

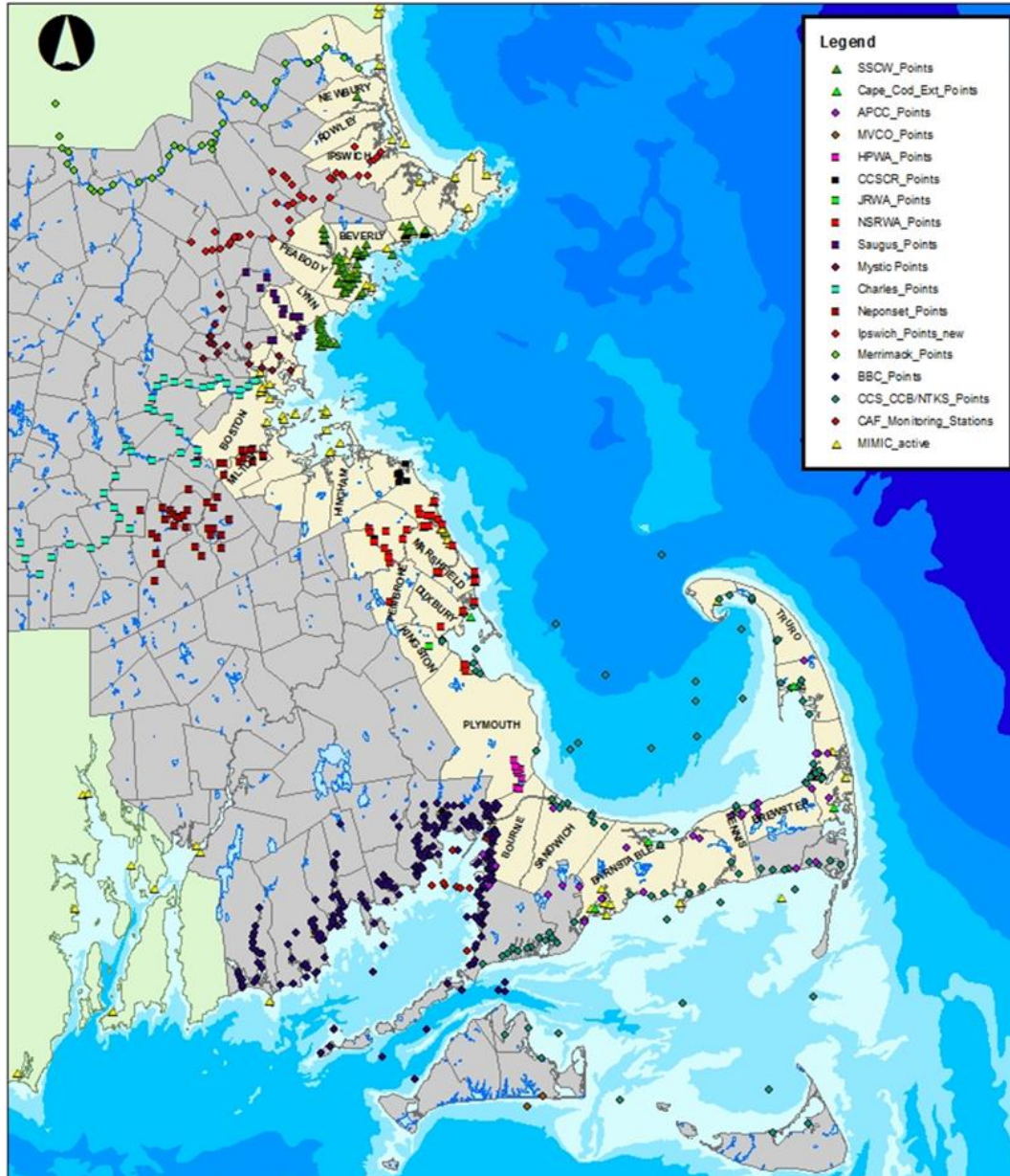


An open-source data tool for water quality monitoring groups

Jill Carr | MassBays National Estuary Partnership

Exchange Network Forum
May 9, 2024

Community-based WQ monitoring in Massachusetts





- Open source R-based package developed for fresh and marine discrete surface water quality monitoring data
- Provides a streamlined and repeatable means of:
 - Screening data for QC,
 - Preparing QC summary report,
 - Creating graphics for analysis, and
 - Formatting data for upload to WQX
- No R experience necessary!

REQUIRED DATA

Meta Data

Site Meta

Monitoring Location ID	Monitoring Location Name	Monitoring Location Latitude	Monitoring Location Longitude	Location Group
ABT-026	Rte 2, Concord	42.465938	-71.391128	Assabet
ABT-062	Rte 62, Acton	42.440765	-71.429409	Assabet
ABT-077	Rte 27/USGS, Maynard	42.432356	-71.449407	Assabet
ABT-144	Rte 62, Stow	42.404519	-71.526349	Assabet
ABT-237	Robin Hill Rd, Marlboro	42.346645	-71.614691	Assabet

DQO Accuracy Meta

Parameter	uom	MDL	UQL	Value Range	Field Duplicate	Lab Duplicate	Field Blank	Lab Blank	Spike/Check Accuracy
Water Temp	deg C	na	na	all	<= 1.0	<= 1.0	na	na	<= 1.0
pH	s.u.	na	na	all	<= 0.5	<= 0.5	na	na	<= 0.2
DO	mg/l	na	na	< 4	< 20%	na	na	na	na
DO	mg/l	na	na	>= 4	< 10%	na	na	na	na
Sp Conductance	uS/cm	na	na	< 250	< 30%	< 30%	na	<= 50	<= 50

