

**Supplemental Report**  
**Water Temperatures in the**  
**Deschutes River, Oregon**  
**SNTEMP Results Based on 1998–99 Data**

*Pelton Round Butte Hydroelectric Project*  
*FERC No. 2030*

Prepared for Portland General Electric Company by

Tim Hardin  
*Hardin-Davis, Inc.*

Charles Huntington  
*Clearwater BioStudies, Inc.*

Richard Raymond  
*E & S Environmental Chemistry, Inc.*

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## INTRODUCTION

The report “Water Temperatures in the Lower Deschutes River, Oregon” (Huntington et al. 1999) presented historical and simulated temperatures from the Reregulating Dam to the mouth of the river. This report included results from the SNTEMP model, which was calibrated using 1997–98 measured weekly average temperatures at the dam and six downstream locations. Using a statistical relationship derived from historical data, we estimated water temperatures at the Reregulating Dam without the Pelton Round Butte Project (PRB). SNTEMP was then used to compare downstream temperatures with and without PRB. Results are summarized in the previous report.

Collection of another year of temperature data provided the opportunity to run the simulations again, this time with 1998–99 data. In this supplemental report, simulation accuracy of the SNTEMP model is detailed for the new data set. Also, predicted downstream temperatures are provided for the with- and without-PRB scenarios.

Objectives of this supplemental report were to

- 1) Provide further validation of SNTEMP modeling accuracy for the Deschutes River,

and

- 2) Determine whether any of the biological inferences based on SNTEMP would be likely to change based on results from a different year.

## PROCEDURES

As with the 1997–98 study, the SNTEMP model was applied with a weekly time step. On-site meteorological data were provided by PGE, and instream temperatures were provided by E&S Environmental Chemistry, Inc., and PGE. Weekly flows on the Deschutes at Pelton and Moody (mouth) were taken from USGS gage data. Tributary flows for Shitike Creek and Warm Springs River were also summarized from USGS daily gage data. Flows were not available from the White River; instead, White River flows were back-calculated so that the total of the Pelton

flow plus tributaries equaled the Moody flow reading. As with the previous study, measured water temperatures for the tributaries were not available for the modeling period; therefore, historical mean monthly values were substituted. Data sources are summarized in Table 1.

**Table 1.** Water temperature and streamflow information used as input data for SNTEMP modeling of the lower Deschutes River, May 1998-May 1999.

<b>STREAMFLOW</b>		
<b>Site</b>	<b>Source</b>	<b>Form of Data</b>
Deschutes R. at Pelton	USGS gage 14092500	mean weekly flows
Deschutes R. at Moody	USGS gage 14103000	mean weekly flows
Shitike Creek at Warm Springs	USGS gage 14093000	mean weekly flows
Warm Springs River near Kah-nee-ta	USGS gage 14097100	mean weekly flows
White R. below Tygh Valley	estimates based on known flows at other points	mean weekly flows
<b>STREAM TEMPERATURE</b>		
<b>Site</b>	<b>Source</b>	<b>Form of Data</b>
Deschutes at Pelton	On-site hourly data, PGE and E&S	weekly averages
Shitike Creek at Warm Springs	historical data (Fritsch 1995)	monthly averages
Warm Springs River near Kah-nee-ta	historical data (Fritsch 1995)	monthly averages
White R. below Tygh Valley	historical data (ODFW et al. 1985)	monthly averages

## Calibration of the SNTEMP Model

The previous version of the SNTEMP model required some changes to accommodate the 1998–99 data. Water temperature recordings from the Nena site (Rkm 95) were missing for part of the year; these values were interpolated from sites 8 km upstream and downstream. The Colorado Rapids (Rkm 6.4) temperature logger was lost in 1999. Therefore, this site was replaced in the new model by Washout Rapids (Rkm 16).

After these adjustments, the new SNTEMP runs were very similar to the 1997–98 version. Again, the correspondence between measured and simulated weekly average temperatures was good. The average simulation error ranged from –0.46 to +0.35, the mean error for all sites combined was –0.14, and the mean absolute error was 0.39 C (Table 2). These are slightly higher than the 1997–98 error ranges, but still well within the guidelines for SNTEMP simulation.

**Table 2.** Summary statistics for SNTMEP modeling of weekly average water temperatures in the Deschutes River, Oregon, late-May 1998 through mid-May 1999.

<b>Validation Site</b>	<b>Weeks Simulated</b>	<b>Mean error in simulation (°C)</b>	<b>Mean absolute error in simulation (°C)</b>
Dry Creek (Rkm 149.7)	52	-0.24	0.24
Kaskela (Rkm 127.2)	52	0.35	0.37
Nena (Rkm 95.0)	52	0.13	0.31
Sandy Beach (Rkm 72.4)	52	-0.41	0.44
Mack's Canyon (Rkm 38.6)	52	-0.46	0.59
Washout Rapids (Rkm 16)	52	-0.20	0.39
<b>All sites combined</b>	<b>312</b>	<b>-0.14</b>	<b>0.39</b>

Measured weekly maximum temperatures were also compared to SNTEMP simulations for mid-May to mid-September (weeks 21–37). The average simulation error ranged from –0.92 to +0.25 C, the mean error for all sites combined was –0.17 C, and the mean absolute error was 0.54 C (Table 3). These error ranges indicate very good model performance, particularly since maximum temperatures are not the strong point of the SNTEMP model.

**Table 3.** Summary statistics for SNTMEP modeling of weekly mean maximum water temperatures in the Deschutes River, Oregon, during summer, 1998 (late-May through mid-September).

<b>Validation Site</b>	<b>Weeks Simulated</b>	<b>Mean error in simulation (°C)</b>	<b>Mean absolute error in simulation (°C)</b>
Dry Creek (Rkm 149.7)	17	+0.13	0.19
Kaskela (Rkm 127.2)	17	+0.15	0.42
Nena (Rkm 95.0)	17	+0.13	0.32
Sandy Beach (Rkm 72.4)	17	+0.25	0.43
Mack's Canyon (Rkm 38.6)	17	-0.92	1.02
Washout Rapids (Rkm 16)	17	-0.75	0.87
<b>All sites combined</b>	102	-0.17	0.54

### Modeling With- vs. Without-PRB Temperatures

Once the SNTTEMP model was calibrated with measured data, it could be run in simulation mode to compare two scenarios. The first was the actual operating conditions from May 1998 to May 1999. The second used all the same flow, tributary, and meteorological data; but the starting water temperature was the estimated temperature that would have occurred without the presence of PRB. As with the previous report, this starting temperature was calculated from a regression equation based on measured temperature and volume of the three major tributaries to Lake Billy Chinook, and the air temperature at Redmond, Oregon (Huntington et al 1999):

$$\text{Water Temp}_{\text{Pelton}} = 2.8 + 0.79(\text{Wghted avg temp of LBC tribs}) + 0.71(\text{Air Temp}_{\text{Redmond}}), r^2 = 0.98$$



## RESULTS OF THE SNTMP SIMULATIONS

### Mean Weekly Temperatures

#### *Immediately below PRB Reregulating Dam (Rkm 161)*

Results for average weekly temperatures were similar to last year's model (Table 4). From early August to mid-December (weeks 32 to 50), PRB elevated weekly average temperatures by about 0.9 C (range 0 to 1.8 C); during the rest of the year, PRB reduced average temperatures by about 1.5 C (range +.2 to -3.0 C).

With PRB in place, the maximum weekly mean temperature was 15.1 C, vs. 15.0 C without PRB; the maximum occurred in week 35 with PRB in place, while the model predicted it would have occurred in week 30 without PRB (Table 5; Appendix D).

**Table 4.** Effect of PRB on the average temperatures by selected time periods, May, 1998 to May, 1999.

Location	Average Temperatures by Major Time Periods (°C)		
	Overall (21–20)	Weeks 32–50	Weeks 21–31; 51–20
Dry Creek	-0.74	0.83	-1.65
Kaskela	-0.63	0.74	-1.43
Nena	-1.23	0.07	-1.98
Sandy Beach	-0.50	0.63	-1.16
Mack's Canyon	-0.48	0.59	-1.10
Washout Rapids	-0.46	0.55	-1.05

#### *Sandy Beach (Rkm 72.4)*

During the August to mid-December period (weeks 32 to 50), PRB increased mean weekly temperatures by an average of about 0.6 C (range -0.6 to +1.4 C); during the remaining months, PRB reduced the mean weekly temperatures by an average of 1.2 C (range +0.2 to -1.9 C).

The SNTEMP model suggests that PRB reduces the peak value for mean maximum weekly temperature by about 0.7 C (19.1 vs. 19.8 C). The peak value for either scenario was predicted to occur in week 30 (Table 5).

**Table 5.** Peak values predicted for weekly mean maximum temperatures along the lower Deschutes River with and without the presence of PRB, Summer/Fall 1999. Statistical weeks in which peak temperature values were predicted to occur are given in parentheses.

Location on Deschutes River	Peak Values Predicted For Weekly Mean Maximum Temperatures		Estimated PRB effect
	With PRB	Without PRB	
Reregulating Dam (Rkm 161.1)	15.06°C (35)	15°C (30)	0.06
Dry Creek (Rkm 149.7)	16.18°C (35)	16.4°C (30)	-0.23
Kaskela (RM 127.2)	17.27°C (35)	17.96°C (30)	-0.69
Nena (Rkm 95.0)	18.28°C (30)	19.05°C (30)	-0.77
Sandy Beach (Rkm 72.4)	19.09°C (30)	19.78°C (30)	-0.69
Mack's Canyon (Rkm 38.6)	20.3°C (30)	20.92°C (30)	-0.62
Washout Rapids (Rkm 16.0)	21.09°C (30)	21.65°C (30)	-0.56
Mouth (Rkm 0)	21.65°C (30)	22.18°C (30)	-0.53

Note: Actual PRB-related reductions of high temperatures may have been greater than suggested by our SNTEMP-based simulations, because predictive relationships we used to estimate “without PRB” temperatures at the Reregulating Dam may have underestimated “natural” temperatures there by as much as several tenths of a degree centigrade.

### *Mack's Canyon (Rkm 38.6)*

During the August to mid-December period, PRB increased mean weekly temperatures by an average of about 0.6 C (range -0.5 to +1.1 C); during the remaining months, PRB reduced the mean weekly temperatures by an average of 1.1 C (range +0.2 to -1.8 C).

The SNTEMP model suggests that PRB reduces the peak value for mean maximum weekly temperature by about 0.6 C (20.3 vs. 20.9 C). The peak value for either scenario was predicted to occur in week 30 (Table 5).

### *Washout Rapids (Rkm 16)*

During the August to mid-December period, PRB increased mean weekly temperatures by an average of about 0.55 C (range -0.5 to +1.2 C); during the remaining months, PRB reduced the mean weekly temperatures by an average of 1.1 C (range +0.2 to -1.8 C).

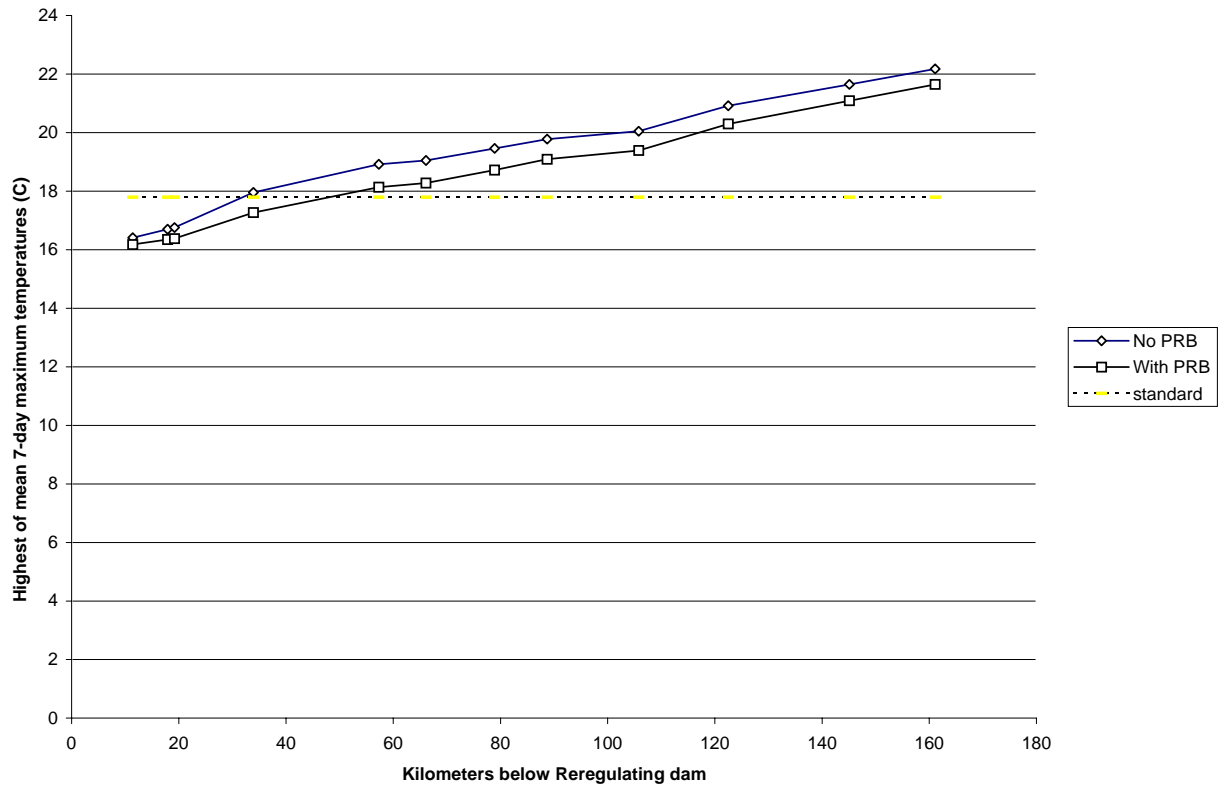
The SNTEMP model suggests that PRB reduces the peak value for mean maximum weekly temperature by about 0.5 C (21.6 vs. 22.2 C). The peak value for either scenario was predicted to occur in week 30 (Table 5).

### **Mean Maximum Temperatures**

Measured mean maximum temperatures ranged from 15.7 at Dry Creek, 12 km below the Reregulating Dam, to 21.0 at Washout Rapids, 16 km above the mouth.

Consistent with last year, it appears that PRB causes a small decrease in weekly mean maximum temperatures downstream. The peak temperature is delayed by several weeks at the upstream sites, but occurs at the same time (week 30) for the remaining sites (Table 5). The measured maxima show this same pattern: upstream, the maxima occur around week 35, while downstream they occur about week 30.

Figure 1 depicts the highest mean maximum temperature as a function of distance from the dam, for the two scenarios. The peak temperatures are lower at each point for the PRB vs. the no-dam scenario. The difference is about 0.6 C for most sites. The State temperature standard of 17.8 C was exceeded 50 km below the Reregulating dam with PRB, vs. 30 km below for the no-dam scenario.



**Figure 1.** Highest mean maximum temperature versus distance from the Reregulating, with and without PRB.

## CONCLUSIONS

The SNTEMP model gave excellent results when compared to measured data in the Deschutes. Comparisons between measured and simulated temperatures indicate that SNTEMP could be used to model downstream effects on weekly mean and maximum temperatures of any starting conditions with great accuracy.

As with last year’s modeling, the 1998–99 data indicate a consistent pattern in PRB effects. PRB increased lower Deschutes River temperatures in the late summer through early winter, then decreased temperatures the rest of the year. The PRB effects attenuate downstream, but are still measurable at the mouth.

Overall, the modeled effects of PRB on mean and maximum weekly temperatures are very similar to those noted in the previous report. Conclusions reached on potential biological effects would not be significantly altered by the 1998–99 data.

## ACKNOWLEDGEMENTS

Mr. Karl Hartzell and Mr. Blake Price carried out many of the calculations required to transform raw data into SNTMP inputs. They also created graphs from the SNTMP output.

## REFERENCES

- Fritsch, Mark A. 1995. Habitat quality and anadromous fish production on the Warm Springs Reservation. Final report from the Confederated Tribes of the Warm Springs Indian Reservation, Project No. 94-56. Report number DOE/BP-32564-1, Division of Fish and Wildlife, Bonneville Power Administration, Portland, Oregon.
- Huntington, Charles W., T. Hardin, and R. Raymond 1999. Water temperatures in the lower Deschutes River, Oregon. Consultant report to the Portland General Electric Company, Portland, Oregon.
- Oregon Department of Fish and Wildlife (ODFW), OTT Water Engineers, Inc., and Buell and Associates. 1985. White River Falls Fish Passage Project, Tygh Valley, Oregon. Volume III: Appendix B, Fisheries Report. Final report to the Division of Fish and Wildlife, Bonneville Power Administration, Portland, Oregon.

## **APPENDIX A**

**SNTEMP-Based Simulations of Weekly Mean Water Temperatures for  
Specific Locations in the Deschutes River, Oregon,  
Late-May 1998 Through Mid-May 1999**

### Deschutes R. below Reregulating Dam (Rkm 161.1)

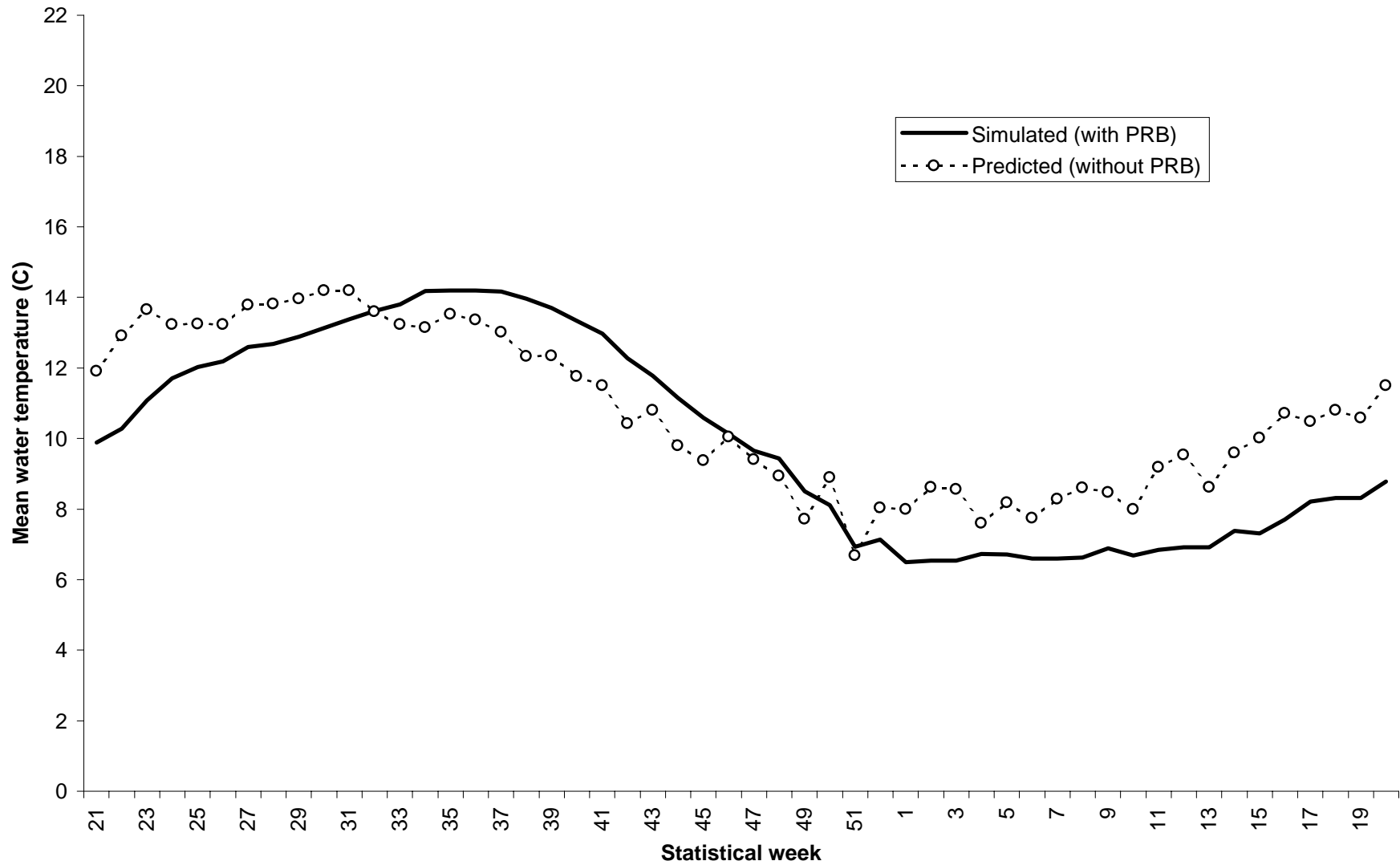


Figure A-1. Measured and SNTemp-simulated mean water temperatures for the Deschutes River at the Reregulating Dam (Rkm 161.1) for statistical week 21 in 1998 through week 20 in 1999.

