this?

The ***Model*** was used to understand oxygen concentrations under the ice during the winter because the Big Eau Pleine has had problems with winter fishkills since it was created in the 1930s. The model allows us to compare the importance of individual factors on winter oxygen concentrations. It is important to note that while the model uses a state-of-the-art computer simulation tool, it simplifies the many and complex processes that occur in the reservoir.

What did we learn?

Oxygen is used under the ice by bacteria decomposing organic material that has accumulated in the sediments. This ***sediment oxygen demand*** is very high in the Big Eau Pleine. That is consistent with the large quantity of nutrients that flow in from the watershed, the resulting high concentration of phosphorus in the reservoir and the conversion of that phosphorus to algae in the reservoir.

Oxygen depletion during the winter follows warming of the water in the reservoir. During the winter, heat stored in the sediment during the summer warms the water from the bottom. This accelerates the upward propagation of low oxygen water during the winter. In reservoirs like the Big Eau Pleine, the high sediment area and the high sediment oxygen demand can rapidly deplete oxygen in the water under the ice.

Figure 2 shows a typical yearly pattern of water ice formation, water level lowering and dissolved oxygen depletion. The study showed the importance of ***winter length*** or the time between ice formation and the spring flush that replaces much of the water in the reservoir on oxygen concentration. In many years, the spring flush occurs by early March. In a few years, the spring flush occurs much later. In 2013, that flush did not occur until March 30.

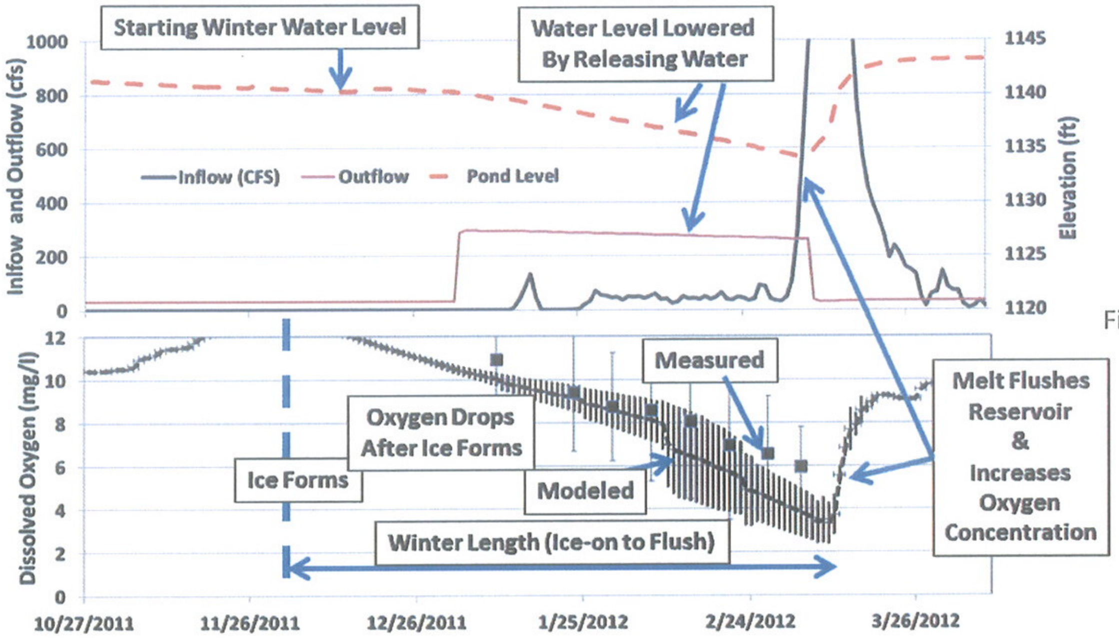


Figure 2.

The w***ater level in the reservoir*** is important to how the oxygen concentration drops during the winter. The model can be used estimate how different water levels would have affected the oxygen concentrations. For example, Figure 3 shows how, using characteristics of the 2013 winter, higher starting water levels at the start of winter would decrease the number of days that the average oxygen concentration is low. For example, starting the winter at 60% full, would result in almost ten more days where the dissolved oxygen would be greater than 2 mg/l than starting at 45% full.

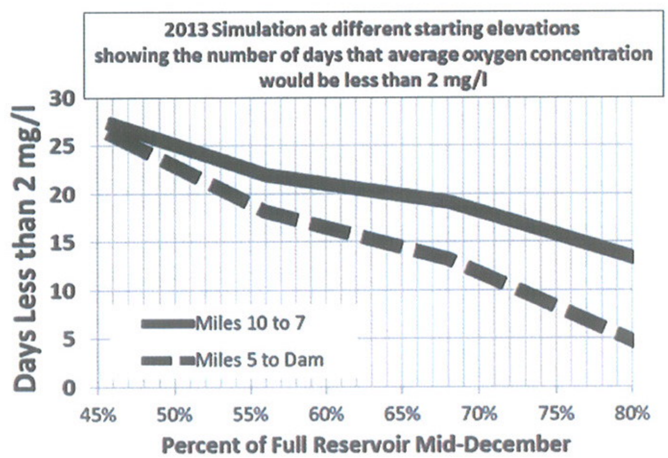


Figure 3.

The model can be used to examine ***the combined effect of water level and winter length***. As Figure 3 shows, for the very long winter length in 2013, although the duration of lower oxygen levels is shorter as the starting elevation is increased, the model projects some days of low oxygen under all the starting water elevations shown.

The study shows how ***reductions in sediment oxygen demand*** will benefit the reservoir. Similar to higher starting elevations, a reduction in sediment oxygen demand leads to more days during the winter that the oxygen concentration is higher. The model projects that a ten percent reduction in sediment oxygen demand would add another week where the average oxygen would be above 2 mg/l near the dam.

The ***aerator*** was also examined in the model. It uses mixing to create an opening in the ice that allows oxygen to transfer from the atmosphere to the water. The result is that the aerator can provide a zone of higher oxygen concentrations. The model suggests this zone will not travel far in low-flow winters but that it should be able to overcome the oxygen demand in the vicinity of the aerator.

For ***more information***, you can view the full report at ***www.uwsp.edu/cnr-ap/watersheds***