DQO Frequency and Completeness

Parameter	Frequency %					Completeness %
	Field Duplicate	Lab Duplicate	Field Blank	Lab Blank	Spike/Check Accuracy	
Water Temp	10	10	na	na	10	90
pH	10	10	na	na	10	90
DO	10	na	na	na	na	90
Sp Conductance	10	10	na	10	10	90

WQX Meta

Parameter	Sampling Method Context	Method Speciation	Result Sample Fraction	Analytical Method	Analytical Method Context
DO	na	na	na	na	na
TP	MassWaterR	as P	Unfiltered	200.7	USEPA
Nitrate	MassWaterR	as N	Unfiltered	300.0	USEPA
Ammonia	MassWaterR	as N	Unfiltered	4500-NH3 D	APHA

REQUIRED DATA

Results

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	Monitoring Location ID	Activity Type	Activity Start Date	Activity Start Time	Activity Depth/Height Measure	Activity Depth/Height Unit	Activity Relative Depth Name	Characteristic Name	Result Value	Result Unit	Quantitation Limit	QC Reference Value	Result Measure Qualifier	Result Attribute	Sample Collection Method ID	Project ID	Result Comment
71	ABT-077	Sample-Routine	5/15/2022	6:10	0.75 ft			TP	0.05	mg/l				DRY	Pole-MassWater	My_WQ	
72	ABT-301	Sample-Routine	5/15/2022	7:34	0.25 ft			TP	0.04	mg/l				DRY	Grab-MassWater	My_WQ	
73	ABT-312	Sample-Routine	5/15/2022	8:01	0.25 ft			TP	0.03	mg/l		0.03		DRY	Grab-MassWater	My_WQ	
74	DAN-013	Sample-Routine	5/15/2022	7:25	0.75 ft			TP	0.04	mg/l		0.04		DRY	Pole-MassWater	My_WQ	
75	ELZ-004	Sample-Routine	5/15/2022	6:50	0.25 ft			TP	0.03	mg/l				DRY	Grab-MassWater	My_WQ	
76	HOP-011	Sample-Routine	5/15/2022	6:55	0.75 ft			TP	0.03	mg/l				DRY	Grab-MassWater	My_WQ	
77	NSH-002	Sample-Routine	5/15/2022	8:35	0.75 ft			TP	0.03	mg/l				DRY	Pole-MassWater	My_WQ	
78	ABT-026	Field Msr/Obs	5/15/2022	8:15	1 ft			Water Temp	22.4	deg C		22.4		DRY		My_WQ	
79	ABT-077	Field Msr/Obs	5/15/2022	6:10	1 ft			Water Temp	22.0	deg C				DRY		My_WQ	
80	ABT-301	Field Msr/Obs	5/15/2022	7:34	1 ft			Water Temp	19.8	deg C				DRY		My_WQ	
81	ABT-312	Field Msr/Obs	5/15/2022	8:01	0.3 ft			Water Temp	22.4	deg C				DRY		My_WQ	
82	DAN-013	Field Msr/Obs	5/15/2022	7:25	0.3 ft			Water Temp	20.4	deg C				DRY		My_WQ	
83	ELZ-004	Field Msr/Obs	5/15/2022	6:50	0.5 ft			Water Temp	22.2	deg C		22.2		DRY		My_WQ	
84	HOP-011	Field Msr/Obs	5/15/2022	6:55	1 ft			Water Temp	21.5	deg C				DRY		My_WQ	
85	NSH-002	Field Msr/Obs	5/15/2022	8:35	1 ft			Water Temp	23.3	deg C		23.3		DRY		My_WQ	
86		Quality Control-Calibration Check	5/15/2022					Water Temp	21.8	deg C		21.8				My_WQ	
87		Quality Control-Calibration Check	5/15/2022					Water Temp	21.8	deg C		21.8				My_WQ	
88		Quality Control-Calibration Check	5/15/2022					Water Temp	21.9	deg C		21.8				My_WQ	
89		Quality Control-Calibration Check	5/15/2022					Water Temp	21.9	deg C		21.8				My_WQ	
90		Quality Control-Meter Lab Duplicate	5/15/2022					Water Temp	21.7	deg C		21.8				My_WQ	
91		Quality Control-Meter Lab Duplicate	5/15/2022					Water Temp	21.8	deg C		21.8				My_WQ	
92		Quality Control-Meter Lab Duplicate	5/15/2022					Water Temp	21.8	deg C		21.8				My_WQ	
93		Quality Control Sample-Field Blank	6/12/2022		0.75 ft			Ammonia	BDL	mg/l					Grab-MassWater	My_WQ	
94		Quality Control Sample-Lab Blank	6/12/2022					Ammonia	BDL	mg/l						My_WQ	
95		Quality Control Sample-Lab Duplicate	6/12/2022					Ammonia	0.1	mg/l		0.1				My_WQ	
96		Quality Control Sample-Lab Duplicate	6/12/2022					Ammonia	0.19	mg/l		0.19				My_WQ	
97		Quality Control Sample-Lab Spike	6/12/2022					Ammonia	94	% recovery		100				My_WQ	
98		Quality Control Sample-Lab Spike	6/12/2022					Ammonia	106	% recovery		100				My_WQ	
99	ABT-026	Sample-Routine	6/12/2022	7:30	0.75 ft			Ammonia	BDL	mg/l				WET	Pole-MassWater	My_WQ	
100	ABT-062	Sample-Routine	6/12/2022	6:15	0.75 ft			Ammonia	0.1	mg/l				WET	Grab-MassWater	My_WQ	