### Deschutes R. at Dry Creek (Rkm 149.7)

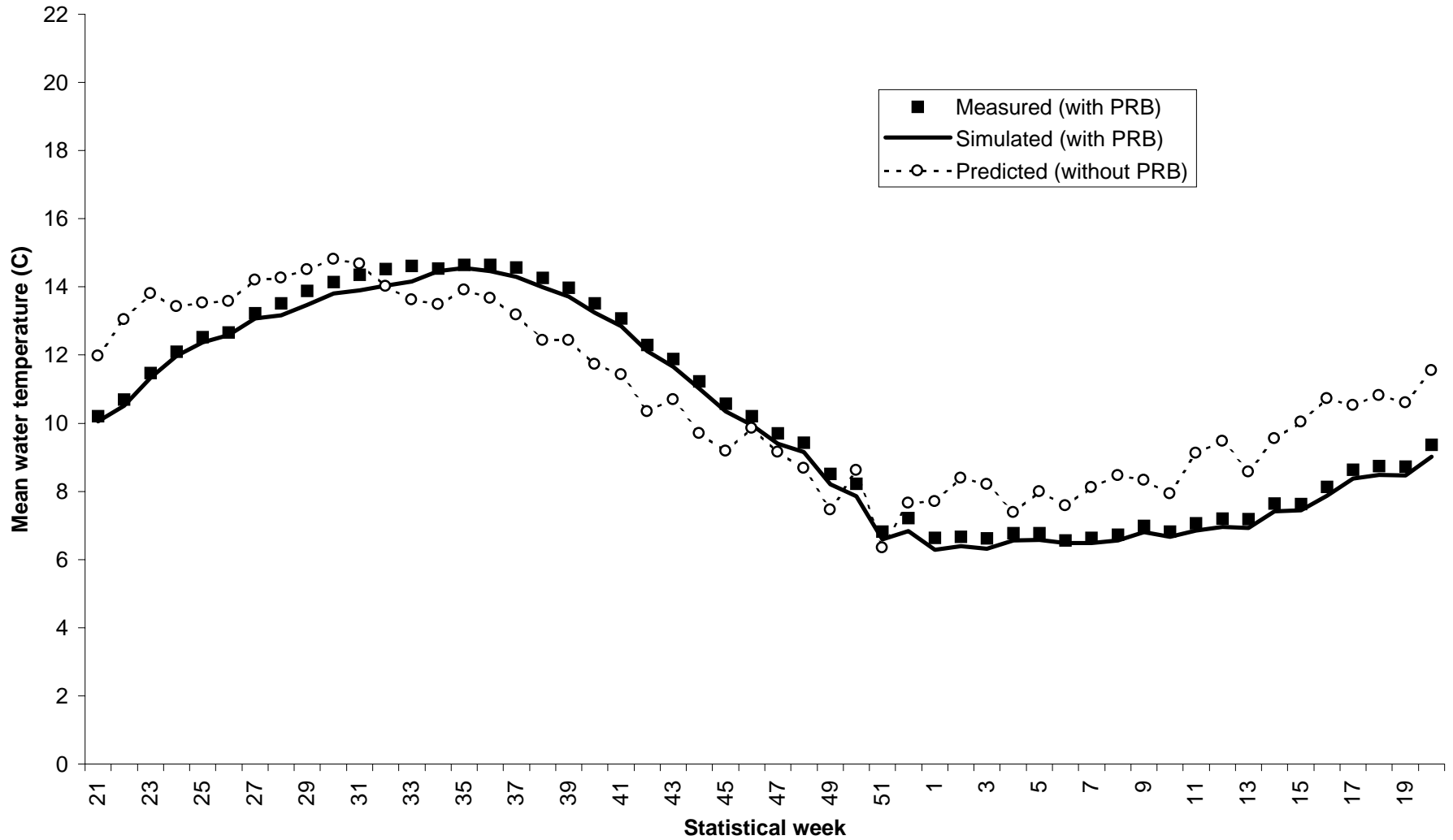


Figure A-2. Measured and SNTEMP-simulated mean water temperatures for the Deschutes River at Dry Creek (Rkm 149.7), for statistical week 21 in 1998 through week 20 in 1999.



Deschutes R. at Kaskela (Rkm 127.2)

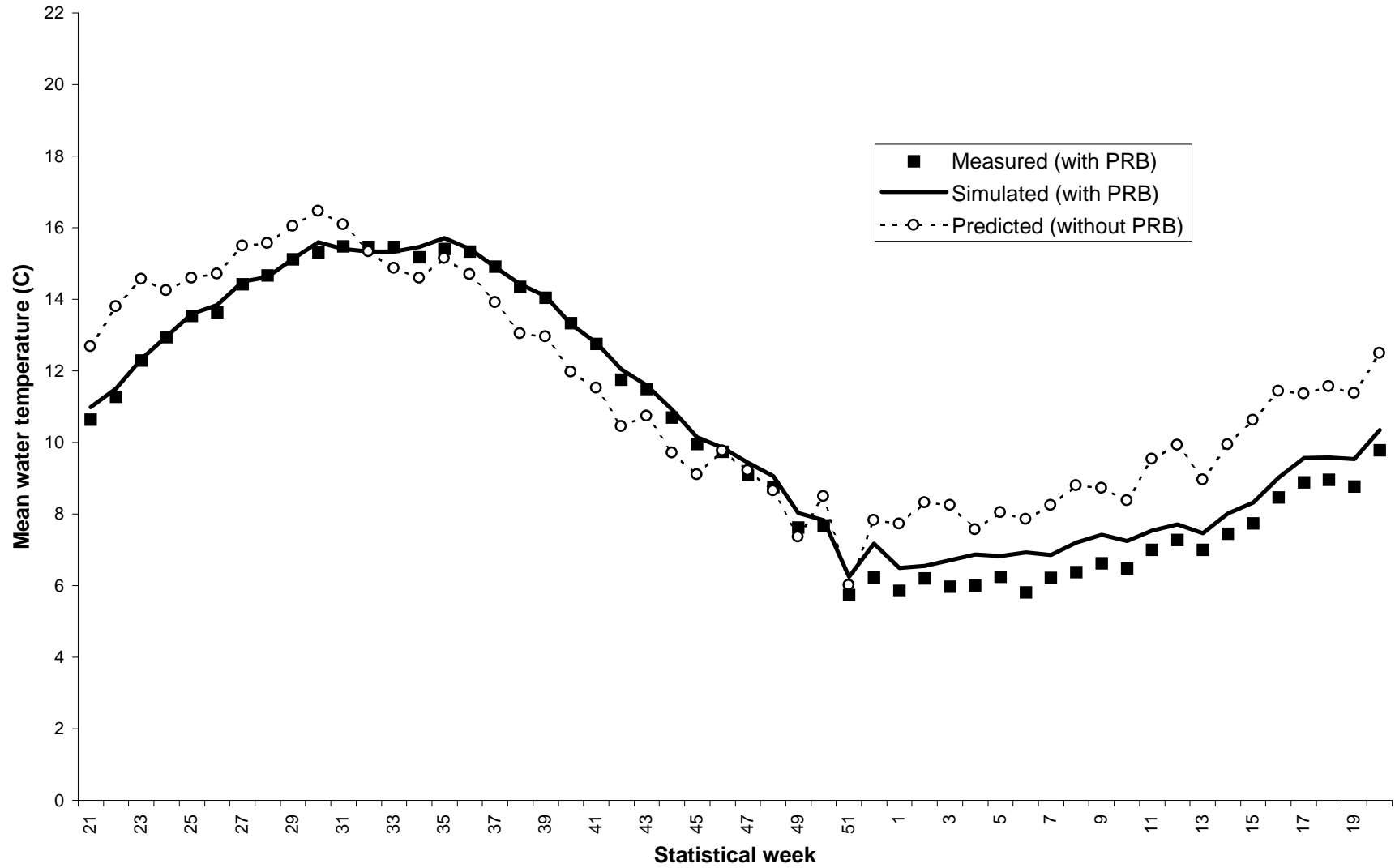


Figure A-3. Measured and SNTemp-simulated mean water temperatures for the Deschutes River at Kaskela (Rkm 127.2), for statistical week 21 in 1998 through week 20 in 1999.

### Deschutes R. at Nena (Rkm 95)

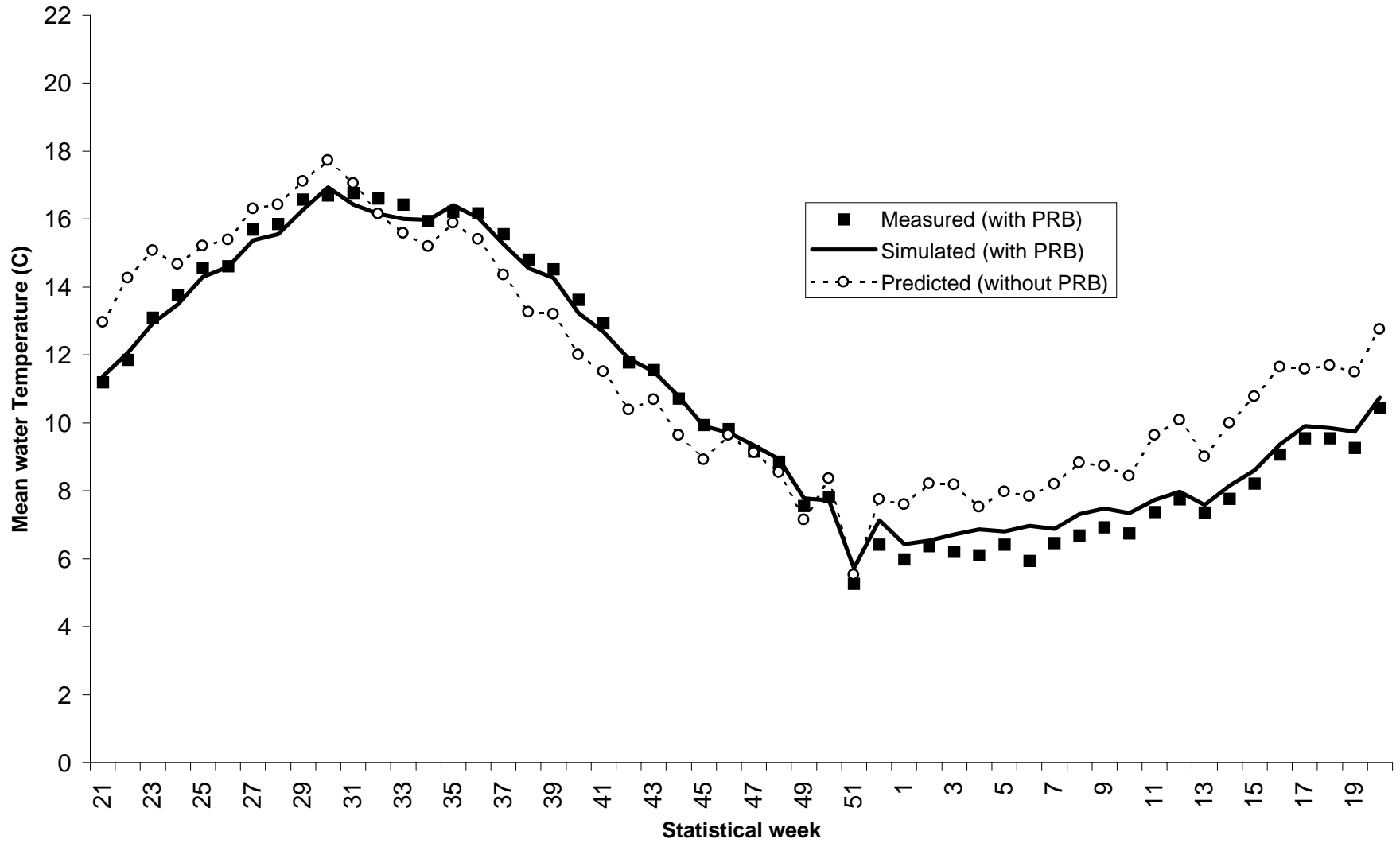


Figure A-4. Measured and SNTEMP-simulated mean water temperatures for the Deschutes River at Nena (Rkm 95.0), for statistical week 21 in 1998 through week 20 in 1999.

### Deschutes R. at Sandy Beach (Rkm 72.4)

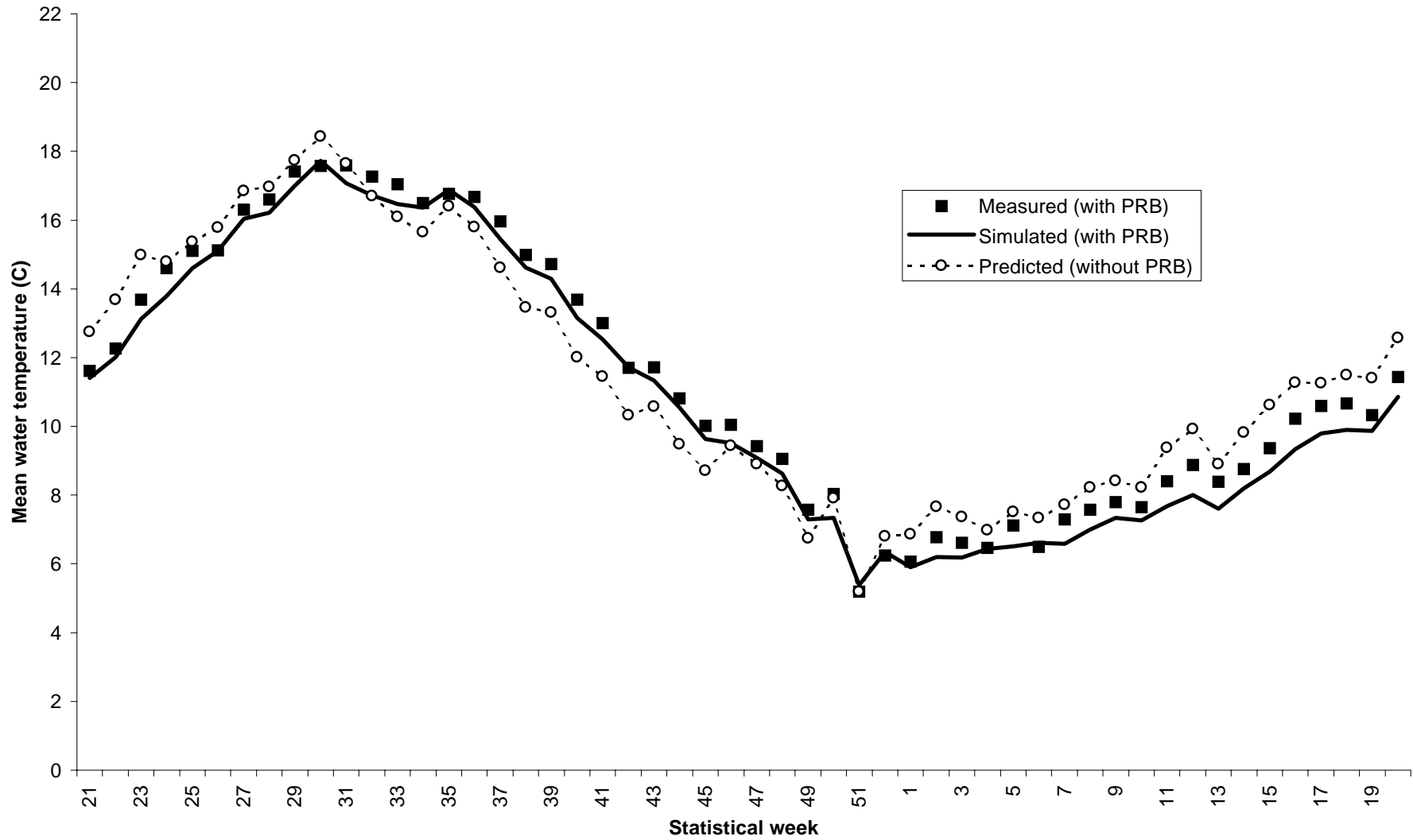


Figure A-5. Measured and SNTemp-simulated mean water temperatures for the Deschutes River at Sandy Beach (Rkm 72.4), for statistical week 21 in 1998 through week 20 in 1999.

### Deschutes R. at Macks Canyon (Rkm 38.6)

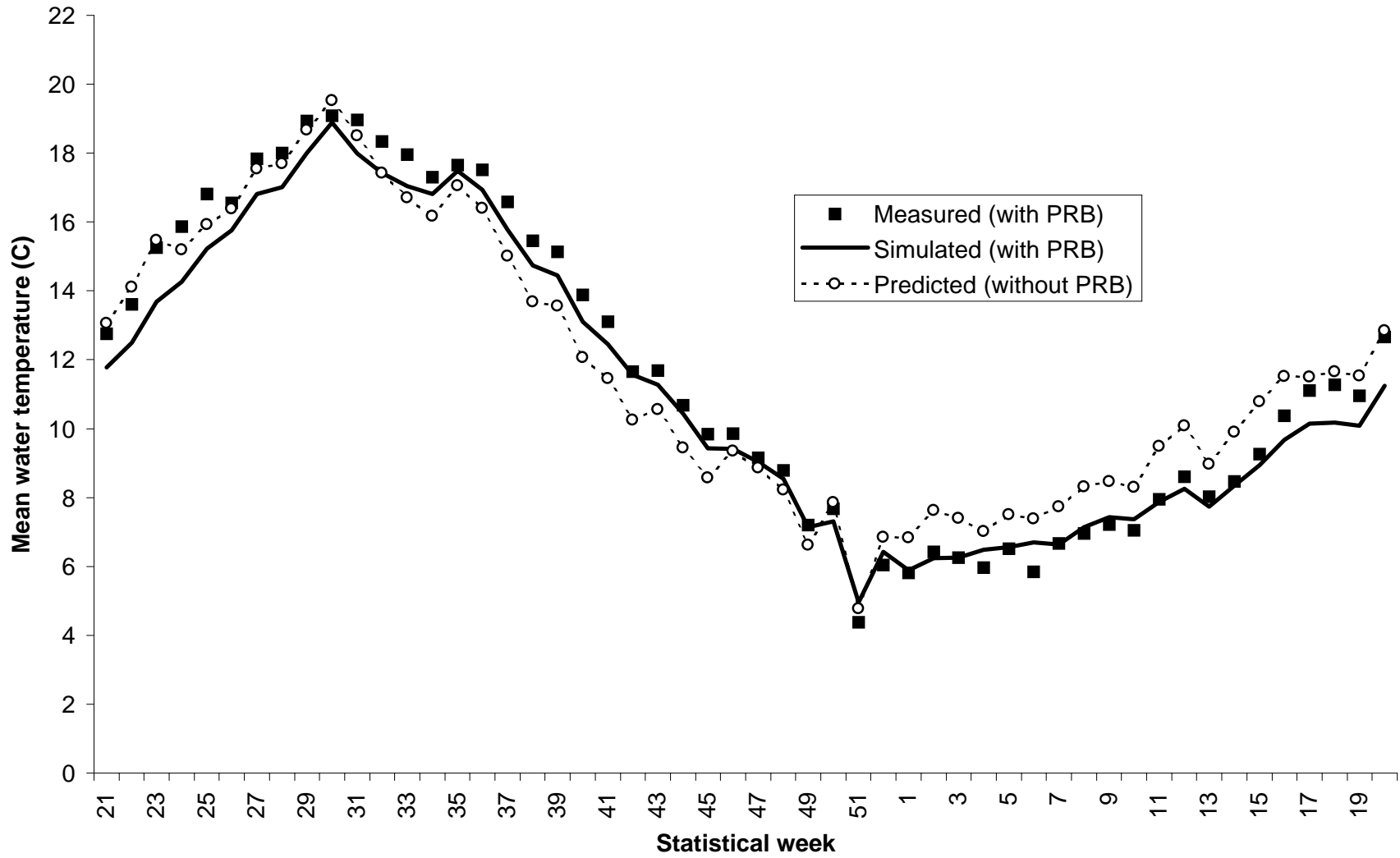


Figure A-6. Measured and SNTemp-simulated mean water temperatures for the Deschutes River at Macks Canyon (Rkm 38.6), for statistical week 21 in 1998 through week 20 in 1999.

### Deschutes R. at Kloan Rapids (Rkm 16)

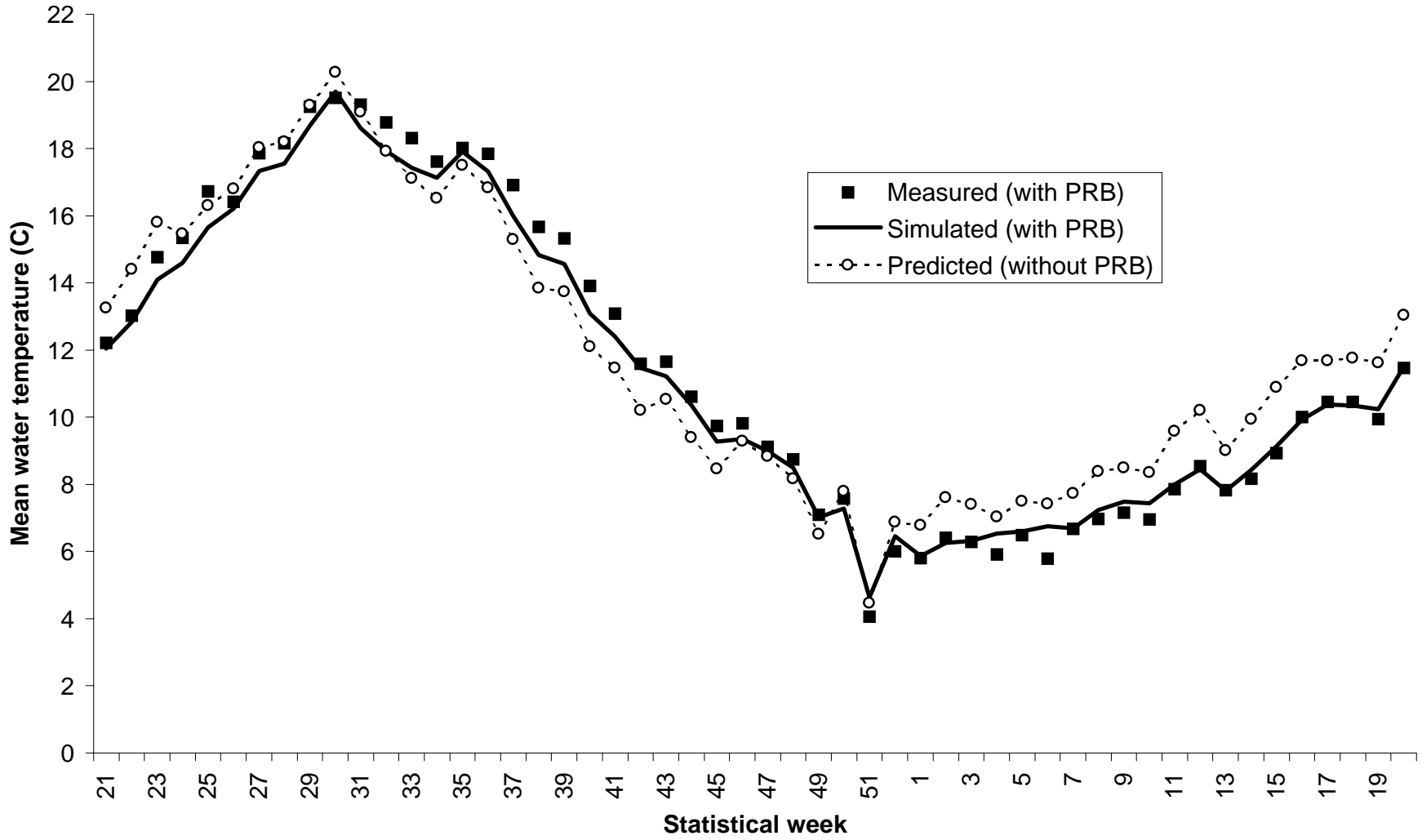


Figure A-7. Measured and SNTemp-simulated mean water temperatures for the Deschutes River at Kloan Rapids (Rkm 16), for statistical week 21 in 1998 through week 20 in 1999.

### Deschutes R. at mouth (Rkm 0)

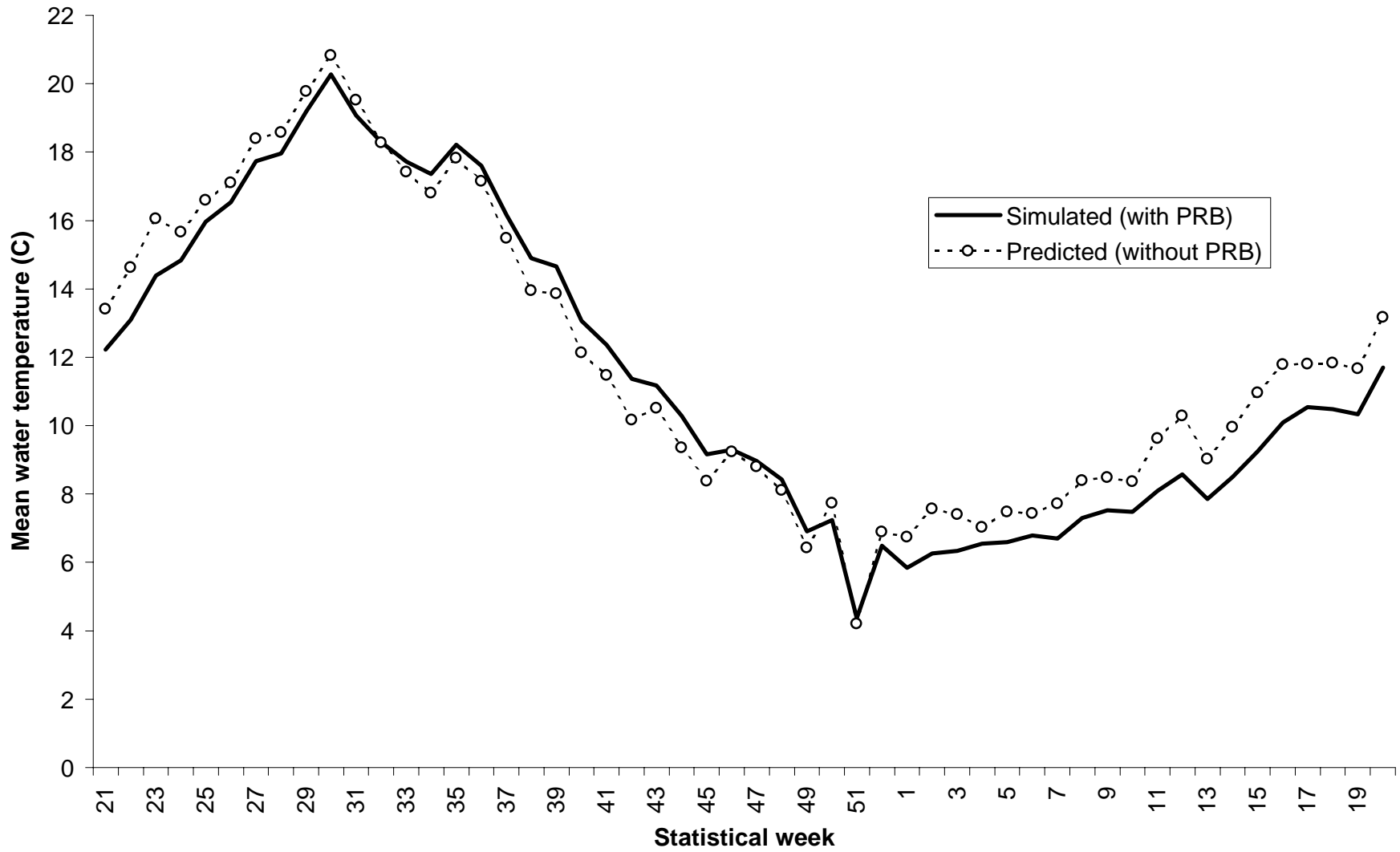


Figure A-8. Measured and SNTemp-simulated mean water temperatures for the Deschutes River at the mouth (Rkm 0), for statistical week 21 in 1998 through week 20 in 1999.

## **APPENDIX B**

**SNTEMP-Based Simulations of Weekly Mean Maximum Water Temperatures for  
Specific Locations in the Lower Deschutes River, Oregon,  
Late-May 1998 Through Mid-May 1999**

### Deschutes R. below Reregulating Dam (Rkm 161.1)

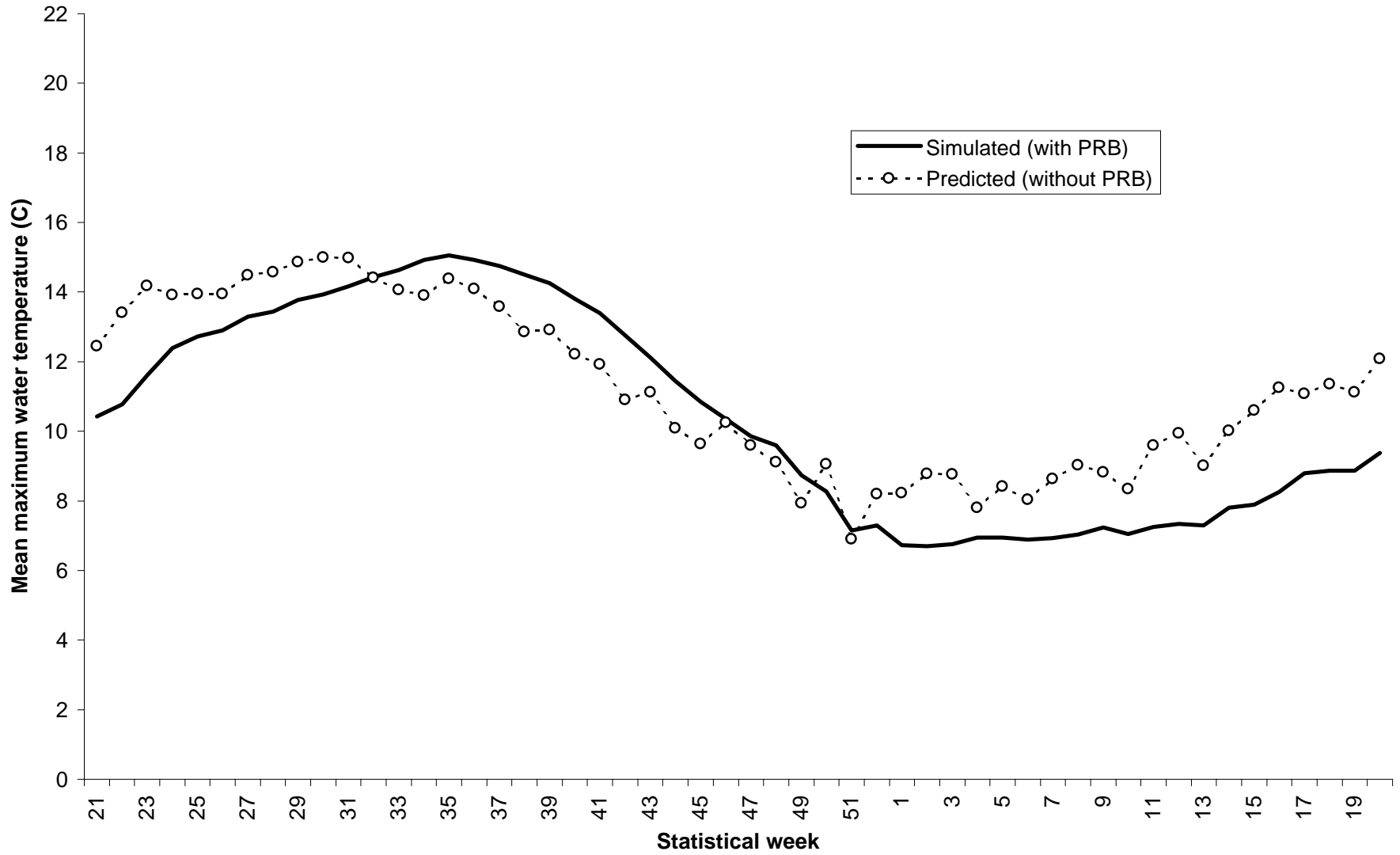


Figure B1. Measured and SNTemp-simulated mean maximum water temperatures for the Deschutes River at the Reregulating Dam (Rkm 161.1), for statistical week 21 in 1998 through week 20 in 1999.



Deschutes R. at Dry Cr. (Rkm 149.7)

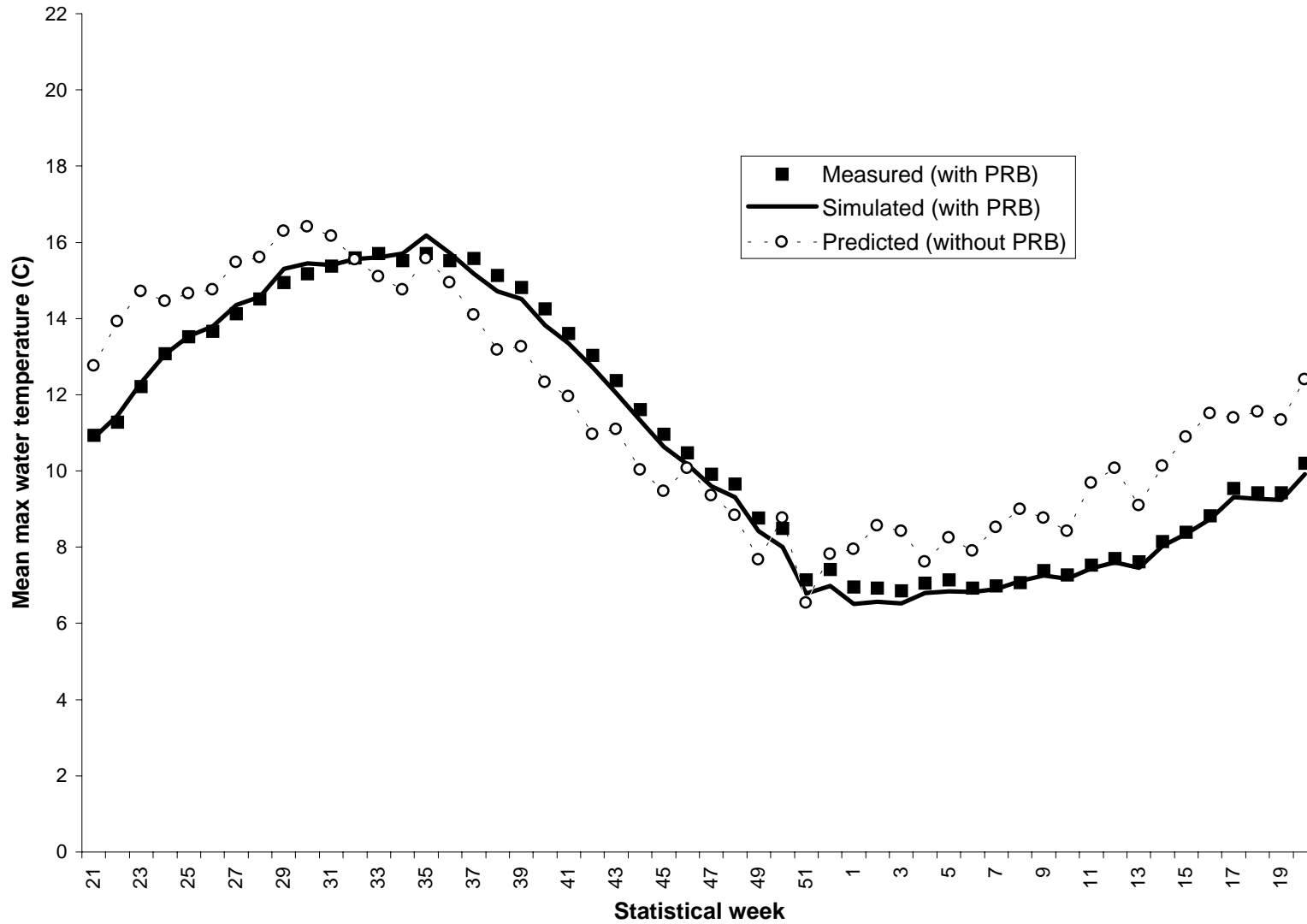


Figure B-2. Measured and SNTemp-simulated mean maximum water temperatures for the Deschutes River at Dry Creek (Rkm 149.7), for statistical week 21 in 1998 through week 20 in 1999.

Deschutes R. at Kaskela (Rkm 127.2)

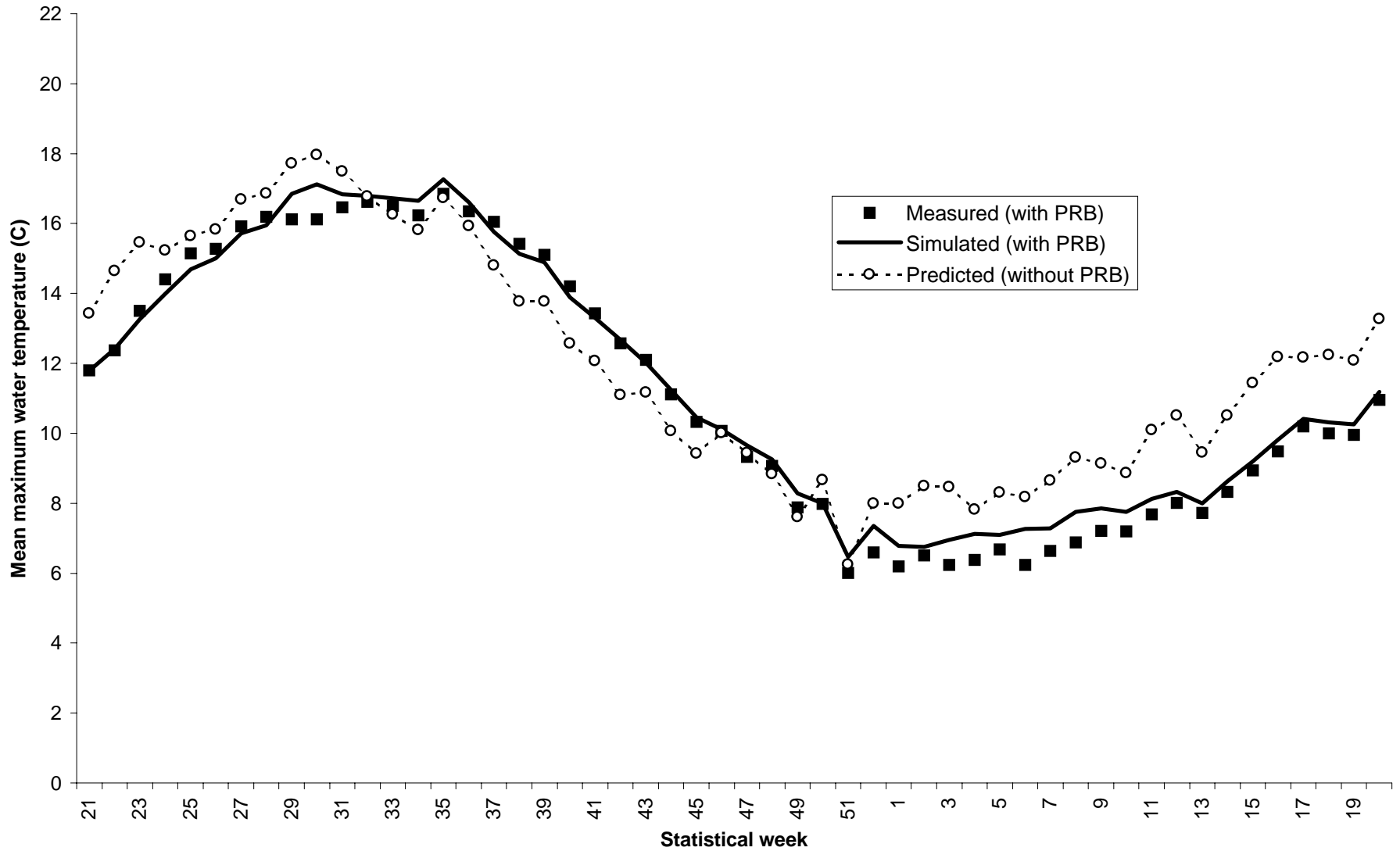


Figure B-3. Measured and SNTemp-simulated mean maximum water temperatures for the Deschutes River at Kaskela (Rkm 127.2), for statistical week 21 in 1998 through week 20 in 1999.

### Deschutes R. at Nena (Rkm 95)

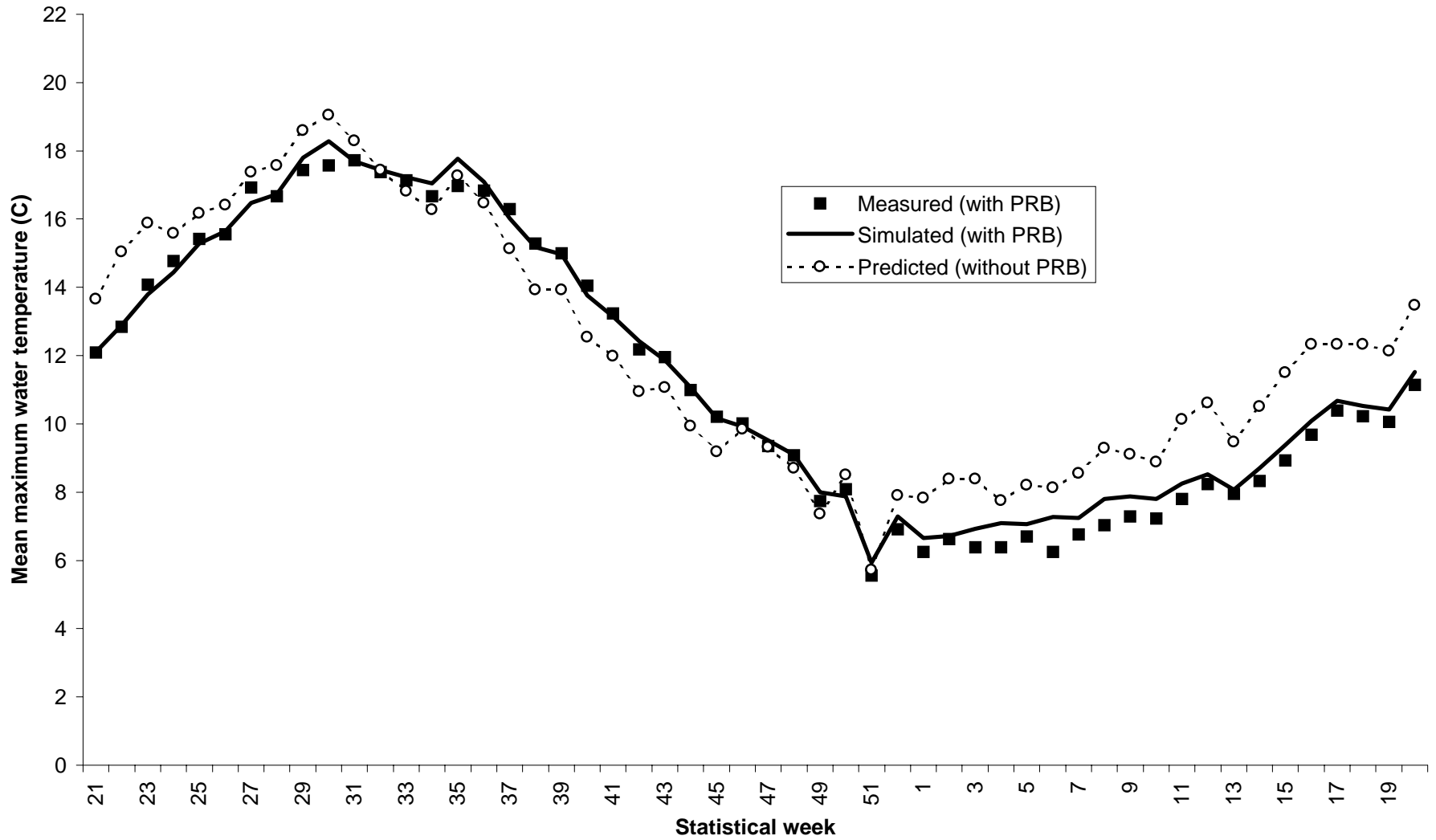


Figure B-4. Measured and SNTemp-simulated mean maximum water temperatures for the Deschutes River Nena (Rkm 95), for statistical week 21 in 1998 through week 20 in 1999.

### Deschutes R. at Sandy Beach (Rkm 72.4)

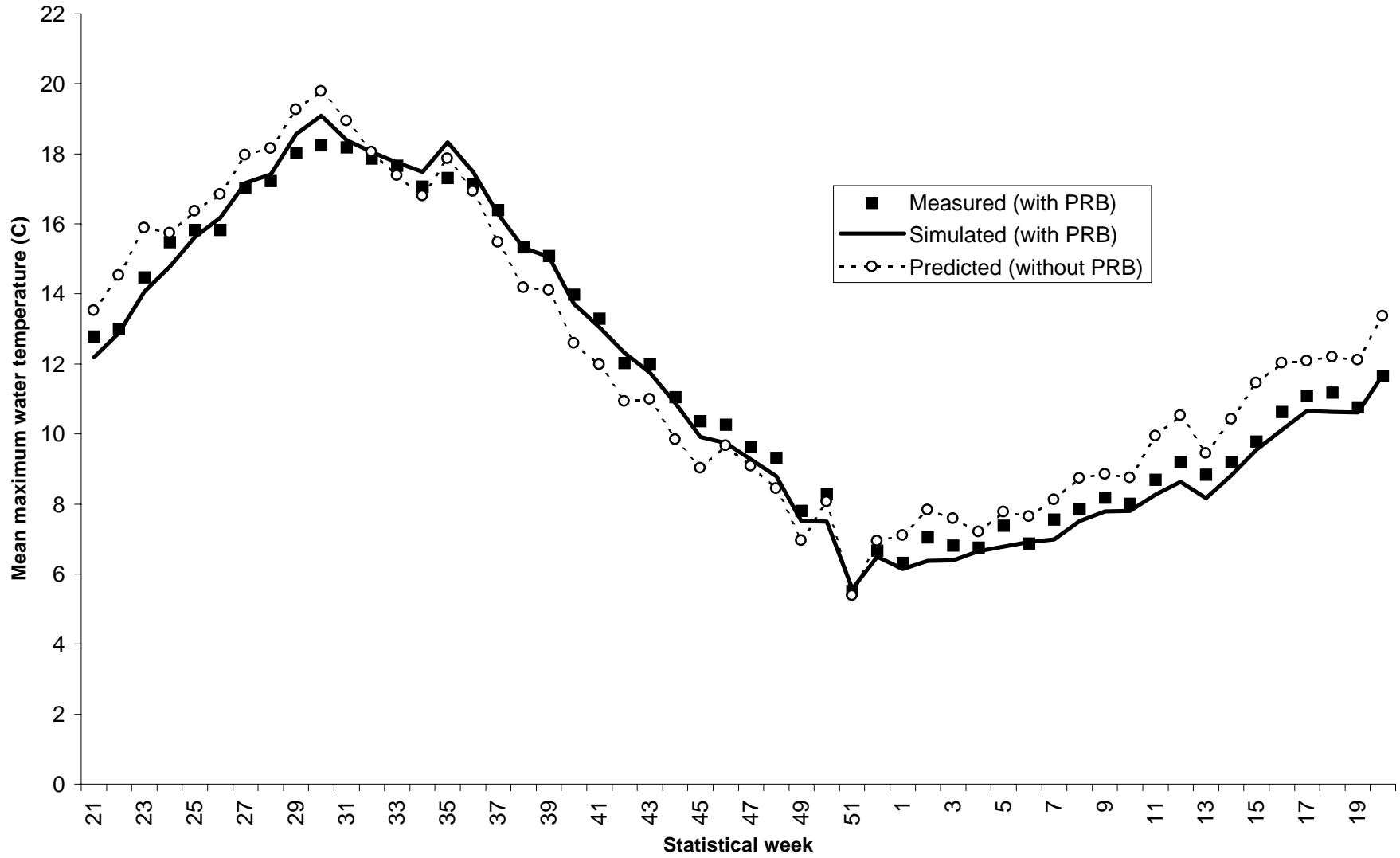


Figure B-5. Measured and SNTMP-simulated mean maximum water temperatures for the Deschutes River at Sandy Beach (Rkm 72.4), for statistical week 21 in 1998 through week 20 in 1999.