DEMO

Website / User Guide

MassWaterR quick start

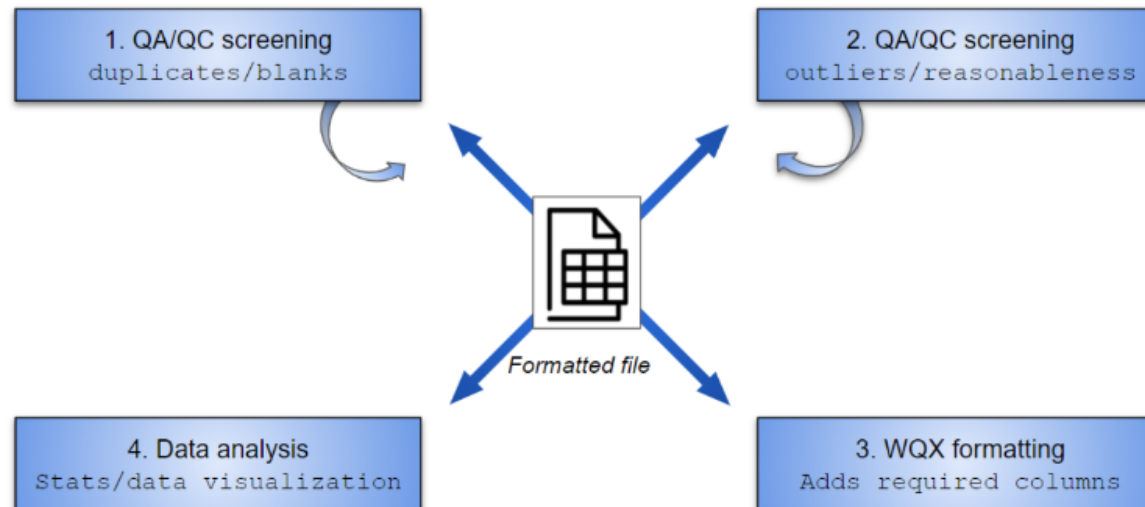


Source: [vignettes/MassWaterR.Rmd](#)

Overview

The MassWaterR R package is developed for surface water monitoring data collected by watershed associations and citizen science groups in Massachusetts. The package is created in collaboration with the [Massachusetts Bays National Estuary Partnership](#) with funding from an EPA Exchange Network Grant (Grant No. OS-84029801-0).

The objective of the package is to automate and facilitate quality control and exploratory analysis of data intended for upload to the EPA [Water Quality Exchange](#) (WQX). The functions provide a streamlined and repeatable means of 1) screening data for quality control, 2) summarizing quality control results, 3) creating graphics for analysis and reports to stakeholders, and 4) formatting data for upload to WQX. The functions are organized around these topics, shown below.



On this page

- Overview
- Package installation
- Data inputs
- Outlier checks
- Quality control functions
- Analyses
- Modifying plots
- Water Quality Exchange output
- Submitting data to Mass DEP
- Uploading data to WQX

Community of Practice (CoP)

The screenshot shows the MassWaterR forum page. At the top left is the Massachusetts Bays National Estuary Partnership logo. The top right has navigation links for 'Getting Started', a search icon, a menu icon, and a user profile icon. The main heading features the MassWaterR logo and a description: 'MassWaterR is a package of R functions developed to help water quality monitoring programs to QA/QC, analyze, and format their data for WQX upload. This Community of Practice forum is space where MassWaterR users can turn for help, share ideas, and suggest improvements.'

Below the heading are filter buttons: 'MassWaterR R Tools', 'all tags', 'Latest' (highlighted in red), and 'Top'. On the right, there are icons for a wrench, '+ New Topic', and a bell. A table below lists forum topics with columns for 'Topic', 'Replies', 'Views', and 'Activity'.

Topic	Replies	Views	Activity
How to get started with MassWaterR ■ setup The MassWaterR R package provides tools for QA/QC, data analysis, and data upload to WQX. Documentation for the package is available in this Github page. Follow the steps below to get started and to work through the Mas... read more	1	30	Nov '22
WQX Account creation ■ wqx	0	2	4h
Data preparation - How to convert data from a wide matrix to a single column ■ loading-data	2	6	4h
Troubleshooting MassWaterR installation ■ setup	0	9	Jan 13
How to update supporting packages in R ■ setup	0	9	Jan 11
Performance Evaluation Samples (Reference Samples) ■ setup	7	19	Dec '22

Questions?



MassWaterR GitHub website (user guide)

<https://massbays-tech.github.io/MassWaterR/articles/MassWaterR.html>

Community of Practice (help forum)