### Deschutes R. at Macks Canyon (Rkm 38.6)

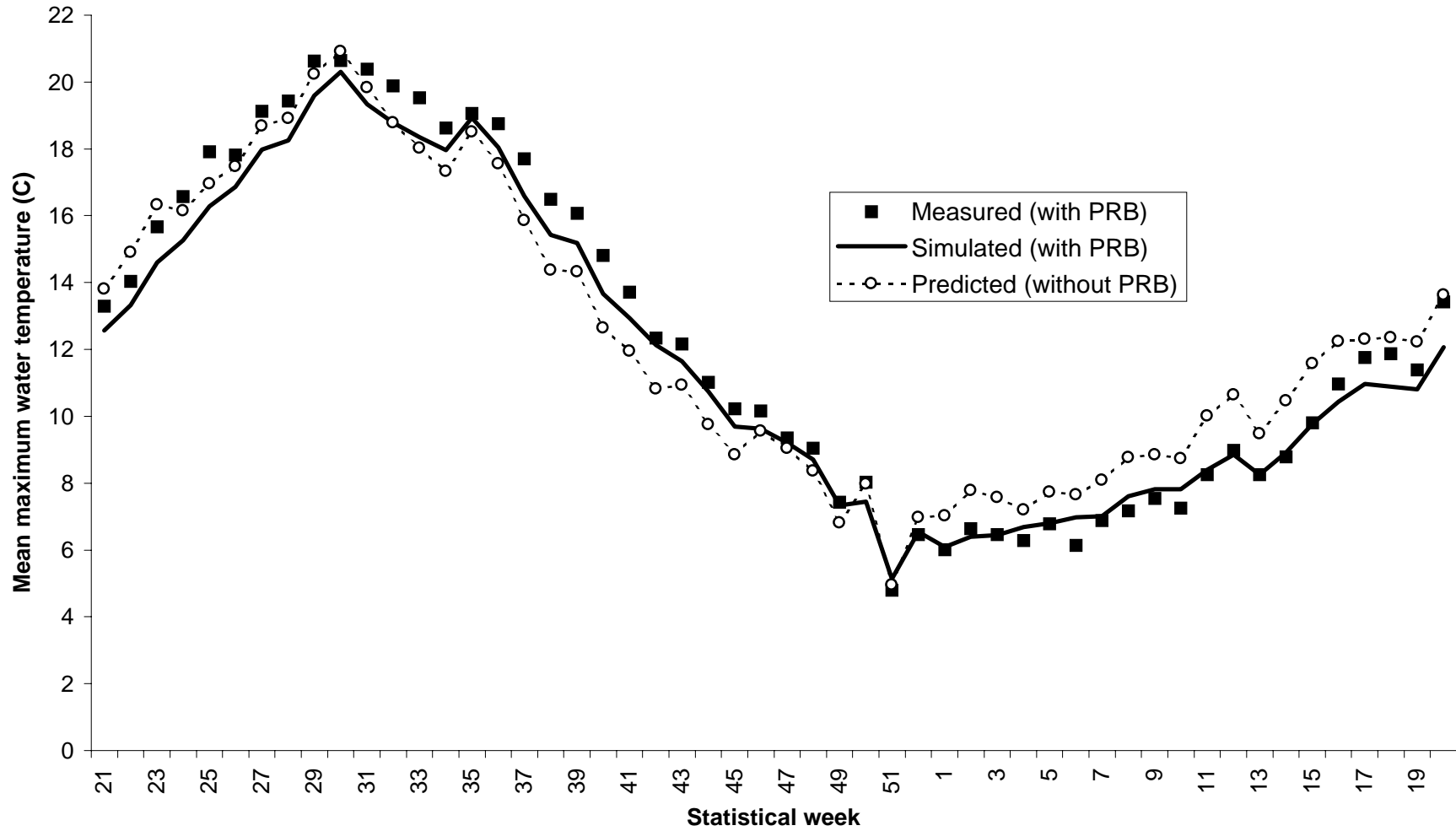


Figure B-6. Measured and SNTEMP-simulated mean maximum water temperatures for the Deschutes River at Macks Canyon (Rkm 38.6), for statistical week 21 in 1998 through week 20 in 1999.

### Deschutes R. at Kloian Rapids (Rkm 16)

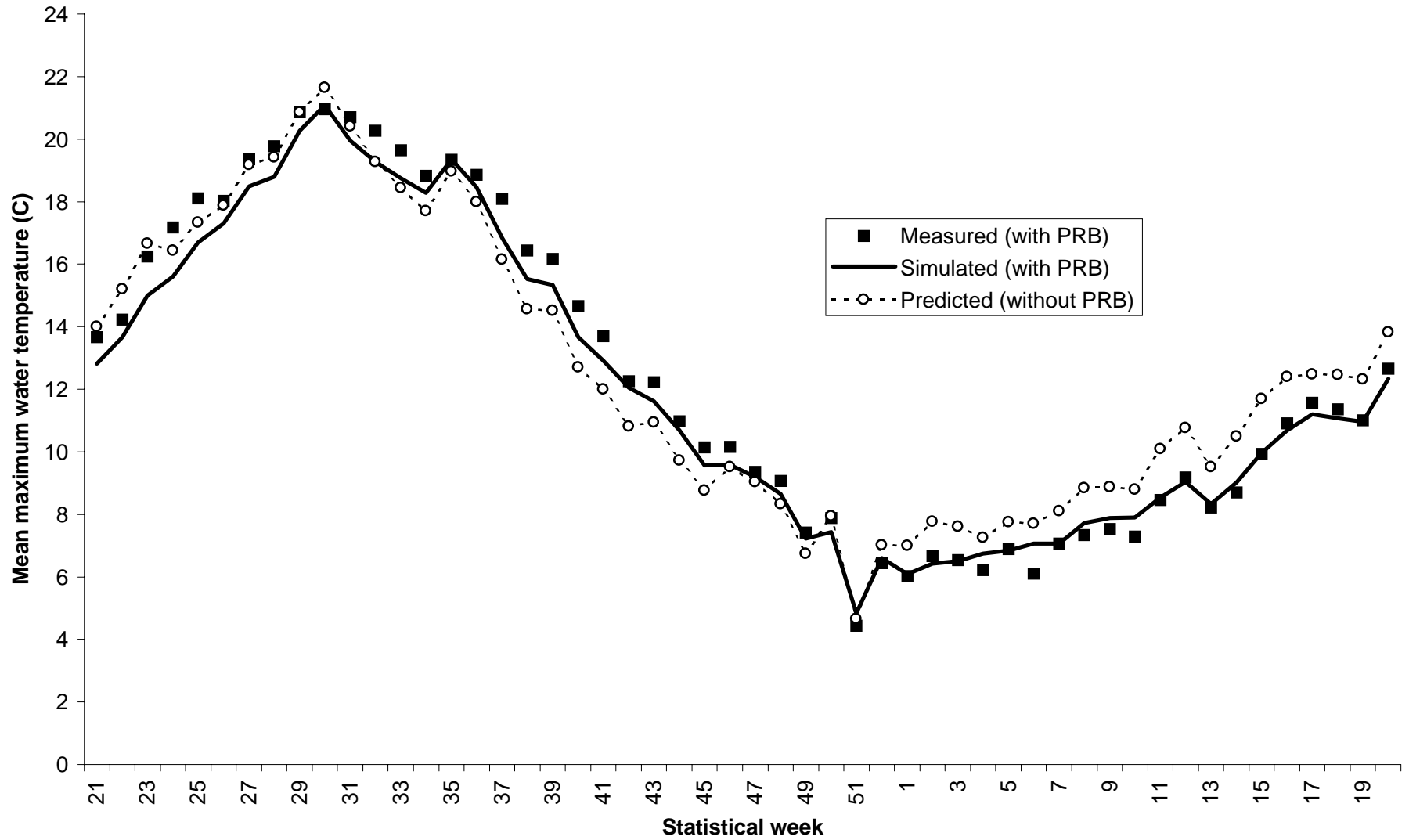


Figure B-7. Measured and SNTMP-simulated mean maximum water temperatures for the Deschutes River at Kloian Rapids (Rkm 16), for statistical week 21 in 1998 through week 20 in 1999.

### Deschutes R. at mouth (Rkm 0)

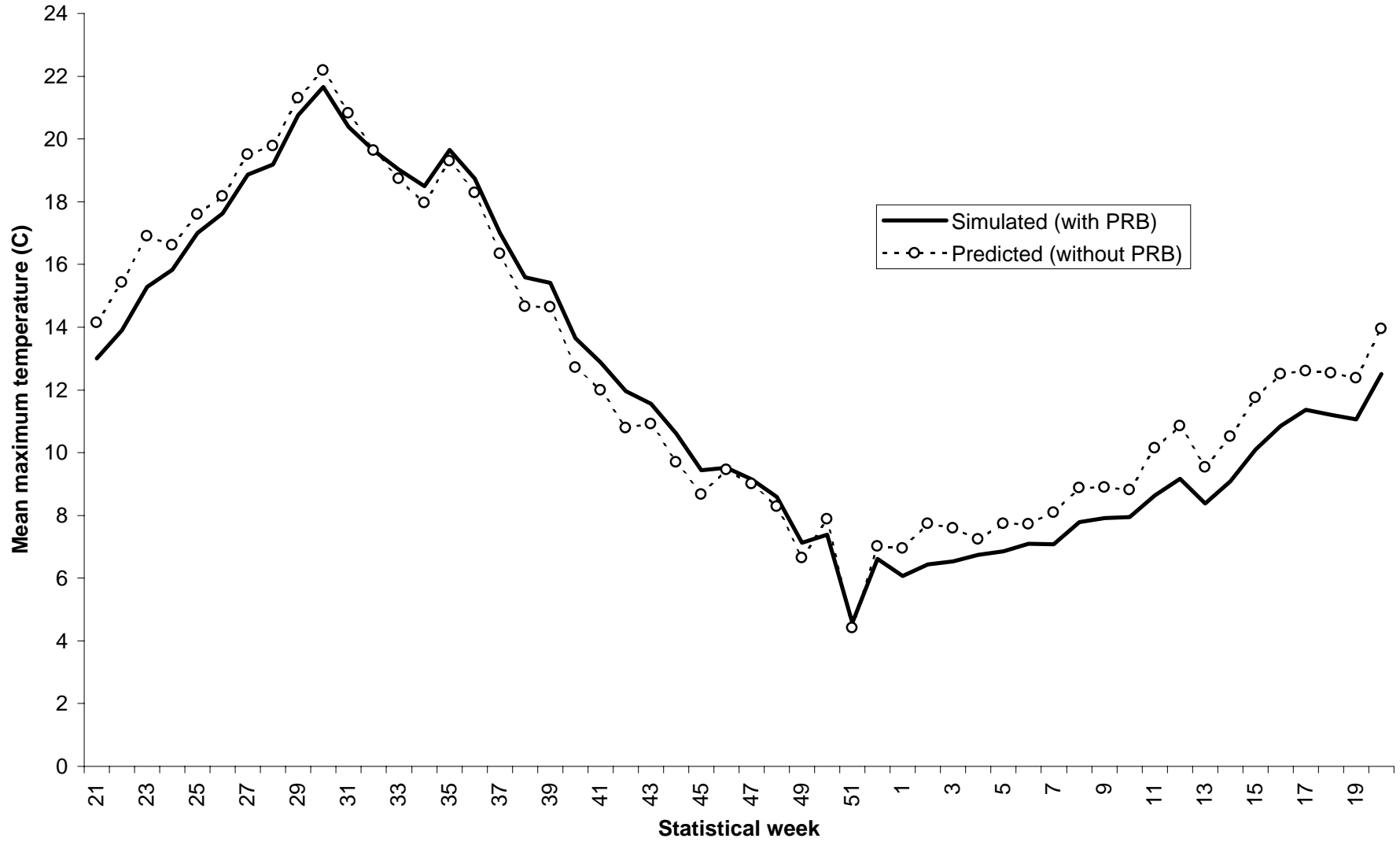


Figure B-8. Measured and SNTemp-simulated mean water temperatures for the Deschutes River at the mouth (Rkm 0), for statistical week 21 in 1998 through week 20 in 1999.

## **APPENDIX C**

**SNTEMP-Based Simulations of Mean Deschutes River Temperatures Versus  
Distance Below PRB Reregulating Dam,  
Late-May 1998 Through Mid-May 1999**



### Statistical week 22

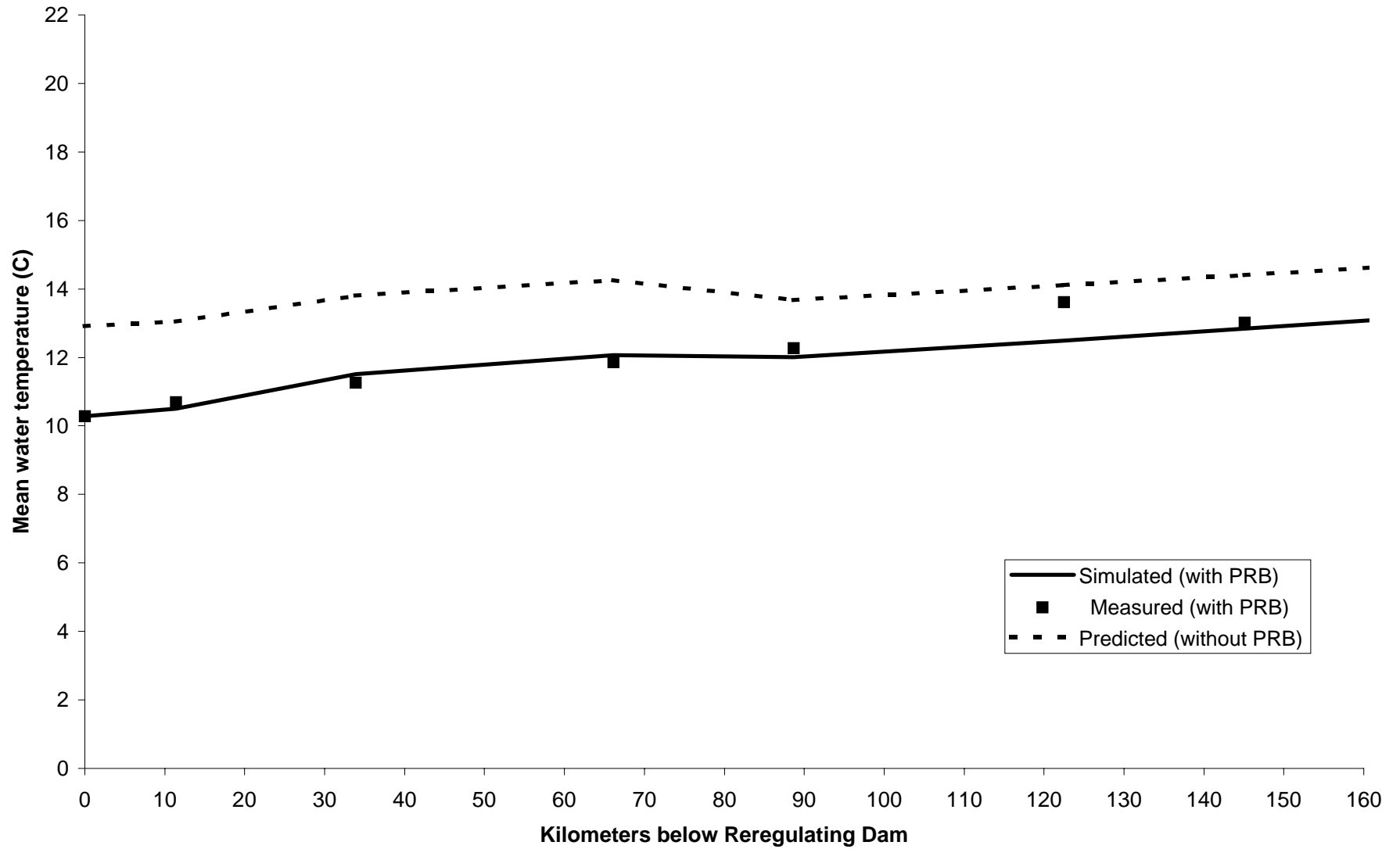


Figure C-1. Mean weekly water temperature in the mainstem Deschutes River versus distance below the PRB Reregulating Dam, statistical week 22, 1998.

### Statistical week 26

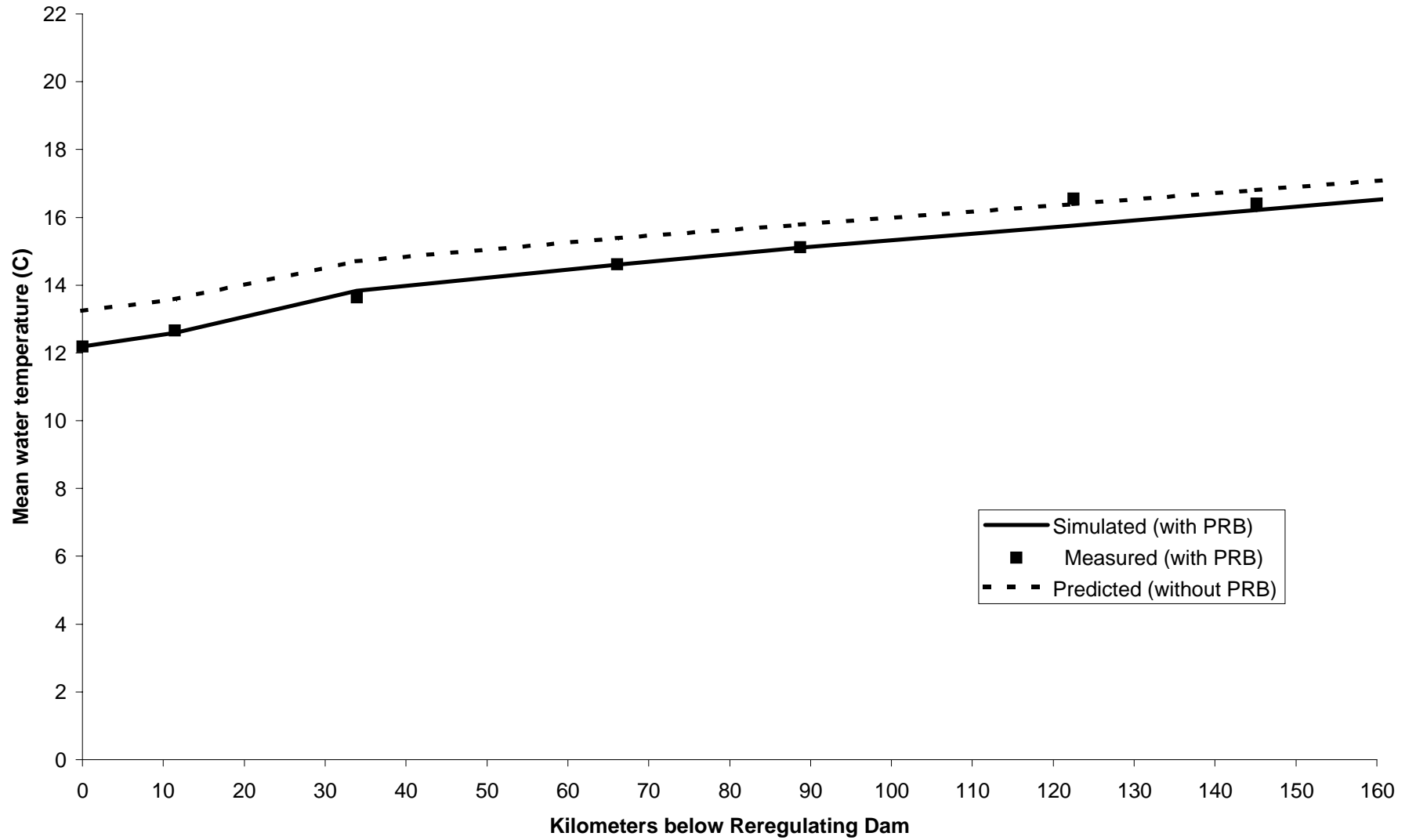


Figure C-2. Mean weekly water temperature in the mainstem Deschutes River versus distance below the PRB Reregulating Dam, statistical week 26, 1998.

### Statistical week 30

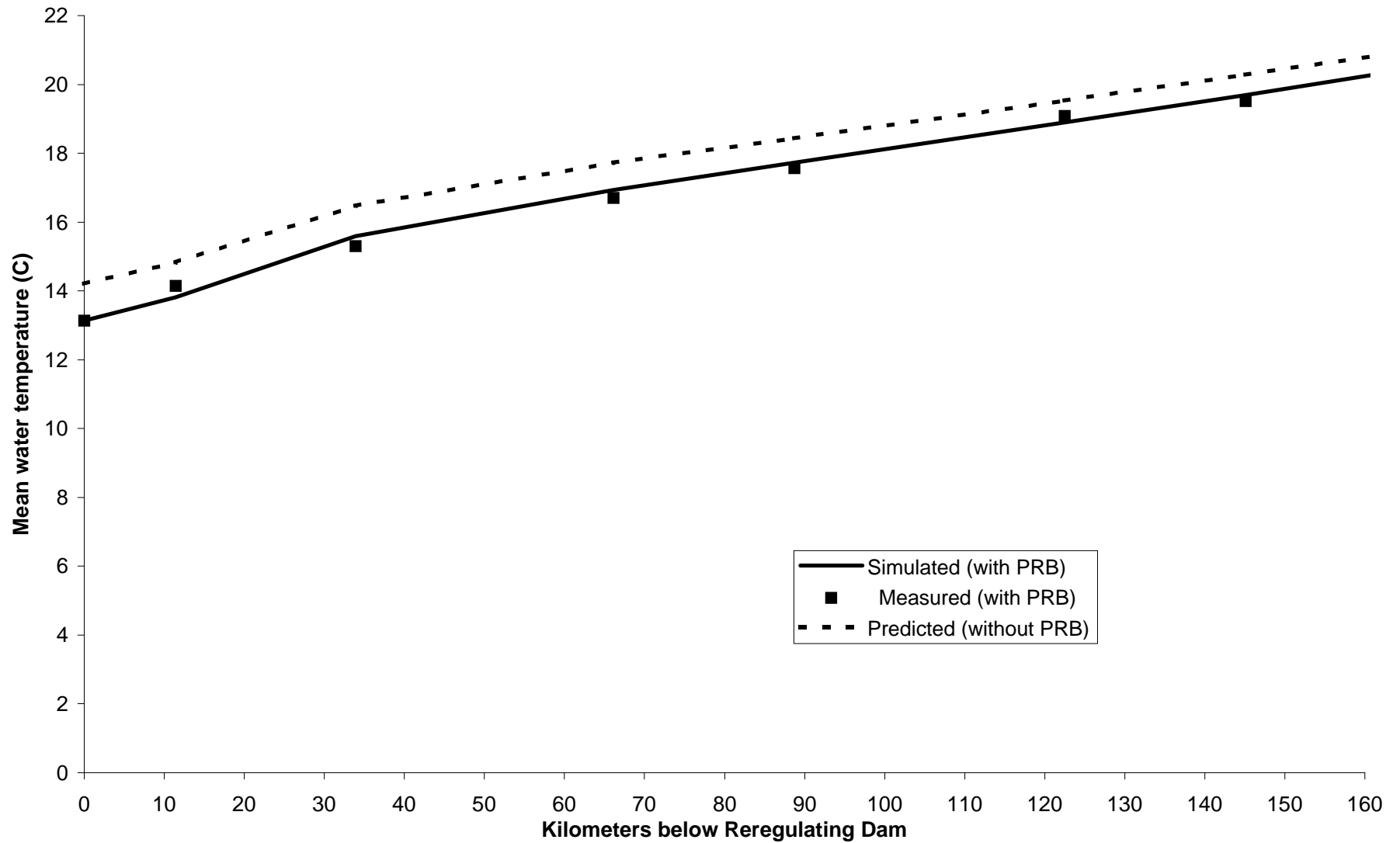


Figure C-3. Mean weekly water temperature in the mainstem Deschutes River versus distance below the PRB Reregulating Dam, statistical week 30, 1998.

### Statistical week 34

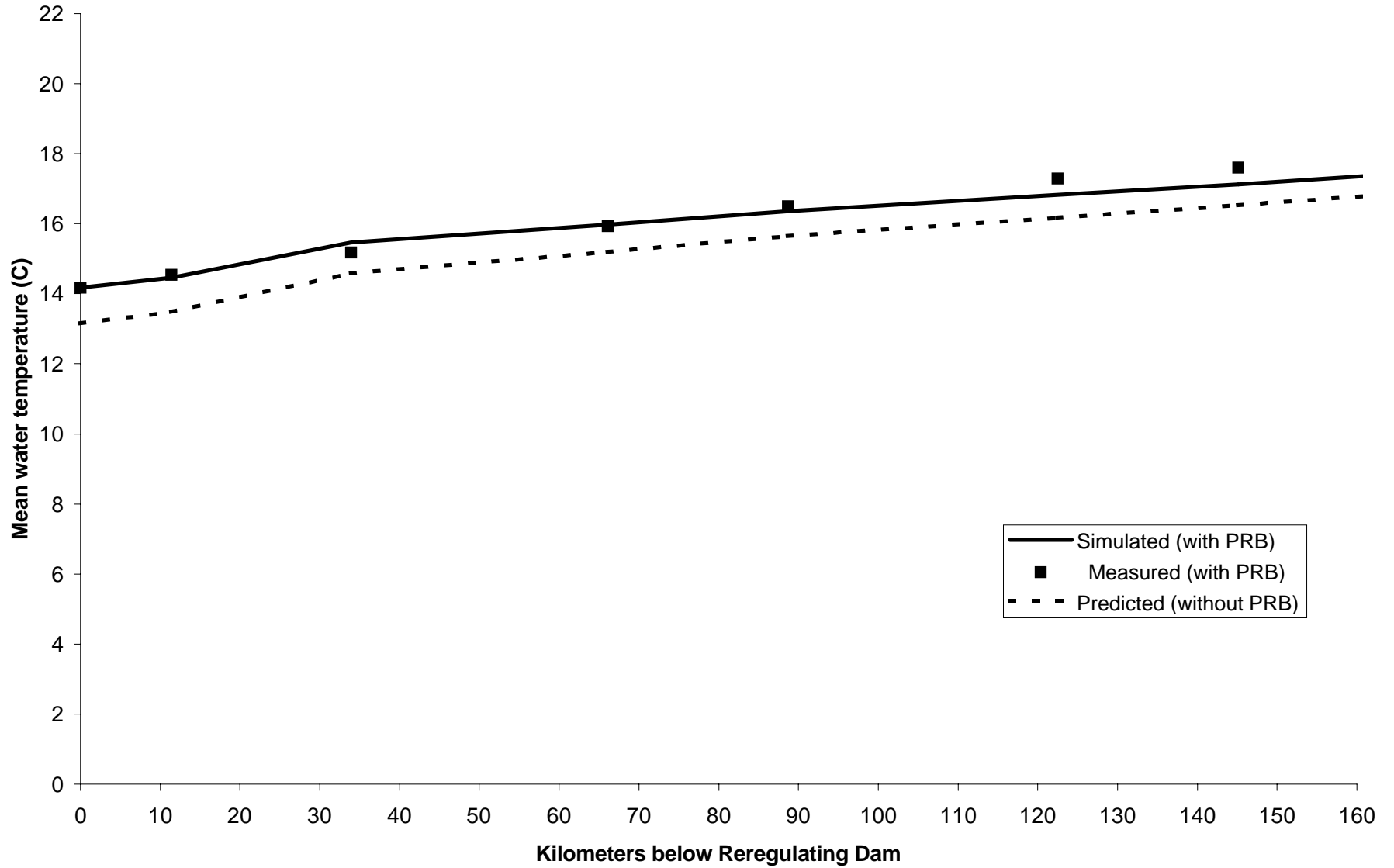


Figure C-4. Mean weekly water temperature in the mainstem Deschutes River versus distance below the PRB Reregulating Dam, statistical week 34, 1998.

### Statistical week 38

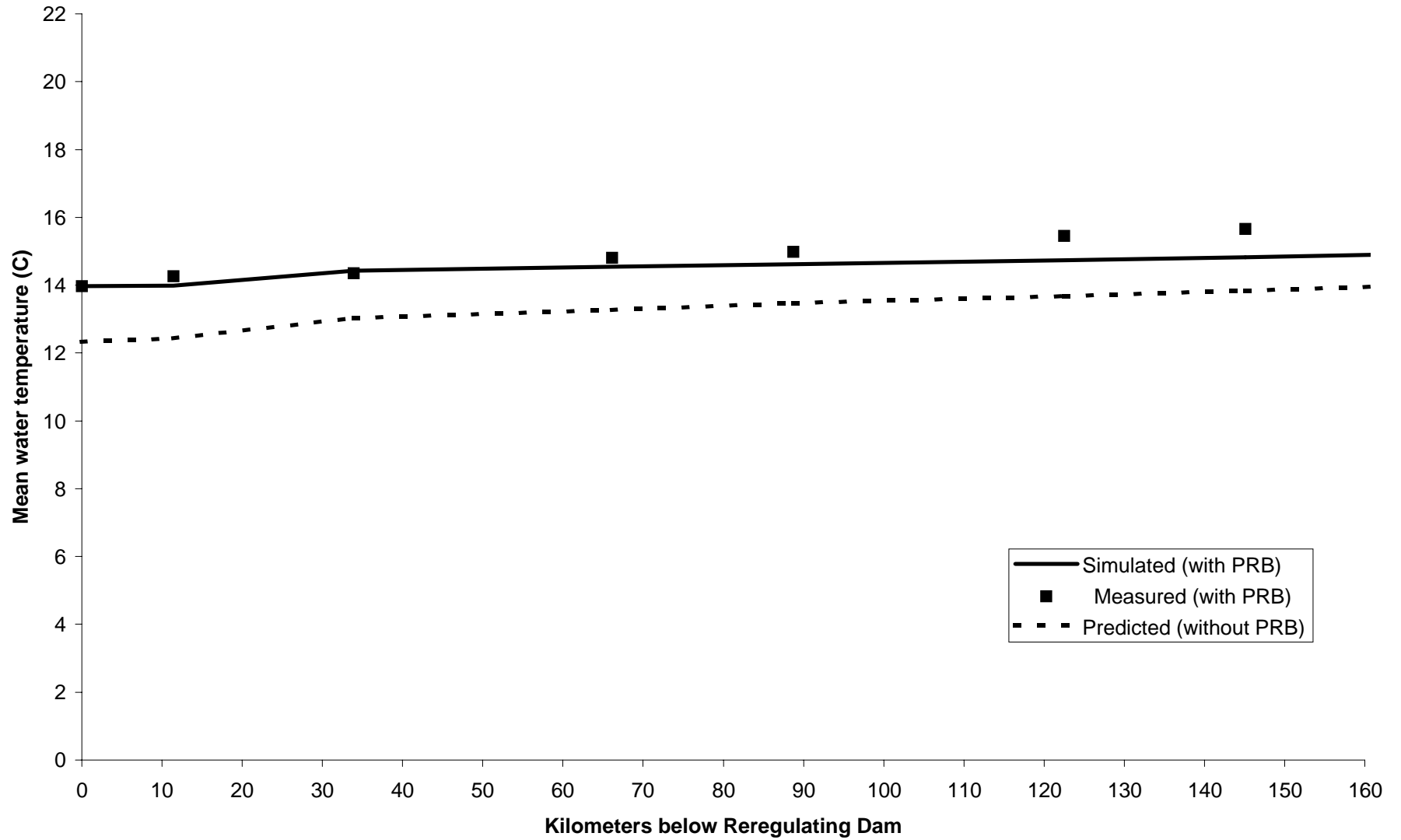


Figure C-5. Mean weekly water temperature in the mainstem Deschutes River versus distance below the PRB Reregulating Dam, statistical week 38, 1998.

### Statistical week 42

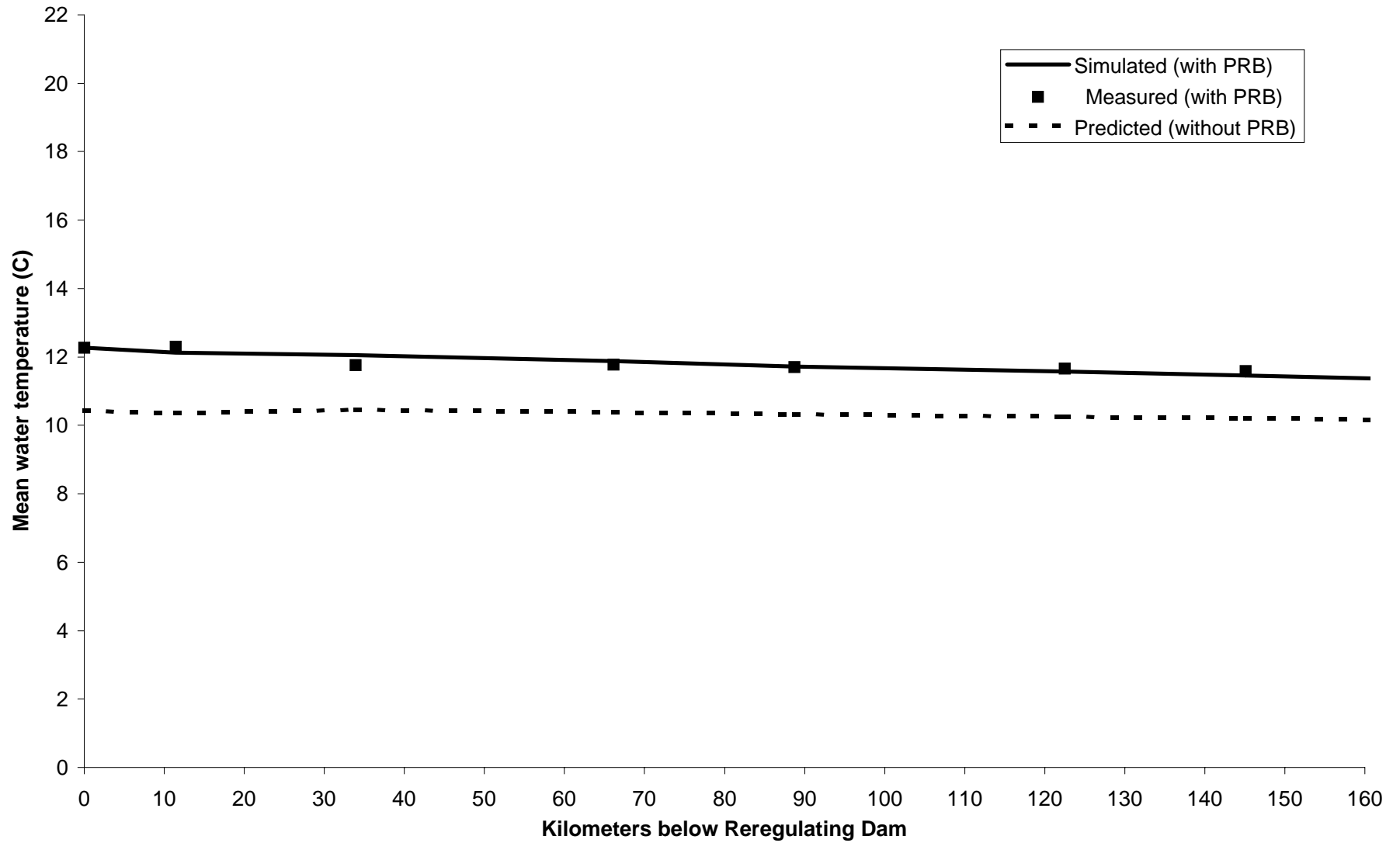


Figure C-6. Mean weekly water temperature in the mainstem Deschutes River versus distance below the PRB Reregulating Dam, statistical week 42, 1998.

### Statistical week 46

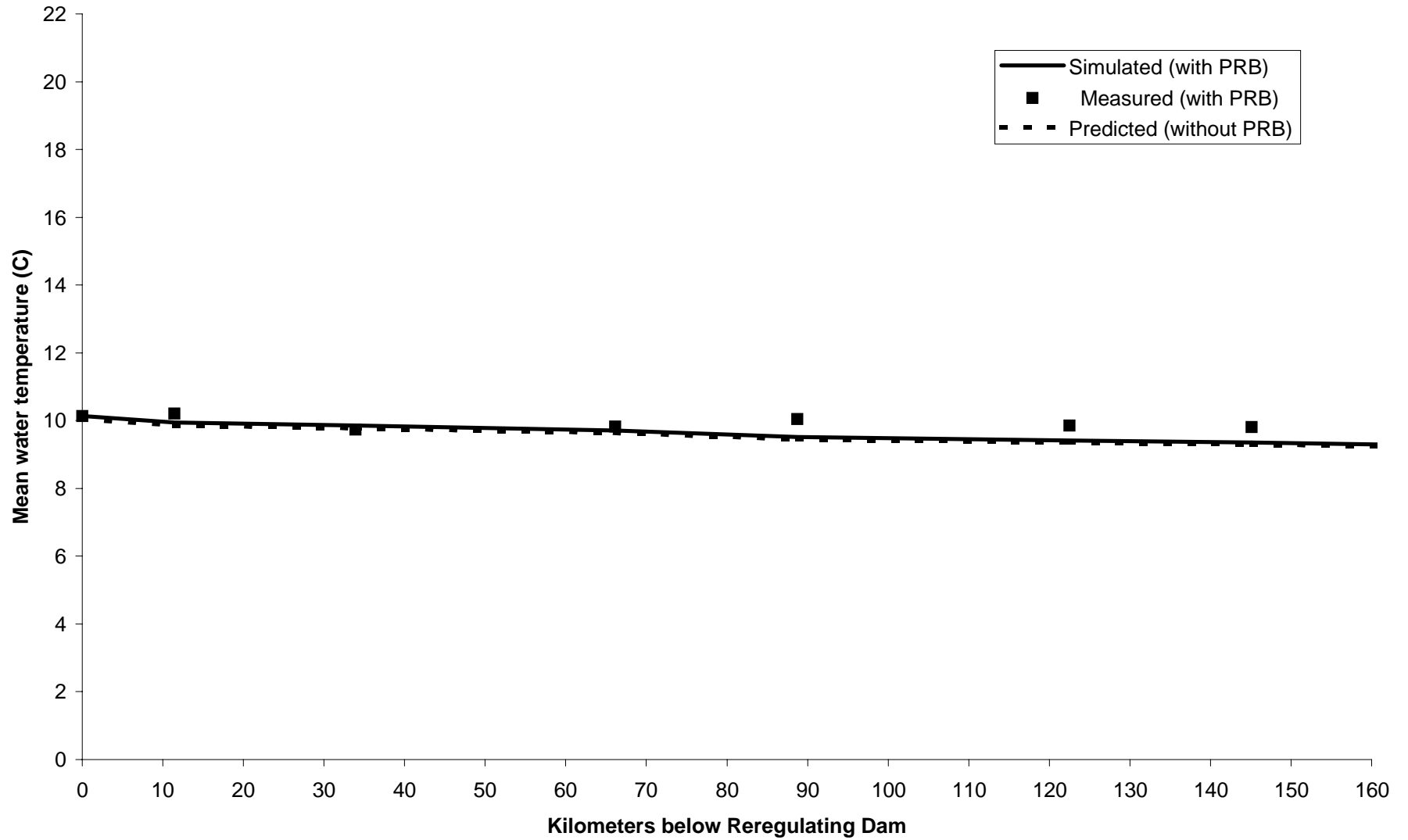


Figure C-7. Mean weekly water temperature in the mainstem Deschutes River versus distance below the PRB Reregulating Dam, statistical week 46, 1998.

### Statistical week 50

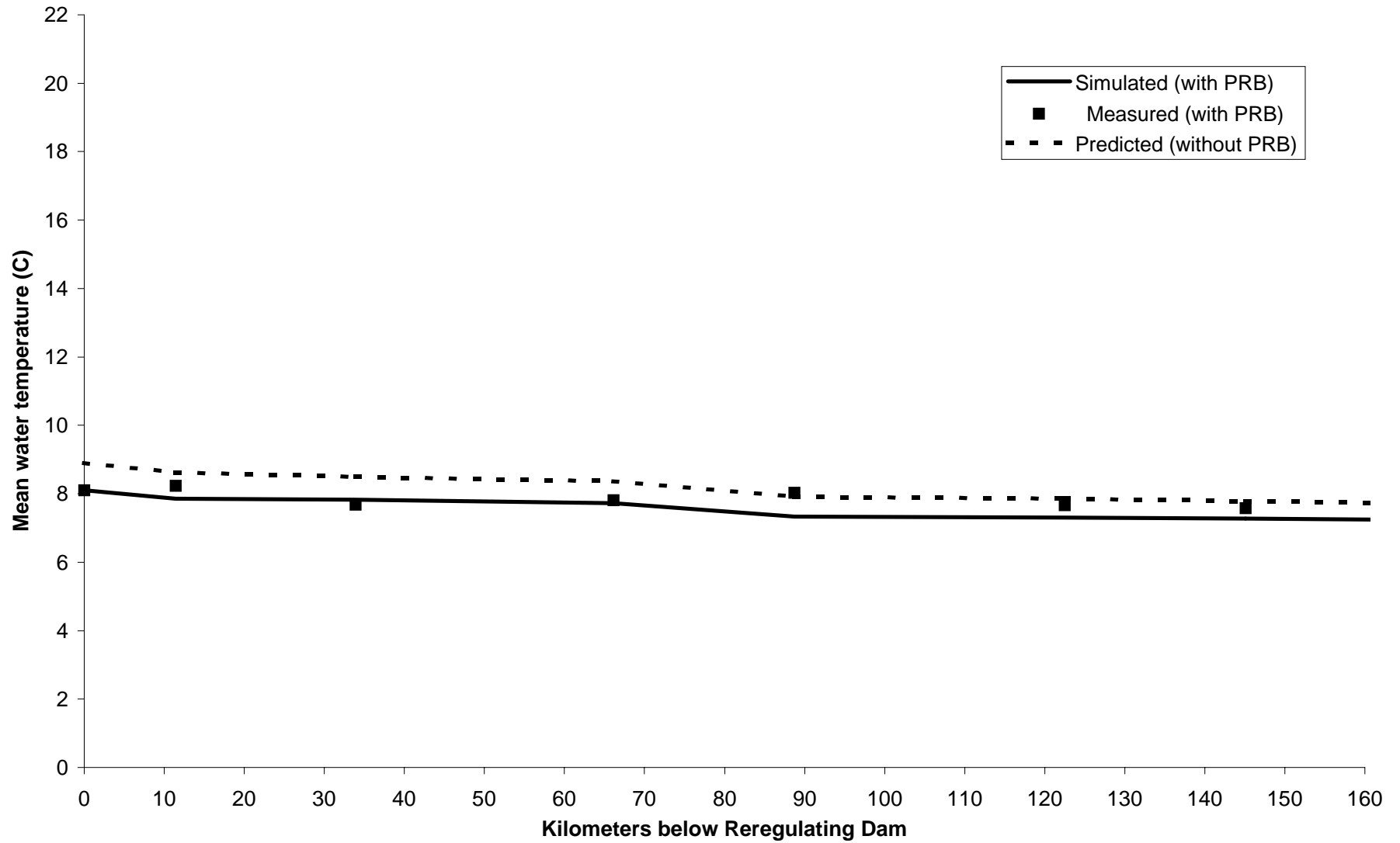


Figure C-8. Mean weekly water temperature in the mainstem Deschutes River versus distance below the PRB Reregulating Dam, statistical week 50, 1998.