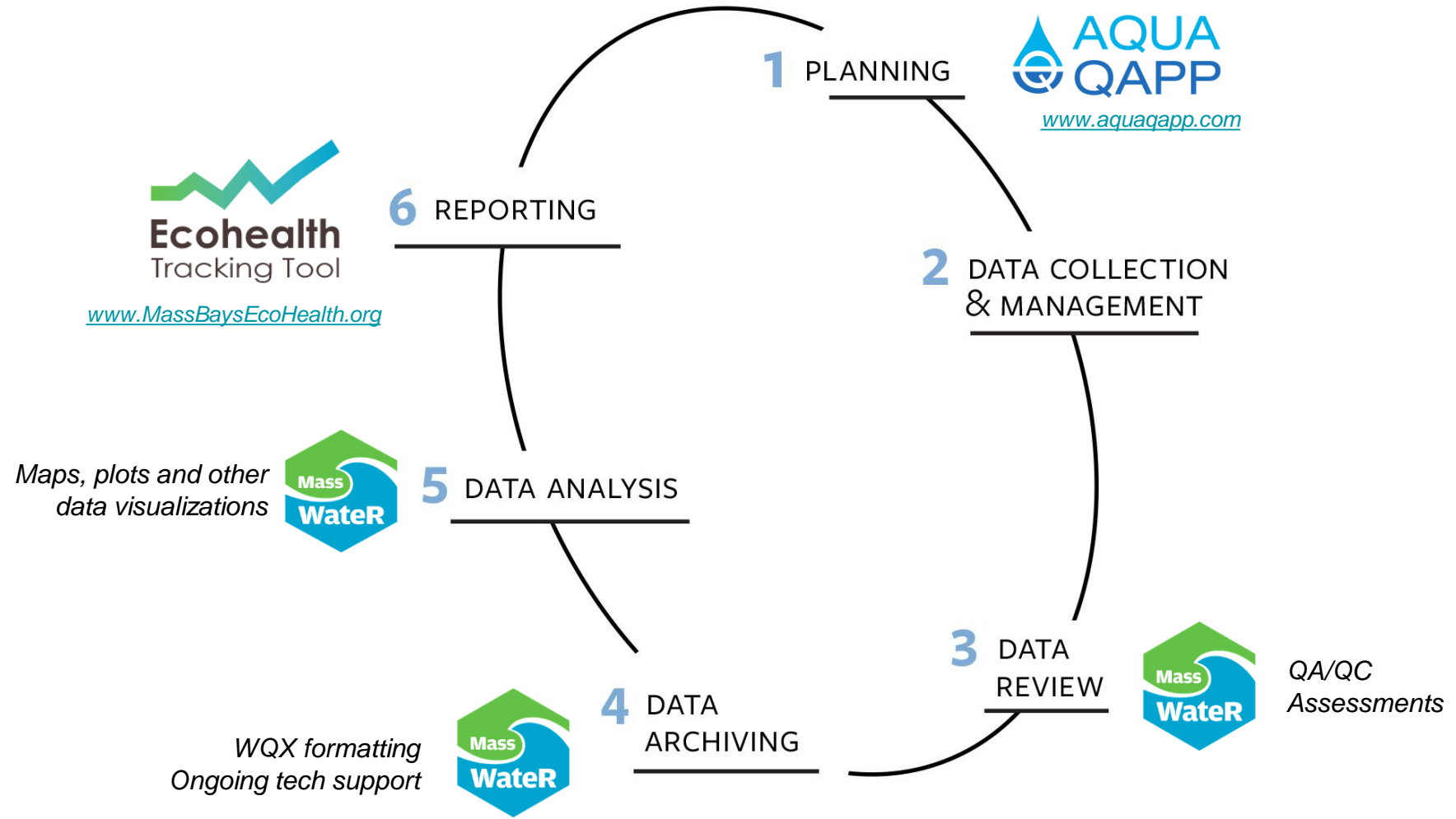
<https://massbays.discourse.group/>

Contact:

Jillian.Carr@umb.edu

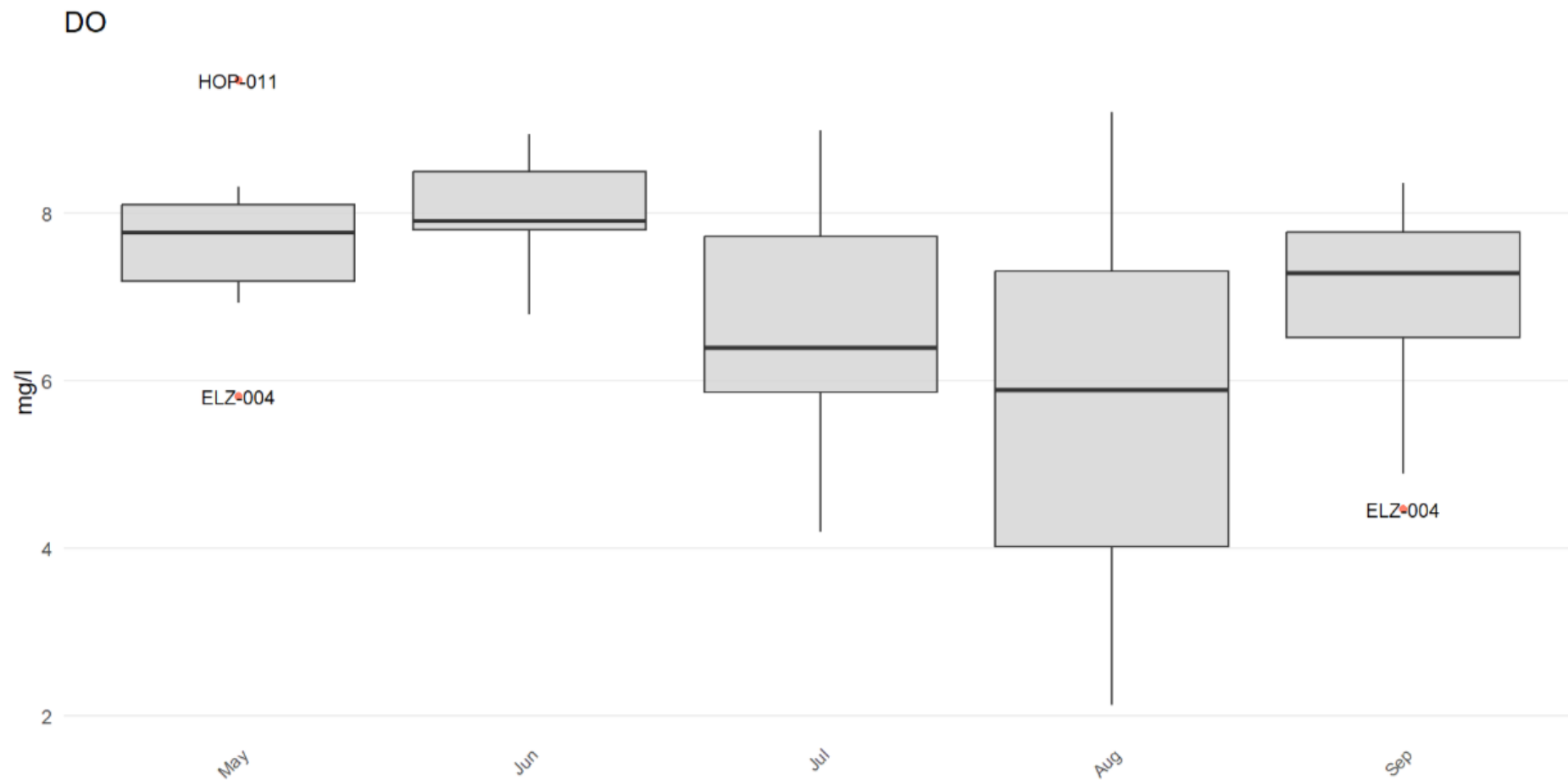
Extra Slides

Other Tools



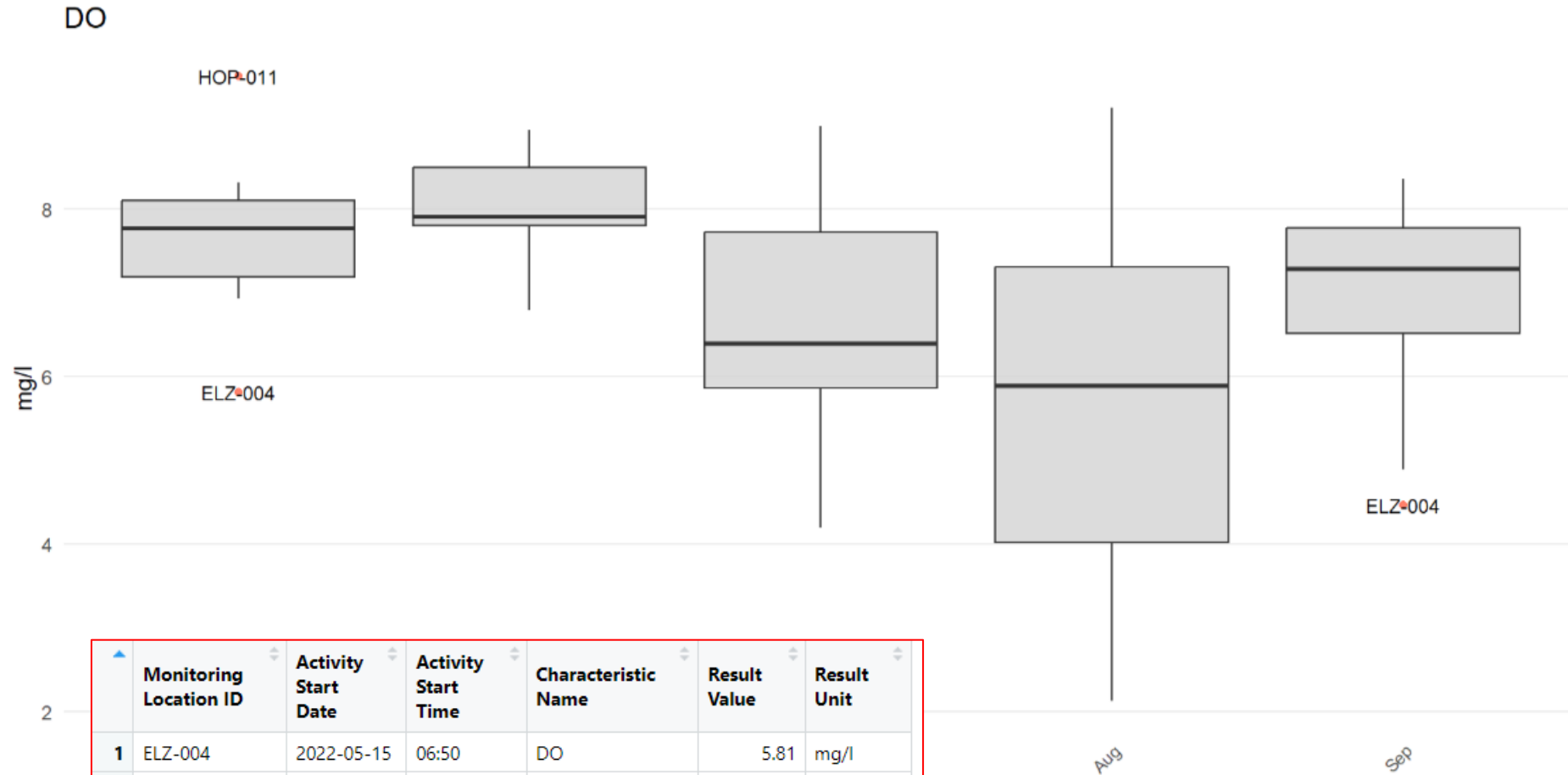
OUTLIER REVIEW

```
1 anlzMWRoutlier(res = resdat, param = "DO", acc = accdat, group = "month")
```



OUTLIER REVIEW

```
1 anlzMWRoutlier(res = resdat, param = "DO", acc = accdat, group = "month")
```



	Monitoring Location ID	Activity Start Date	Activity Start Time	Characteristic Name	Result Value	Result Unit
1	ELZ-004	2022-05-15	06:50	DO	5.81	mg/l
2	HOP-011	2022-05-15	06:55	DO	9.58	mg/l
3	ELZ-004	2022-09-11	07:20	DO	4.46	mg/l

QC Report

```

28
29 qcMWRreview(fset = fset1s, rawdata = TRUE,
30               output_dir=getwd(), output_file = "my_QCReport")
31