### Statistical week 2

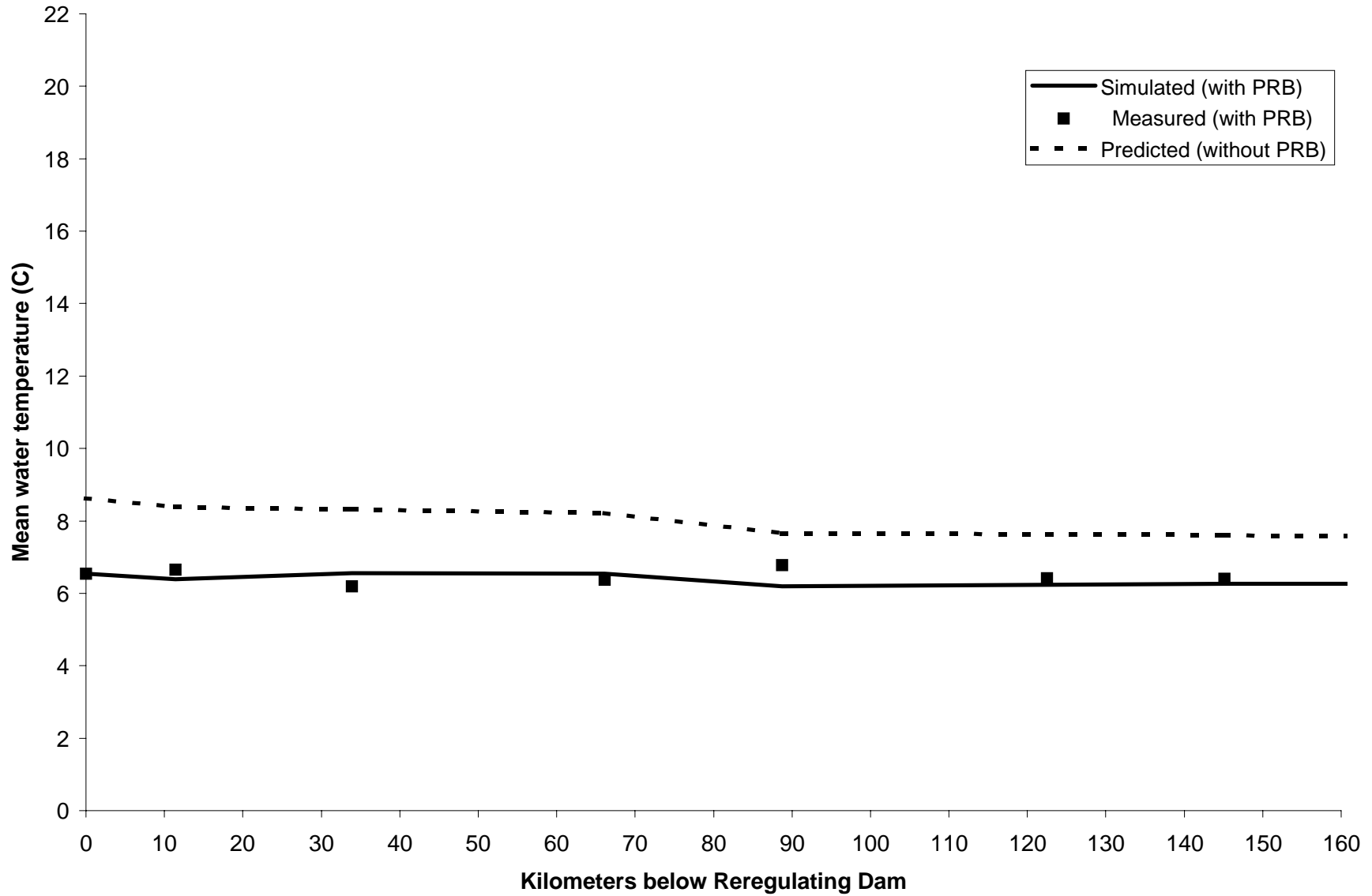


Figure C-9. Mean weekly water temperature in the mainstem Deschutes River versus distance below the PRB Reregulating Dam, statistical week 2, 1999.

### Statistical week 6

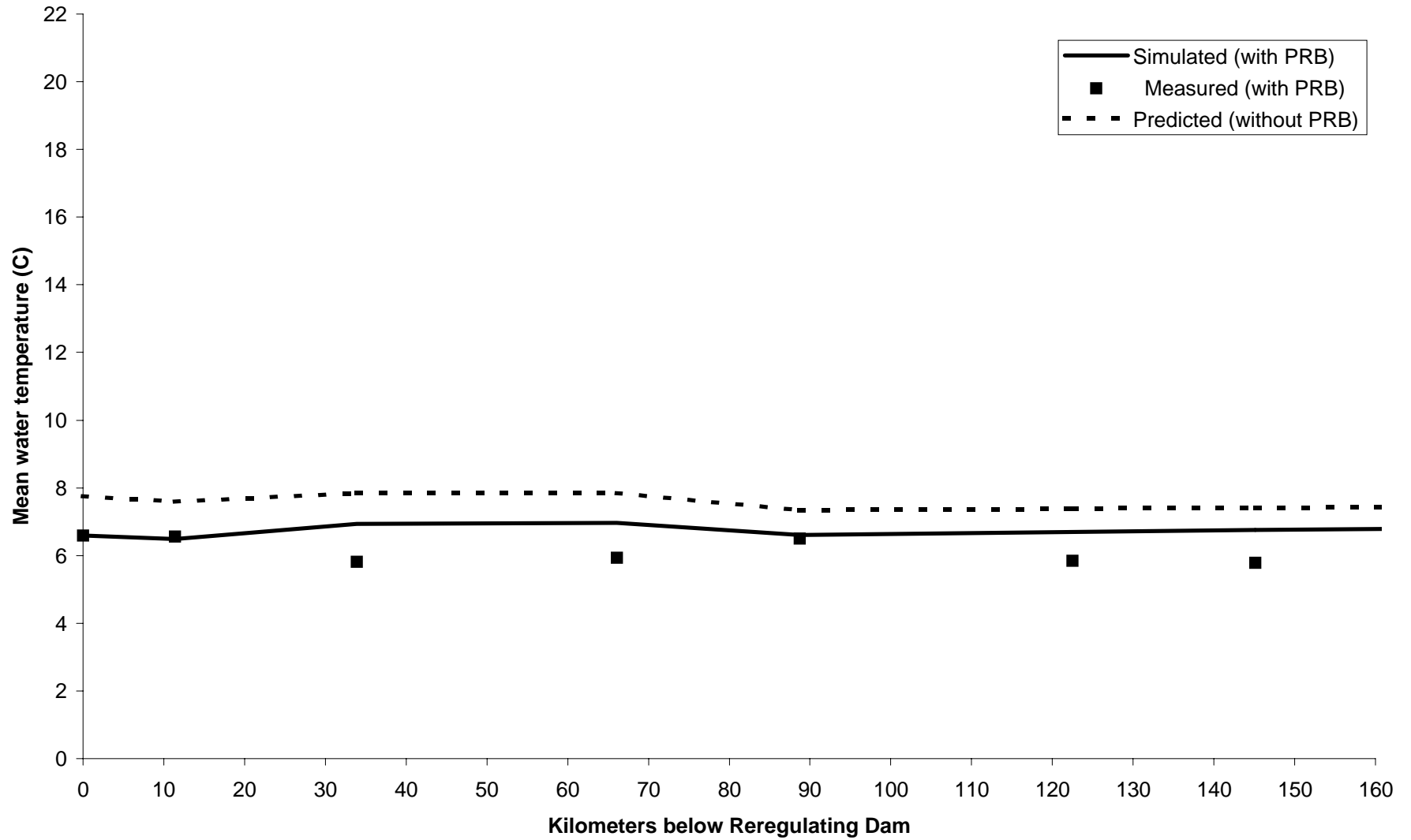


Figure C-10. Mean weekly water temperature in the mainstem Deschutes River versus distance below the PRB Reregulating Dam, statistical week 6, 1999.

### Statistical week 10

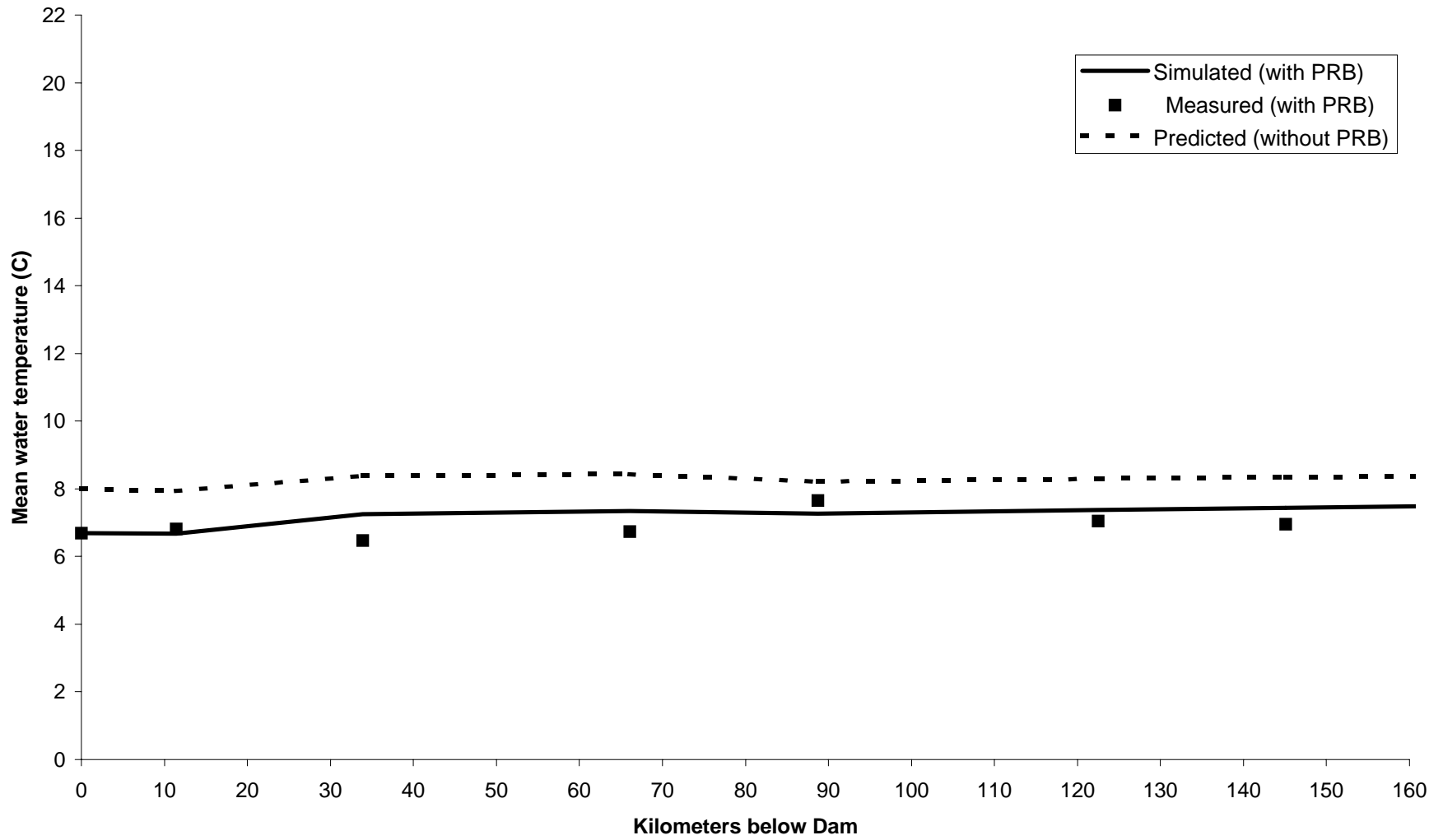


Figure C-11. Mean weekly water temperature in the mainstem Deschutes River versus distance below the PRB Reregulating Dam, statistical week 10, 1999.

### Statistical week 14

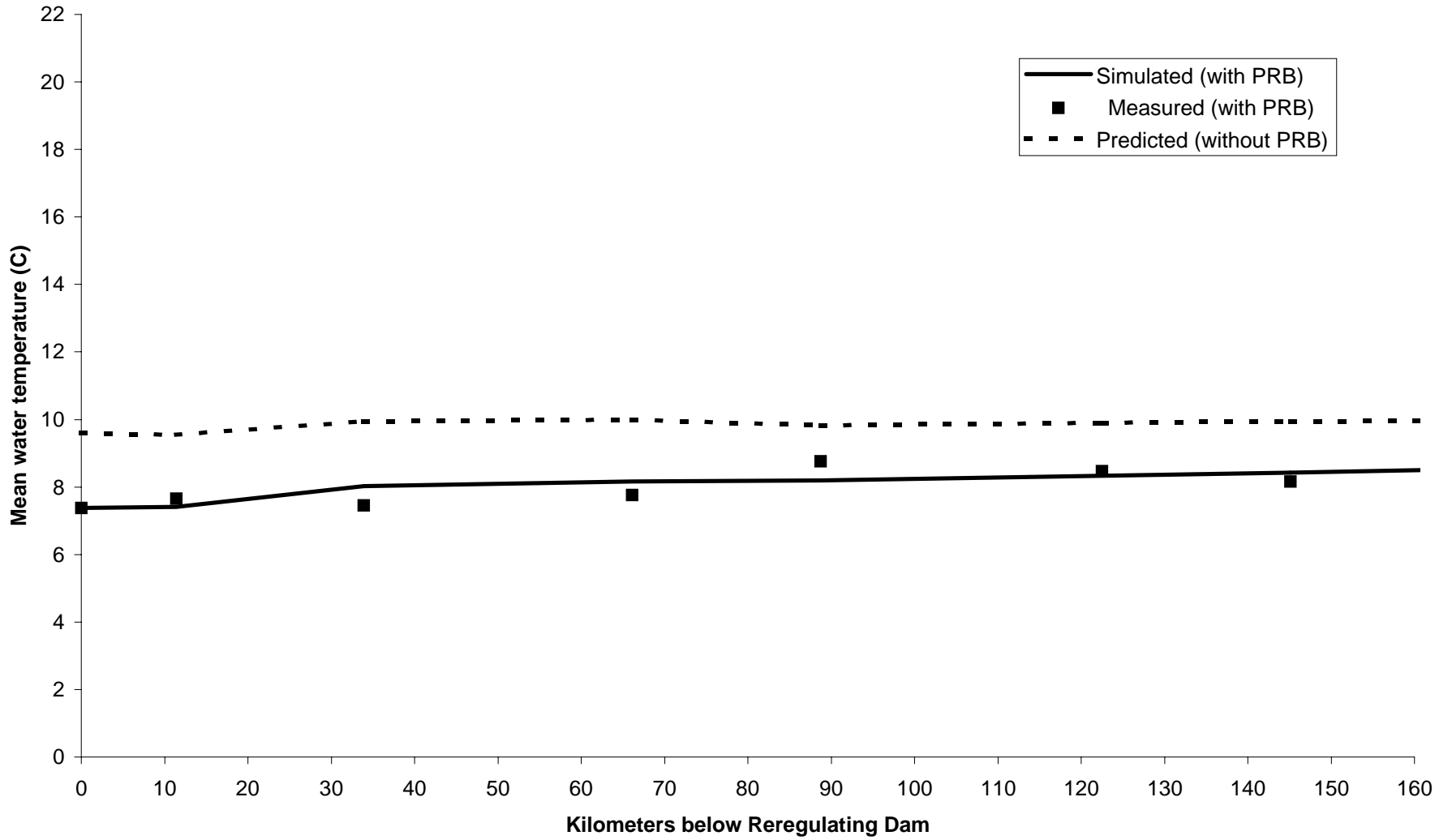


Figure C-12. Mean weekly water temperature in the mainstem Deschutes River versus distance below the PRB Reregulating Dam, statistical week 14, 1999.

### Statistical week 18

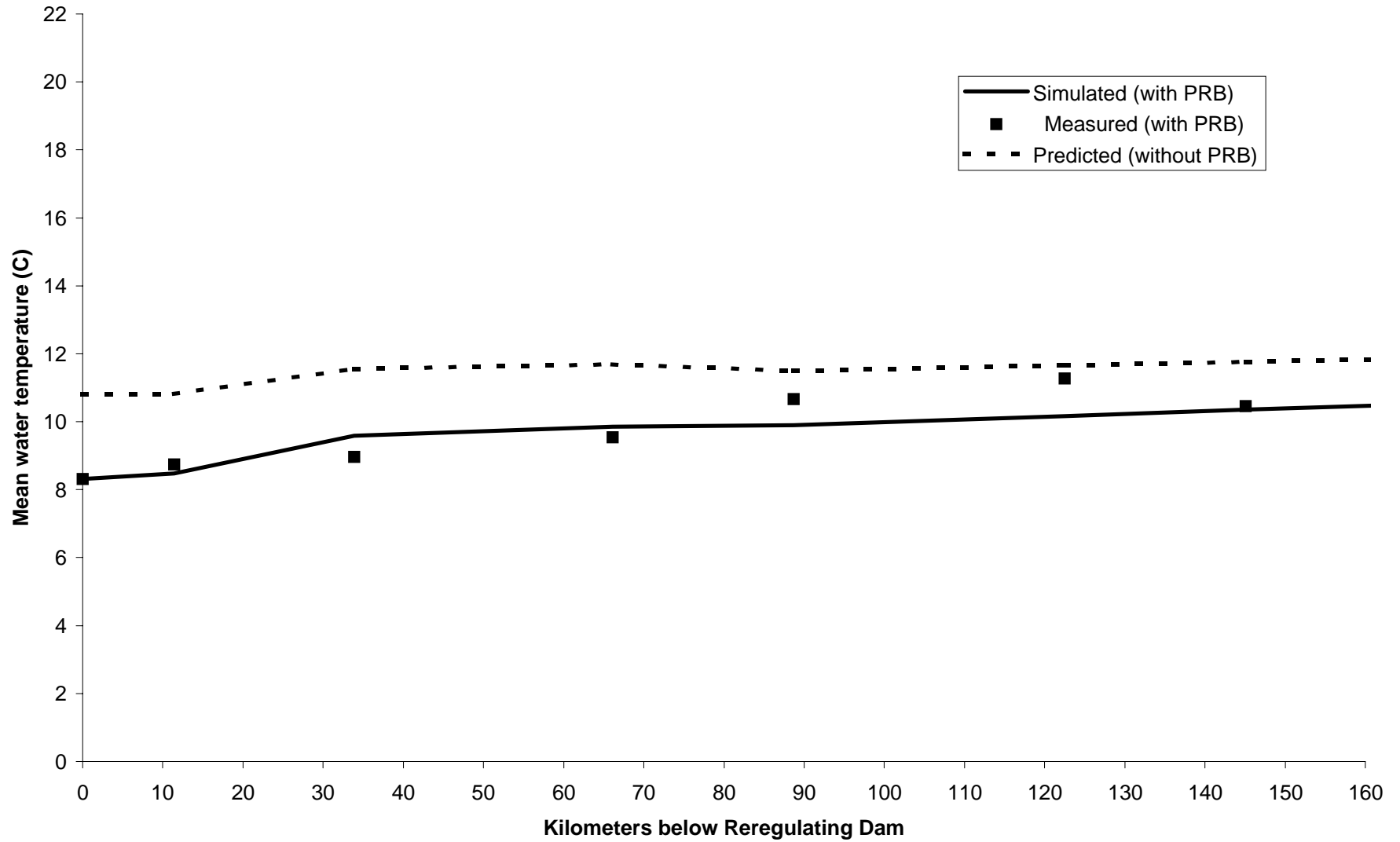


Figure C-13. Mean weekly water temperature in the mainstem Deschutes River versus distance below the PRB Reregulating Dam, statistical week 18, 1999.

## **APPENDIX D**

**SNTEMP-Based Simulations of Weekly Mean Maximum Water Temperatures in  
the Deschutes River Versus Distance Below PRB Reregulating Dam,  
Late-May 1998 Through Mid-May 1999**

### Statistical week 22

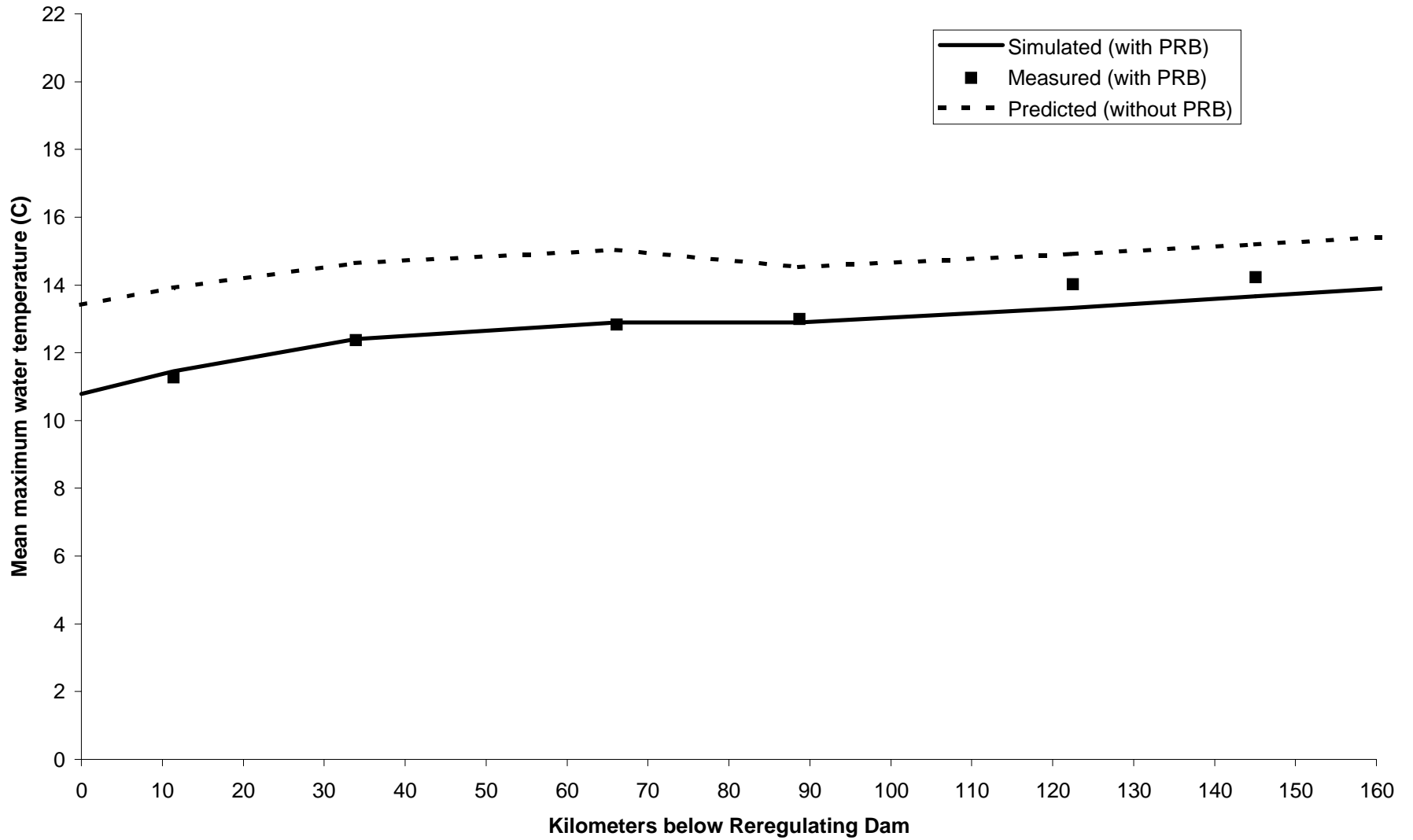


Figure D-1. Mean maximum water temperature in the mainstem Deschutes River versus distance below the PRB Reregulating Dam, statistical week 22, 1998.

### Statistical week 26

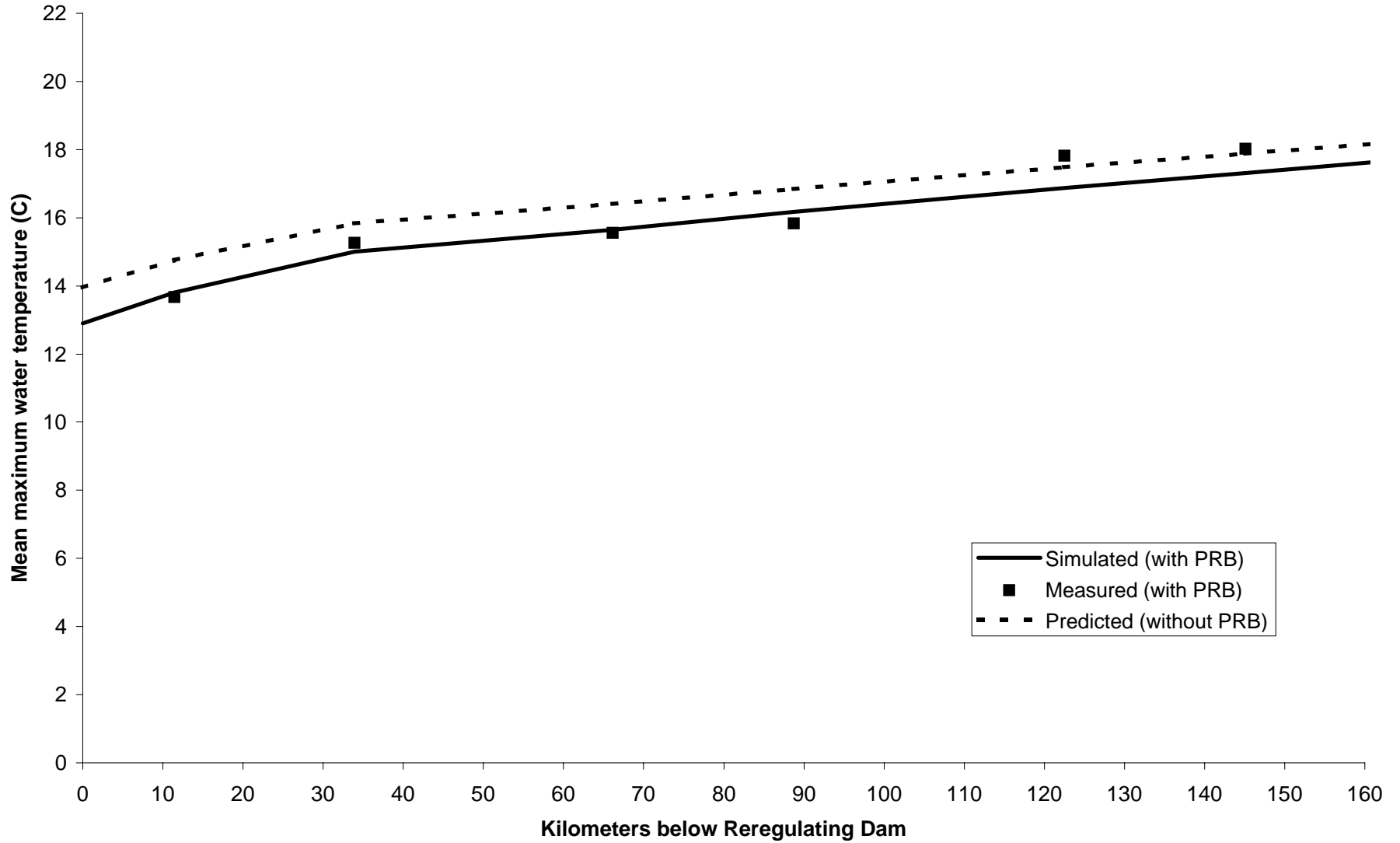


Figure D-2. Mean maximum water temperature in the mainstem Deschutes River versus distance below the PRB Reregulating Dam, statistical week 26, 1998.



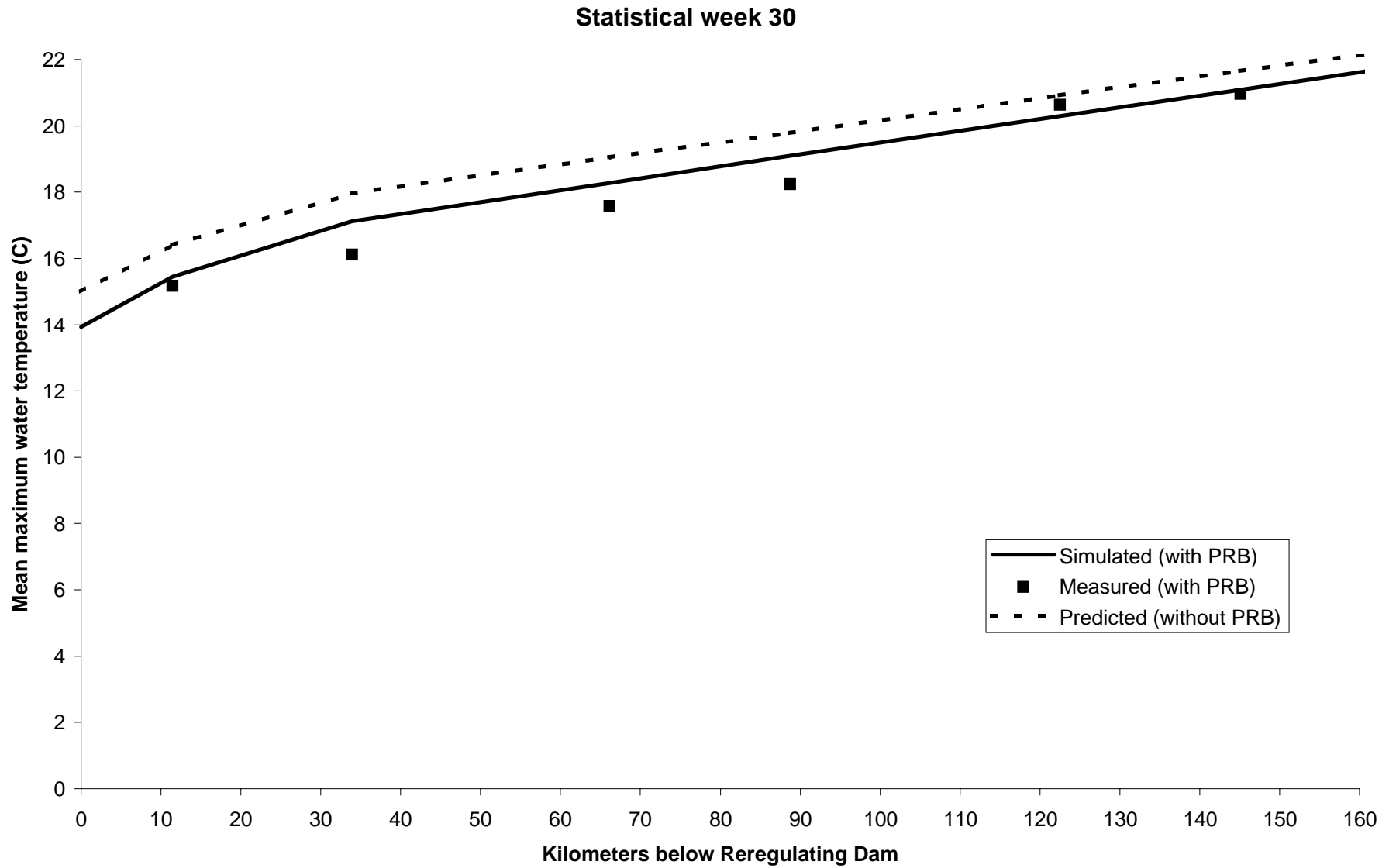


Figure D-3. Mean maximum water temperature in the mainstem Deschutes River versus distance below the PRB Reregulating Dam, statistical week 30, 1998.

### Statistical week 34

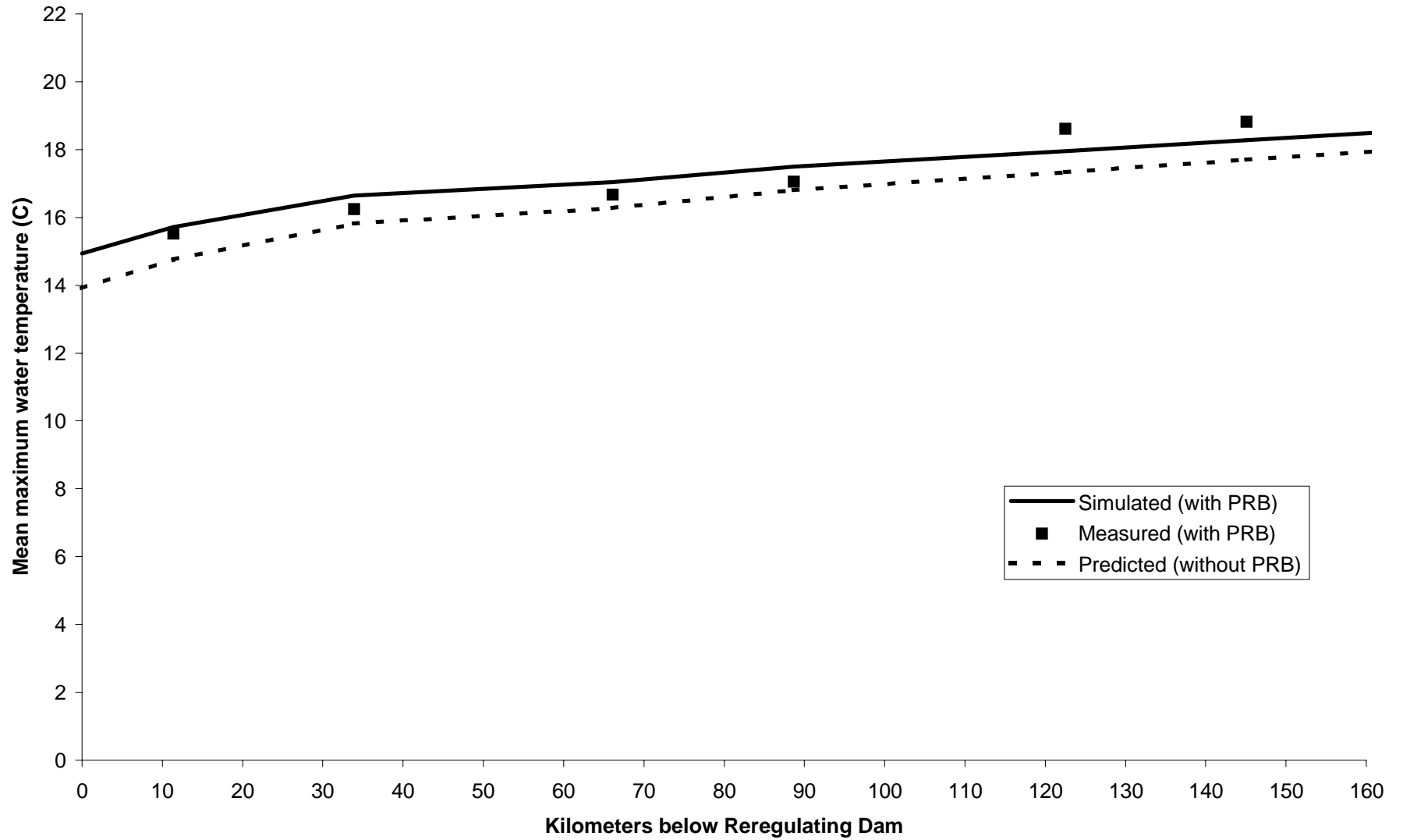


Figure D-4. Mean maximum water temperature in the mainstem Deschutes River versus distance below the PRB Reregulating Dam, statistical week 34, 1998.

### Statistical week 38

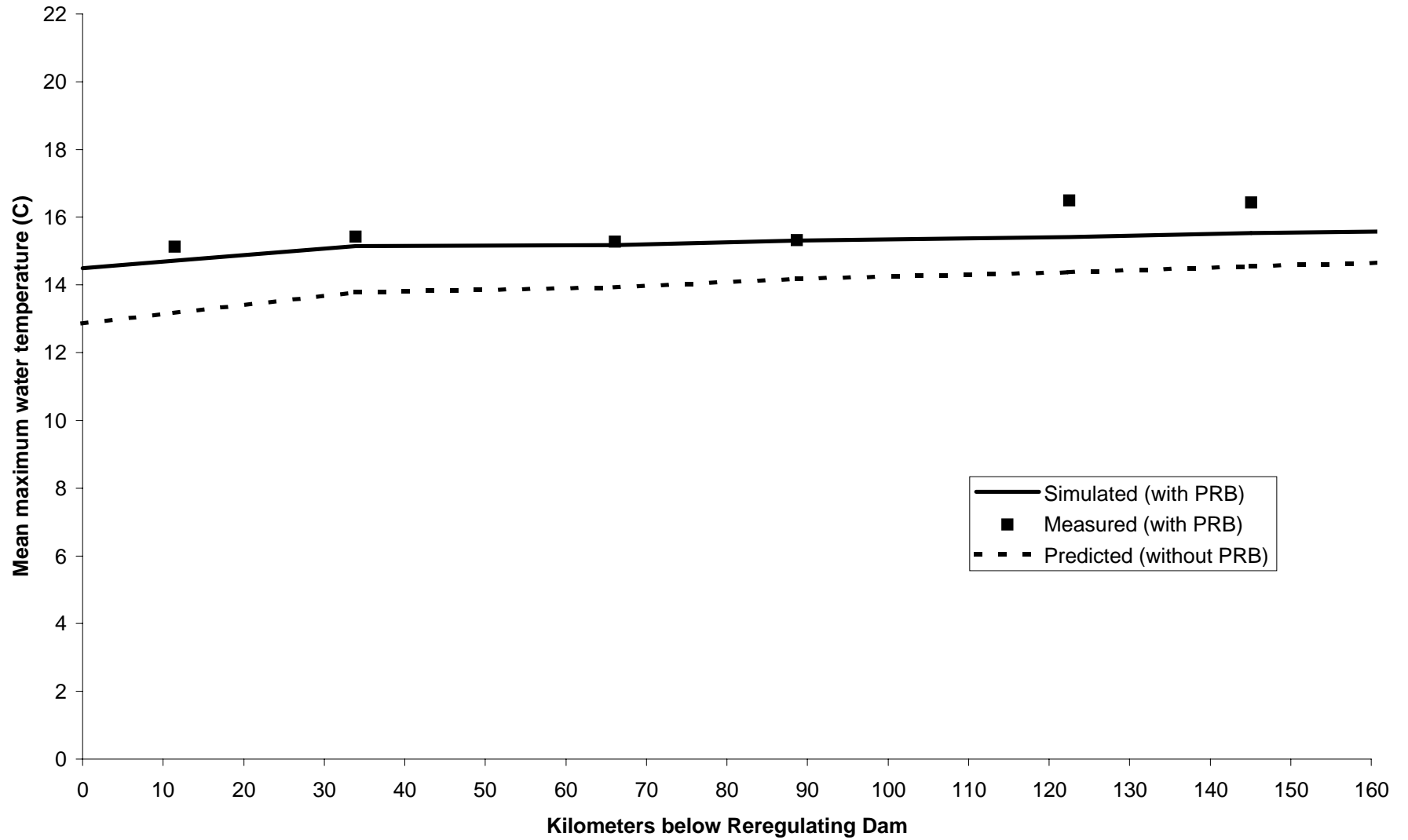


Figure D-5. Mean maximum water temperature in the mainstem Deschutes River versus distance below the PRB Reregulating Dam, statistical week 38, 1998.

### Statistical week 42

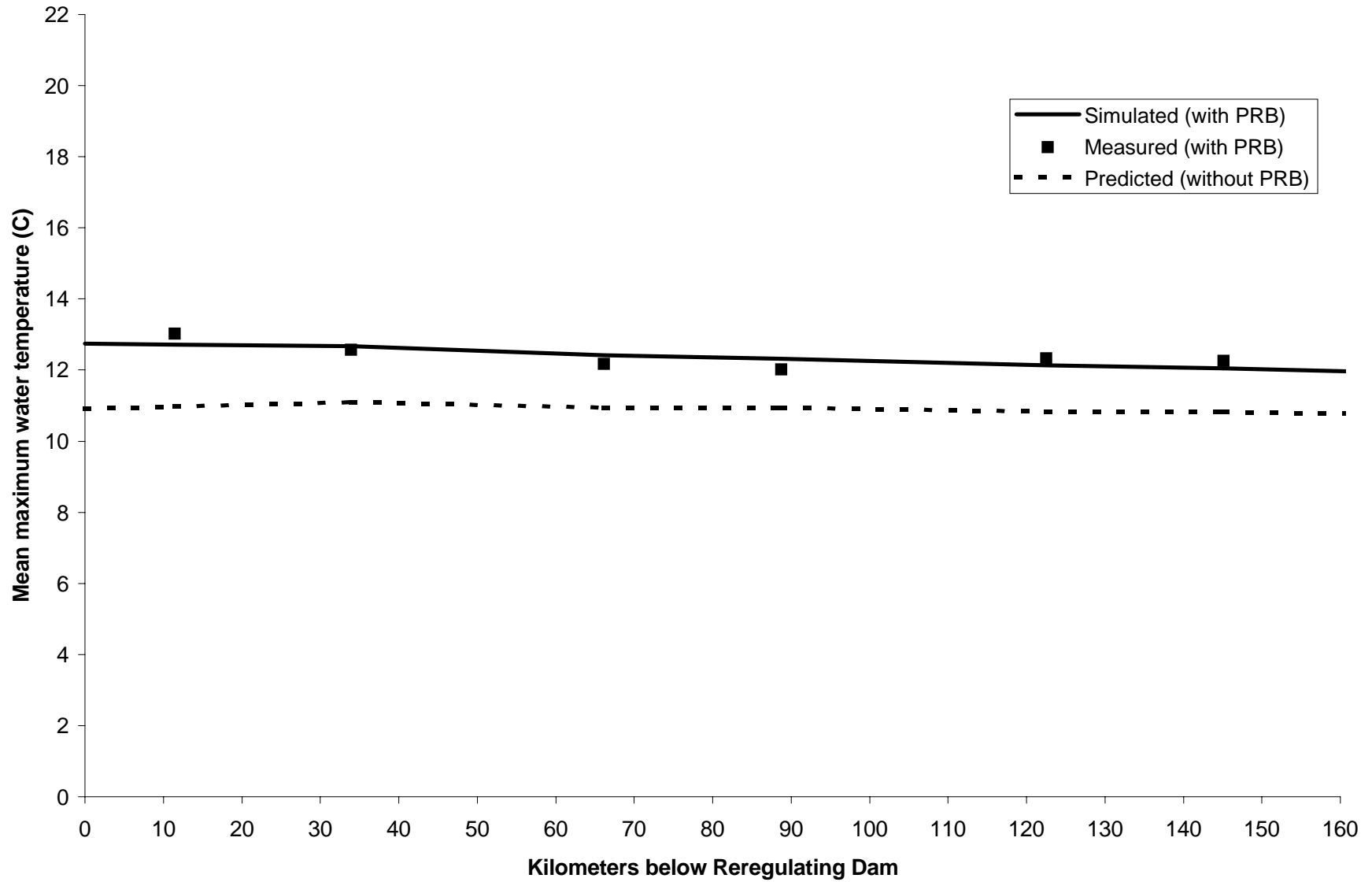


Figure D-6. Mean maximum water temperature in the mainstem Deschutes River versus distance below the PRB Reregulating Dam, statistical week 42, 1998.

### Statistical week 46

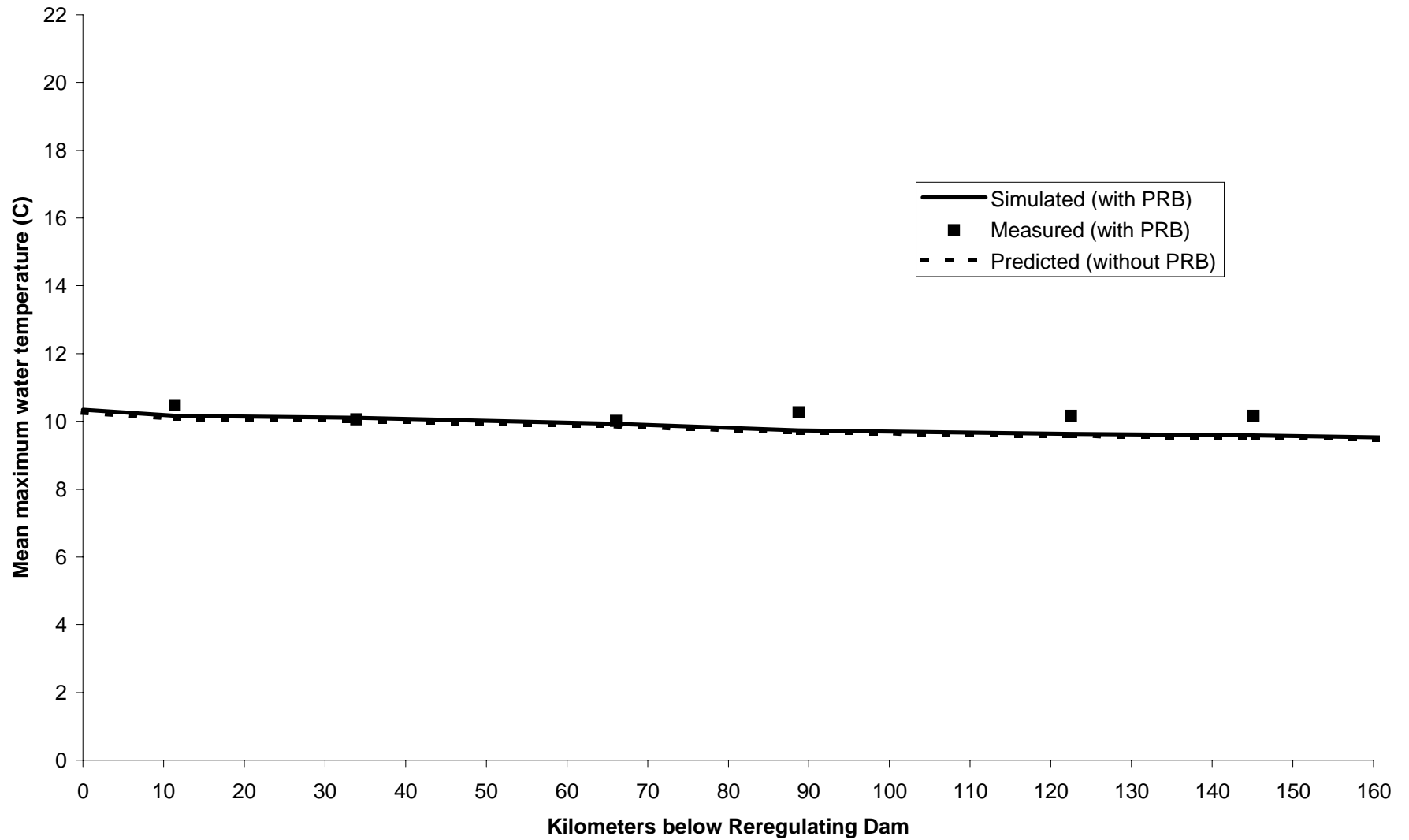


Figure D-7. Mean maximum water temperature in the mainstem Deschutes River versus distance below the PRB Reregulating Dam, statistical week 46, 1998.