```

QC Frequencies for 5/15/2022 to 9/11/2022

Parameter	Field Duplicate	Lab Duplicate	Field Blank	Lab Blank	Spike/Check Accuracy
Ammonia	9%	23%	16%	16%	21%
DO	22%	-	-	-	-
E.coli	17%	33%	33%	0%	-
Nitrate	10%	50%	35%	25%	50%
pH	22%	35%	-	-	41%
Sp Conductance	22%	35%	-	43%	43%
TP	10%	33%	23%	10%	31%
Water Temp	22%	35%	-	-	39%

Type	Parameter	Number of Data Records	Number of Dups/Blanks/Spikes	Frequency %	Hit/Miss
Field Duplicates	Ammonia	43	4	9%	MISS
	DO	49	11	22%	
	E.coli	12	2	17%	
	Nitrate	20	2	10%	
	pH	49	11	22%	
	Sp Conductance	49	11	22%	
	TP	48	5	10%	
	Water Temp	49	11	22%	
Lab Duplicates	Ammonia	43	10	23%	

QC Accuracy Summary for 5/15/2022 to 9/11/2022

Parameter	Field Duplicate	Lab Duplicate	Field Blank	Lab Blank	Spike/Check Accuracy
Ammonia	75%	100%	100%	86%	100%
DO	100%	-	-	-	-
E.coli	100%	100%	100%	-	-
Nitrate	100%	100%	100%	100%	90%
pH	100%	94%	-	-	95%
Sp Conductance	100%	100%	-	95%	100%
TP	80%	100%	91%	100%	100%
Water Temp	100%	100%	-	-	95%

Type	Parameter	Number of QC Checks	Number of Misses	% Acceptance
Field Duplicates	Ammonia	4	1	75 %
	DO	11	0	100 %
	E.coli	2	0	100 %
	Nitrate	2	0	100 %
	pH	11	0	100 %
	Sp Conductance	11	0	100 %
	TP	5	1	80 %
	Water Temp	11	0	100 %
Lab Duplicates	Ammonia	10	0	100 %
	E.coli	4	0	100 %

Data Completeness for 5/15/2022 to 9/11/2022

Parameter	Number of Data Records	Number of Qualified Records	% Completeness	Hit/ Miss	Number of Censored Records	Notes
Ammonia	43	0	100%			
DO	49	0	100%			
E.coli	12	0	100%			
Nitrate	20	0	100%		1	1 sample censored due to contamination
pH	49	0	100%			
Sp Conductance	49	0	100%			
TP	48	5	90%	MISS		5 samples qualified due to lab dup miss

WQX FORMATTING

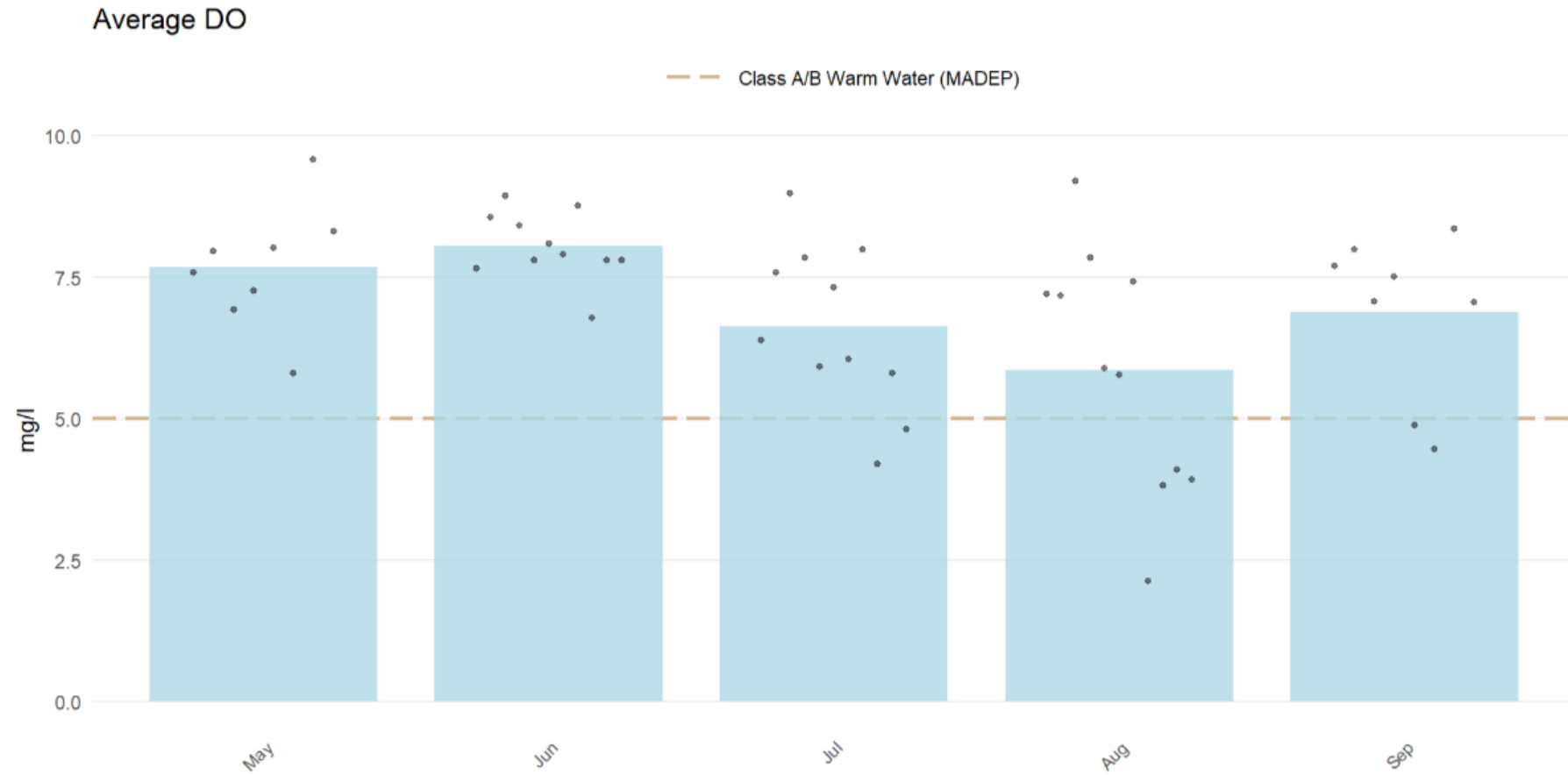
```
1 tabMWRwqx(res = resdat, acc = accdat, sit = sitdat, wqx = wqxdat, output_dir = get
```

	A	B	C	D	E
1	Project ID	Monitoring Location ID	Activity ID	Activity Type	Activity Media Name
2	My_WQ	ABT-026	ABT-026:20220515:0815:1:FM	Field Msr/Obs	Water
3	My_WQ	ABT-077	ABT-077:20220515:0610:1:FM	Field Msr/Obs	Water
4	My_WQ	ABT-301	ABT-301:20220515:0734:1:FM	Field Msr/Obs	Water
5	My_WQ	ABT-312	ABT-312:20220515:0801:0.3:FM	Field Msr/Obs	Water
6	My_WQ	DAN-013	DAN-013:20220515:0725:0.3:FM	Field Msr/Obs	Water
7	My_WQ	ELZ-004	ELZ-004:20220515:0650:0.5:FM	Field Msr/Obs	Water
8	My_WQ	HOP-011	HOP-011:20220515:0655:1:FM	Field Msr/Obs	Water
9	My_WQ	NSH-002	NSH-002:20220515:0835:1:FM	Field Msr/Obs	Water
10	My_WQ	ABT-026	ABT-026:20220612:0730:1:FM	Field Msr/Obs	Water
11	My_WQ	ABT-062	ABT-062:20220612:0615:0.5:FM	Field Msr/Obs	Water
12	My_WQ	ABT-077	ABT-077:20220612:1019:1:FM	Field Msr/Obs	Water
13	My_WQ	ABT-144	ABT-144:20220612:0925:1:FM	Field Msr/Obs	Water
14	My_WQ	ABT-237	ABT-237:20220612:0745:1:FM	Field Msr/Obs	Water
15	My_WQ	ABT-301	ABT-301:20220612:0730:1:FM	Field Msr/Obs	Water
16	My_WQ	ABT-312	ABT-312:20220612:0810:1:FM	Field Msr/Obs	Water
17	My_WQ	DAN-013	DAN-013:20220612:0838:0.3:FM	Field Msr/Obs	Water
18	My_WQ	ELZ-004	ELZ-004:20220612:0956:0.5:FM	Field Msr/Obs	Water
19	My_WQ	HOP-011	HOP-011:20220612:0645:1:FM	Field Msr/Obs	Water
20	My_WQ	NSH-002	NSH-002:20220612:0820:0.5:FM	Field Msr/Obs	Water

[View Output](#)

SEASONAL ANALYSIS

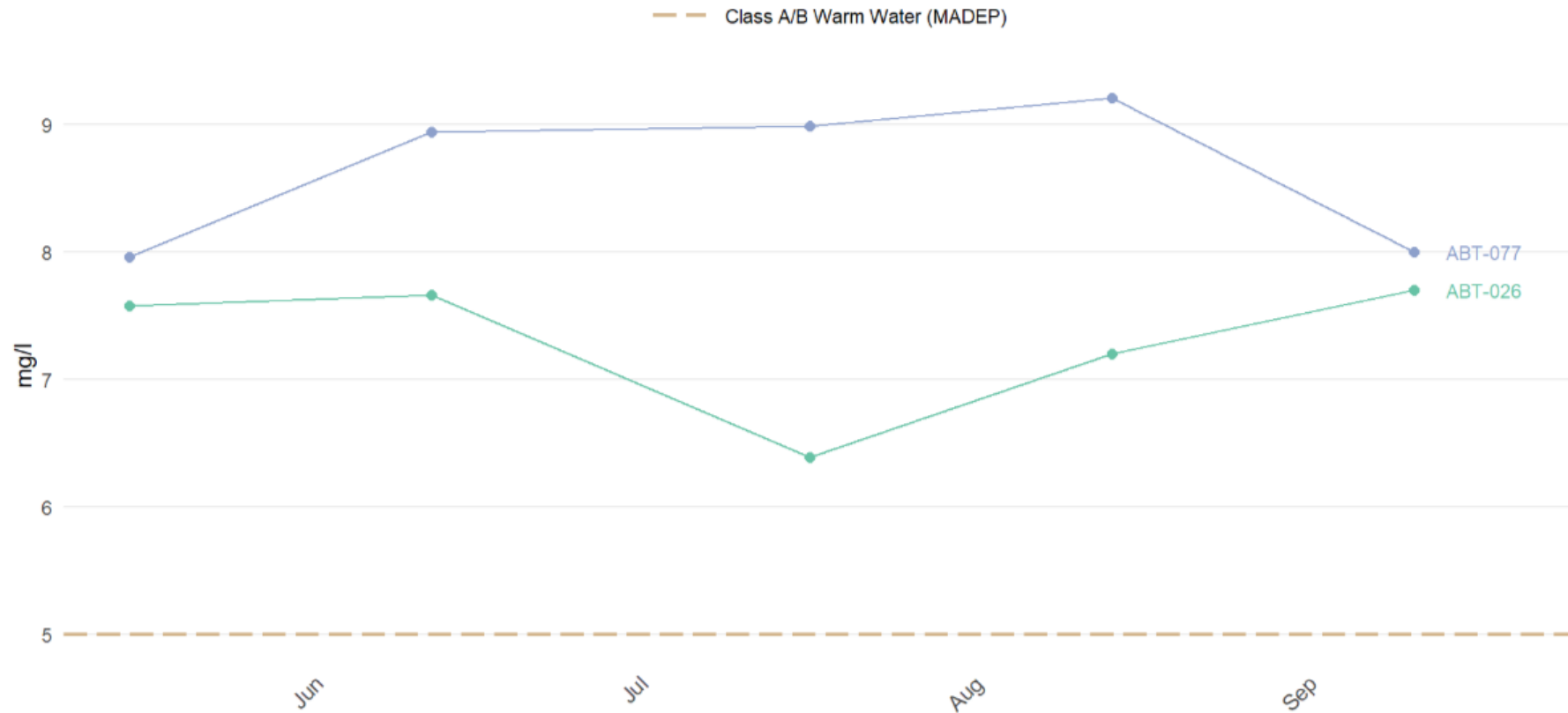
```
1 anlzMWRseason(res = resdat, param = "DO", acc = accdat, thresh = "fresh", group =
```