### Statistical week 50

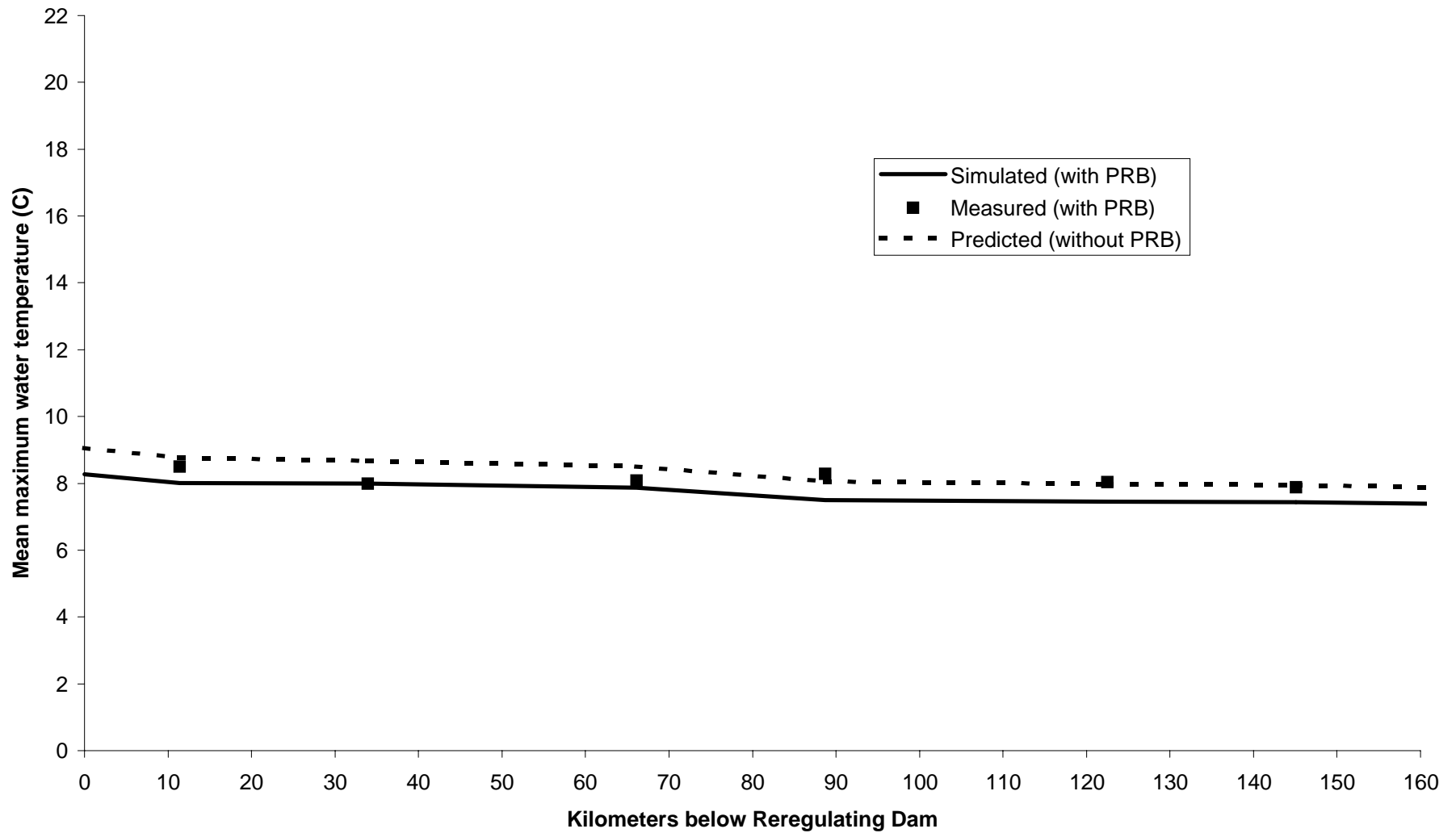


Figure D-8. Mean maximum water temperature in the mainstem Deschutes River versus distance below the PRB Reregulating Dam, statistical week 50, 1998.

### Statistical week 2

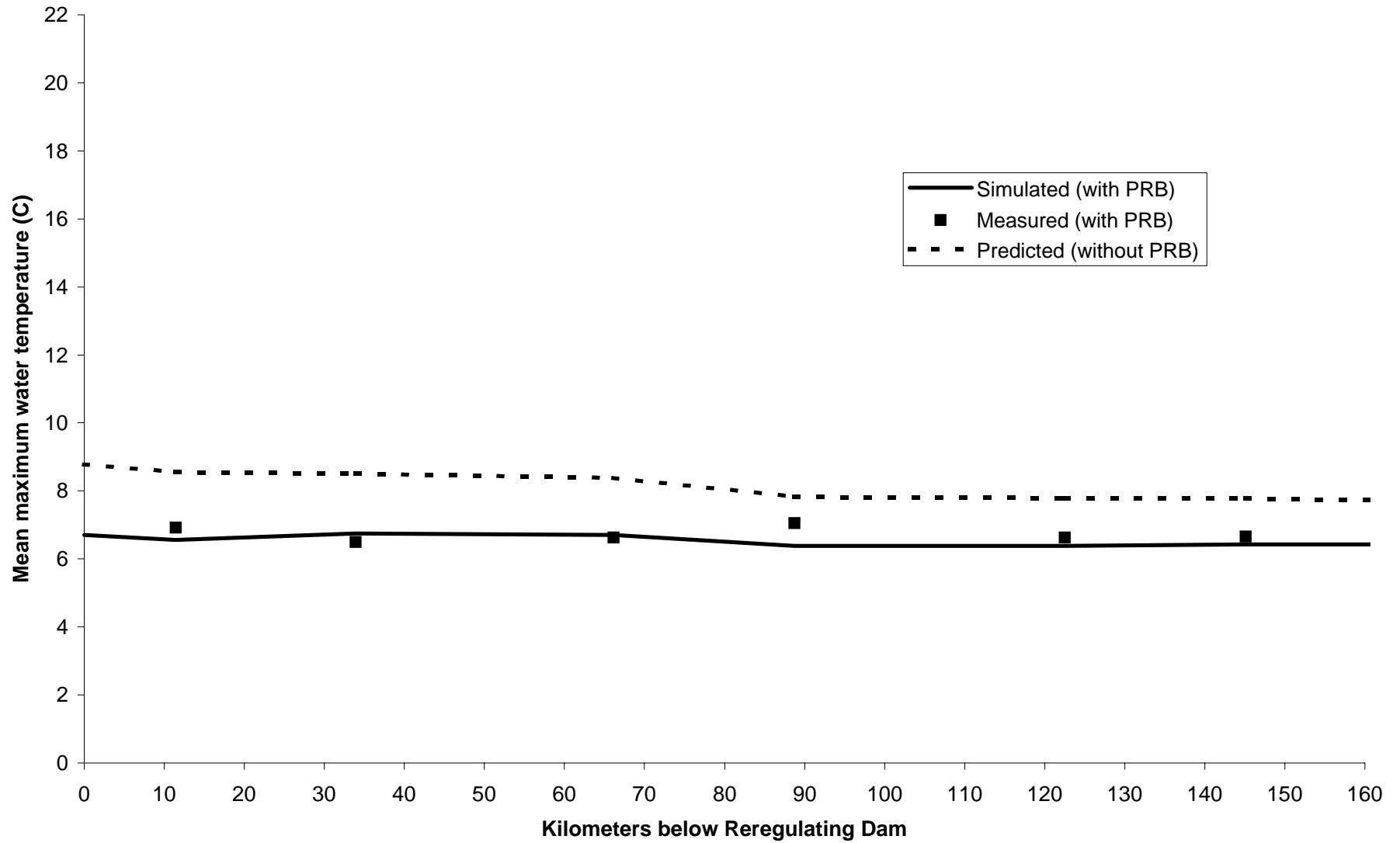


Figure D-9. Mean maximum water temperature in the mainstem Deschutes River versus distance below the PRB Reregulating Dam, statistical week 2, 1999.

### Statistical week 6

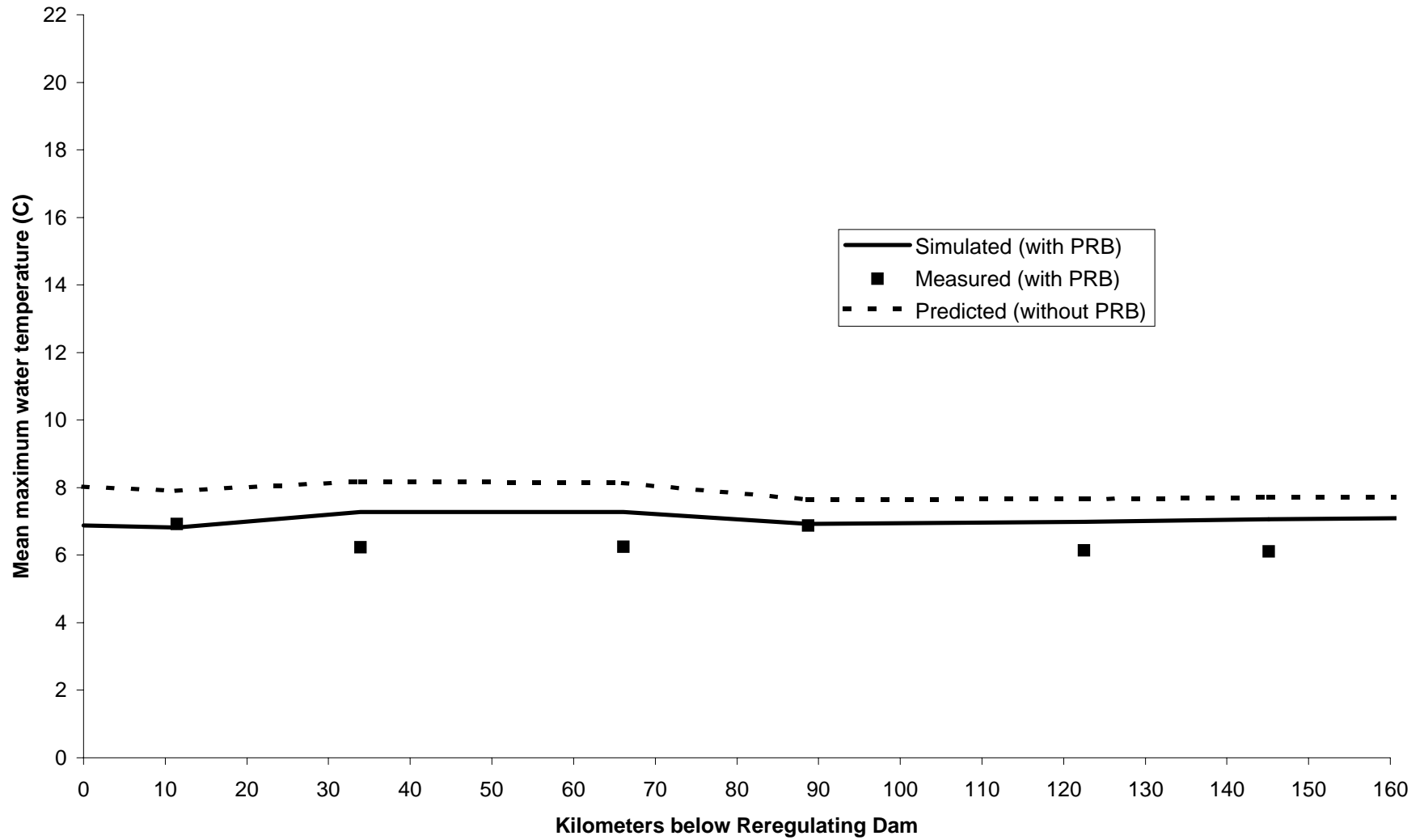


Figure D-10. Mean maximum water temperature in the mainstem Deschutes River versus distance below the PRB Reregulating Dam, statistical week 6, 1999.



### Statistical wk 10

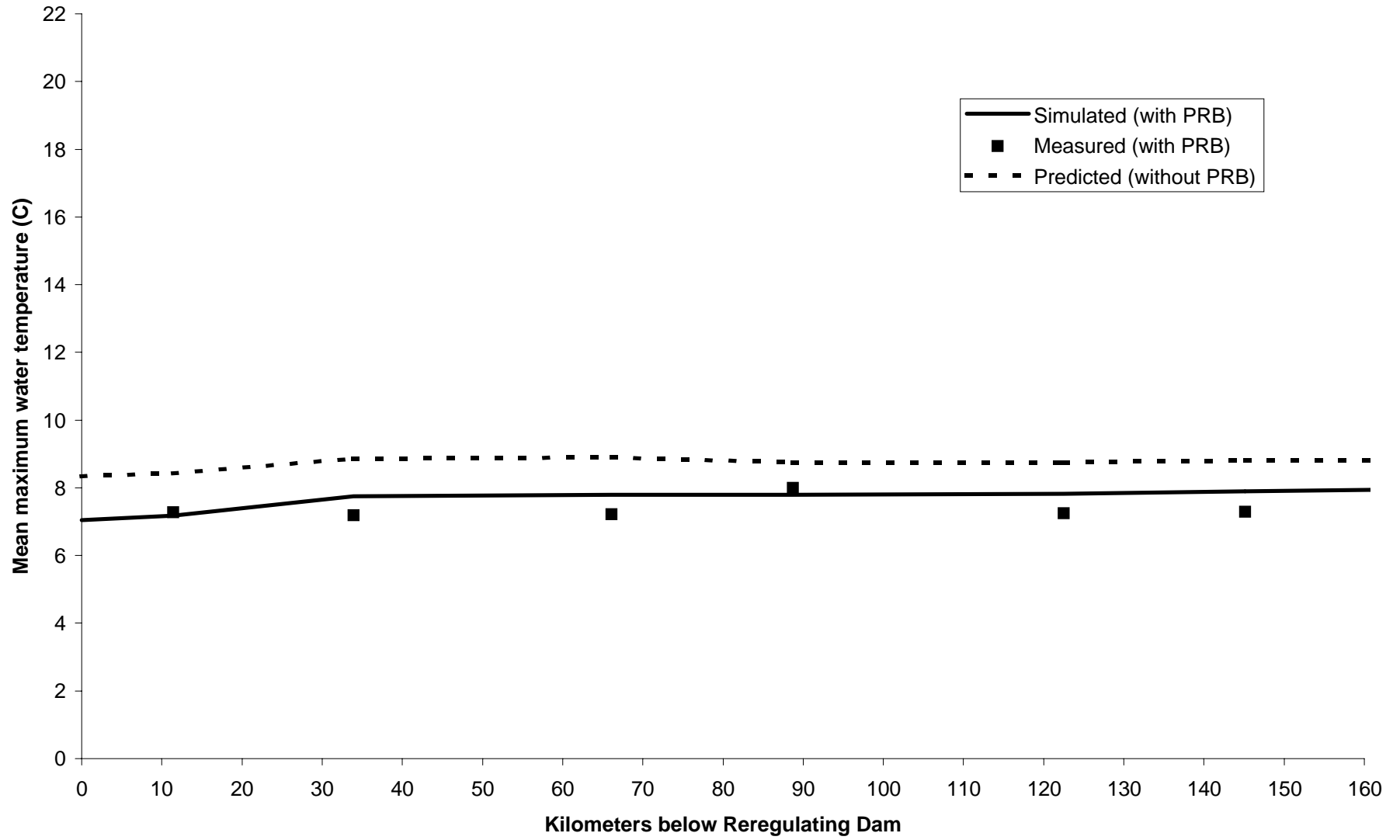


Figure D-11. Mean maximum water temperature in the mainstem Deschutes River versus distance below the PRB Reregulating Dam, statistical week 10, 1999.

### Statistical week 14

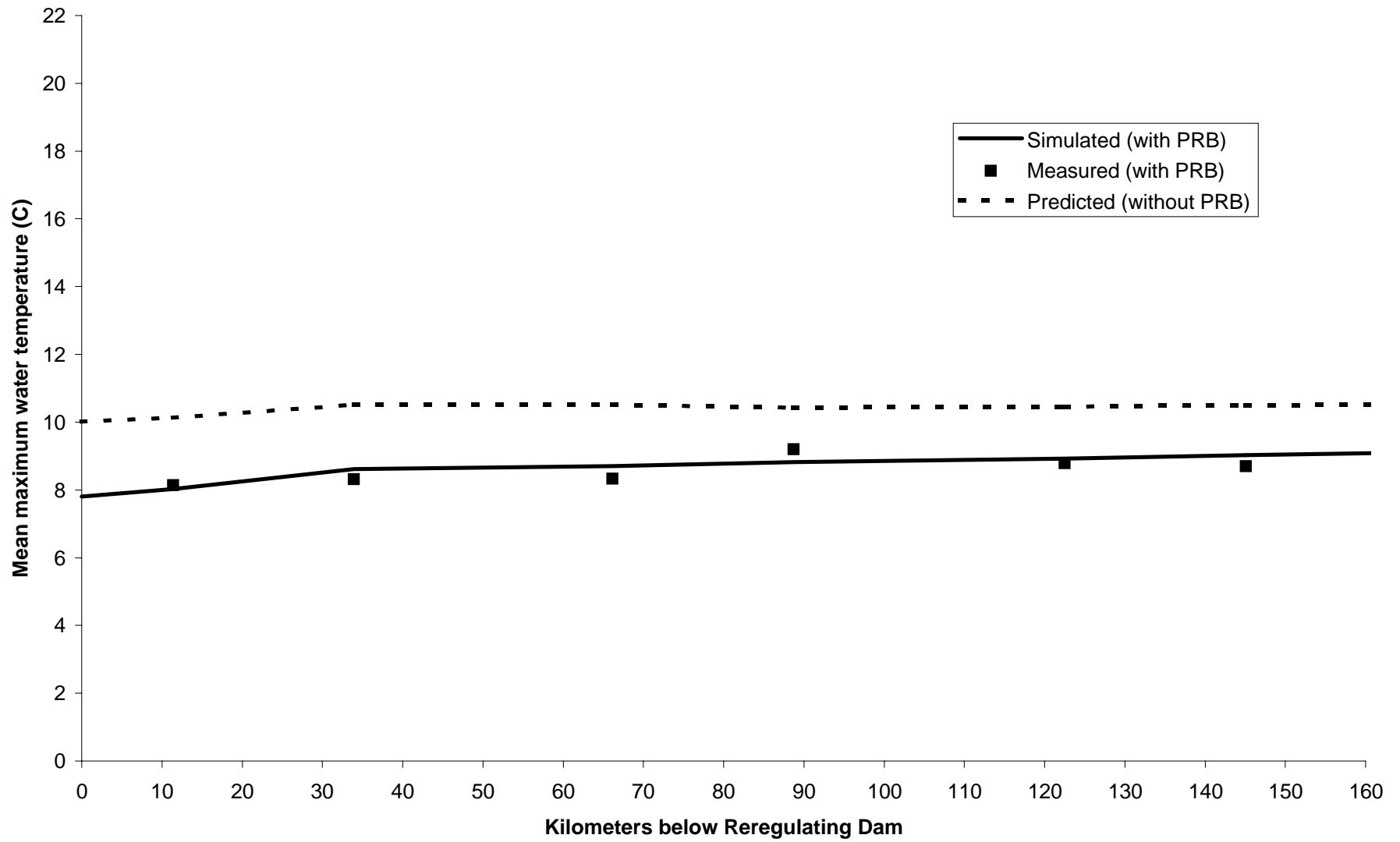


Figure D-12. Mean maximum water temperature in the mainstem Deschutes River versus distance below the PRB Reregulating Dam, statistical week 14, 1999.

### Statistical week 18

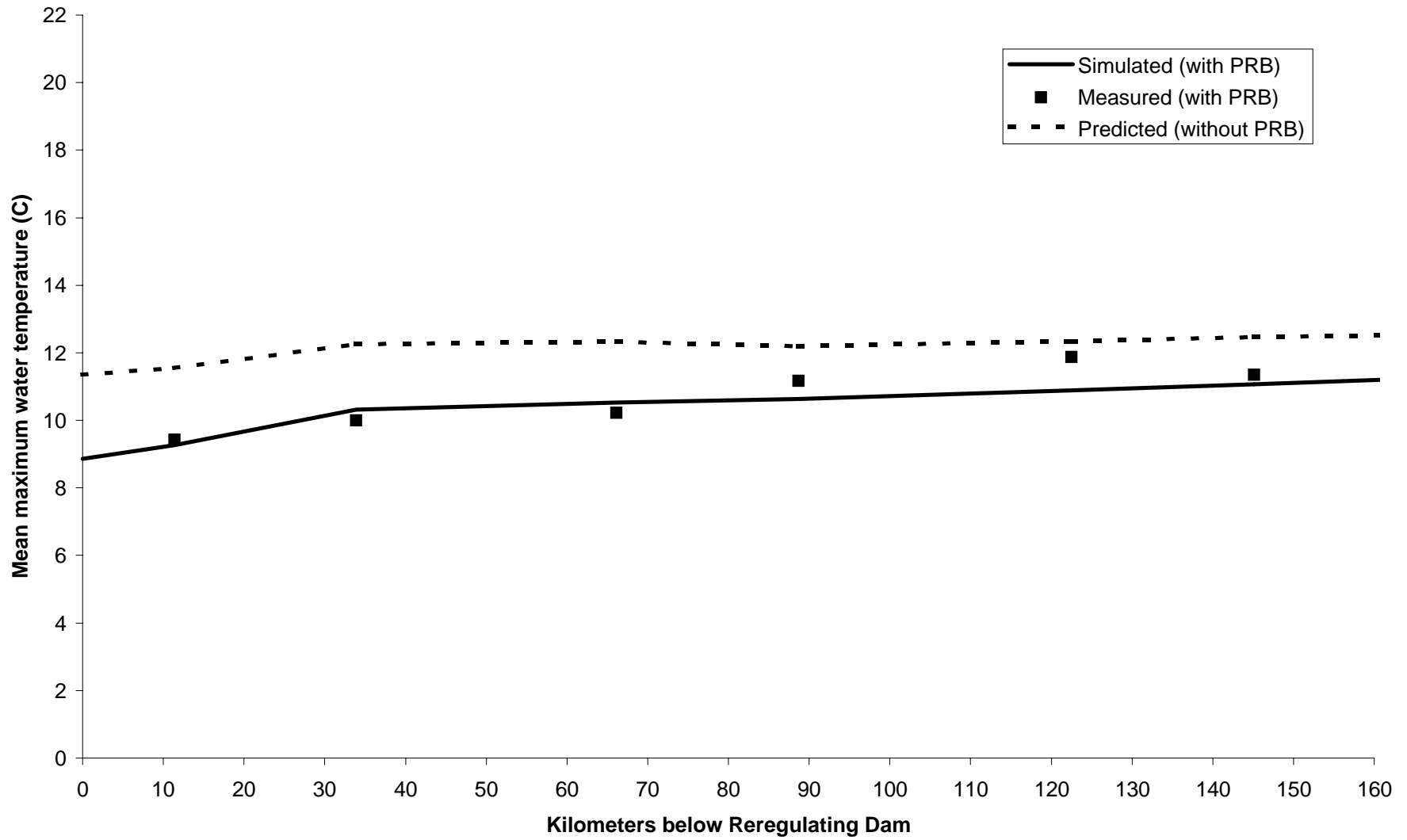


Figure D-13. Mean maximum water temperature in the mainstem Deschutes River versus distance below the PRB Reregulating Dam, statistical week 18, 1999.