TIME-SERIES ANALYSIS

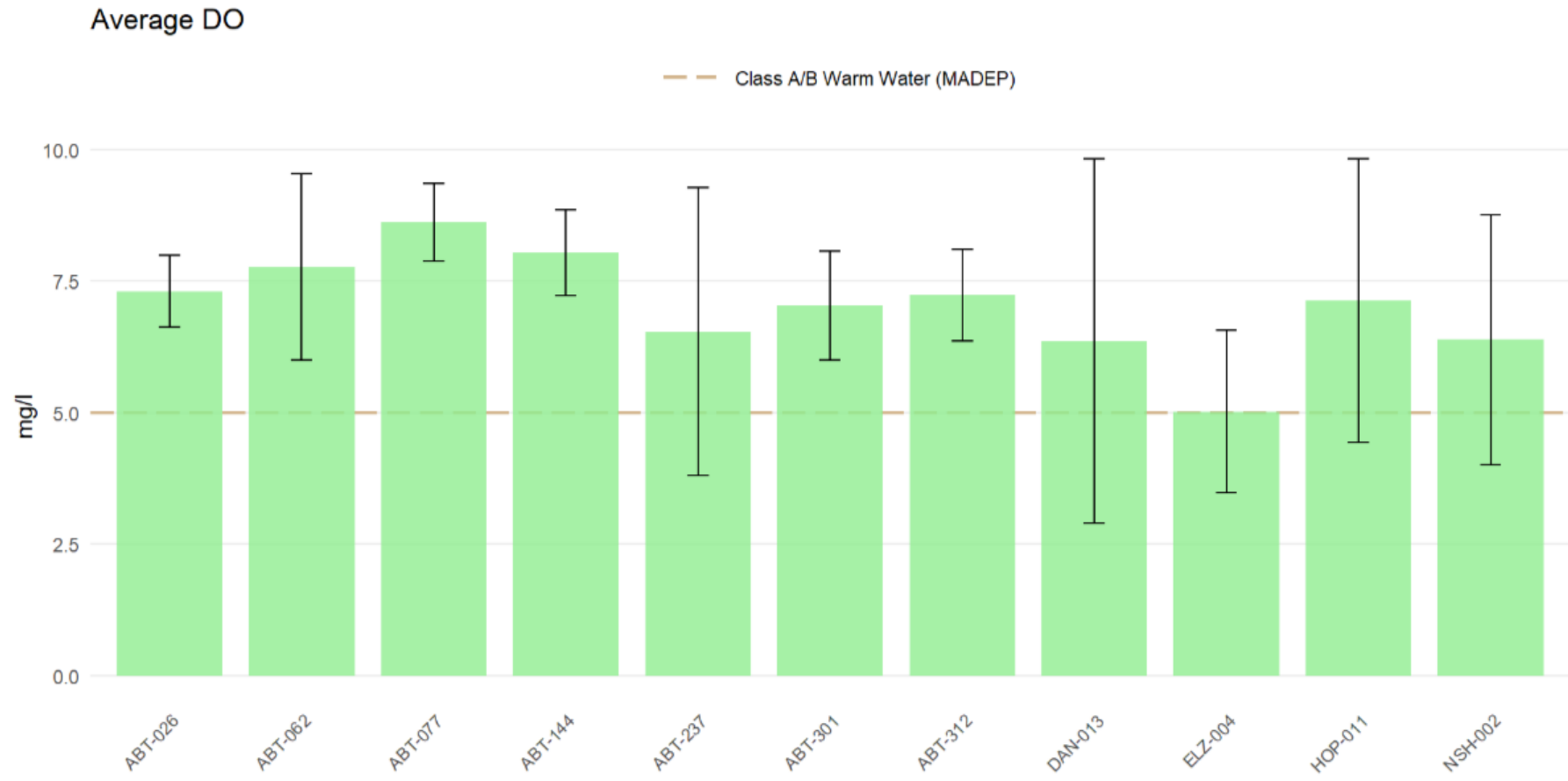
```
1 anlzMWRdate(res = resdat, param = "DO", acc = accdat, thresh = "fresh", group = "s
```

DO, data filtered by sites



SITE ANALYSIS

```
1 anlzMWRsite(res = resdat, param = "DO", acc = acmdat, thresh = "fresh", type = "ba
```



MAP ANALYSIS

```
1 anlzMWRmap(res = resdat, param = "DO", acc = accdat, sit = sitdat, addwate
```

