Illinois Environmental Protection Agency

Bureau of Water • 1021 N. Grand Avenue E. • P.O. Box 19276 • Springfield • Illinois • 62794-9276

Division of Water Pollution Control
ANNUAL FACILITY INSPECTION REPORT
for NPDES Permit for Storm Water Discharges from Separate Storm Sewer Systems (MS4)

This fillable form may be completed online, a copy saved locally, printed and signed before it is submitted to the Compliance Assurance Section at the above address. Complete each section of this report.

Report Period: From March, 2024 To March, 2025

Permit No. ILR40 0454

MS4 OPERATOR INFORMATION: (As it appears on the current permit)

Name: City of St. Charles Mailing Address 1: 2 E. Main Street

Mailing Address 2: County: Kane

City: St. Charles State: IL Zip: 60174 Telephone: 630-377-4400

Contact Person: Chris Gottlieb Email Address: cgottlieb@stcharlesil.gov
(Person responsible for Annual Report)

Name(s) of governmental entity(ies) in which MS4 is located: (As it appears on the current permit)

Kane County DuPage County

THE FOLLOWING ITEMS MUST BE ADDRESSED.

A. Changes to best management practices (check appropriate BMP change(s) and attach information regarding change(s) to BMP and measurable goals.)

1. Public Education and Outreach ☐
2. Public Participation/Involvement ☐
3. Illicit Discharge Detection & Elimination ☐
4. Construction Site Runoff Control ☐
5. Post-Construction Runoff Control ☐
6. Pollution Prevention/Good Housekeeping ☐

B. Attach the status of compliance with permit conditions, an assessment of the appropriateness of your identified best management practices and progress towards achieving the statutory goal of reducing the discharge of pollutants to the MEP, and your identified measurable goals for each of the minimum control measures.

C. Attach results of information collected and analyzed, including monitoring data, if any during the reporting period.

D. Attach a summary of the storm water activities you plan to undertake during the next reporting cycle (including an implementation schedule.)

E. Attach notice that you are relying on another government entity to satisfy some of your permit obligations (if applicable).

F. Attach a list of construction projects that your entity has paid for during the reporting period.

Any person who knowingly makes a false, fictitious, or fraudulent material statement, orally or in writing, to the Illinois EPA commits a Class 4 felony. A second or subsequent offense after conviction is a Class 3 felony. (415 ILCS 5/44(h))

[signature] 5/28/25

Owner Signature: Date:

Chris Gottlieb, P.E. Public Works Manager - Engineering

Printed Name: Title:

EMAIL COMPLETED FORM TO: epa.ms4annualinsp@illinois.gov

or Mail to: ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
WATER POLLUTION CONTROL
COMPLIANCE ASSURANCE SECTION #19
1021 NORTH GRAND AVENUE EAST
POST OFFICE BOX 19276
SPRINGFIELD, ILLINOIS 62794-9276

Illinois Environmental Protection Agency

2025 Annual Facility Inspection Report

for NPDES Permit for Stormwater Discharges from Municipal Separate Storm Sewer Systems (MS4)

City of Saint Charles, IL

MS4 Permit No. ILR400454
Reporting Period March 1, 2024 to February 28, 2025

Table of Contents

Part A. Changes to Best Management Practices A-1

Part B. Status of Compliance with Permit Conditions B-1

Part C. Information and Data Collection Results C-1

Part D. Summary of Future Stormwater Activities D-1

Part E. Notice of Relying on another Government Entity E-1

Part F. Construction Projects Conducted During the Reporting Year F-1

Attachment A. Kane County MS4 Annual Facility Inspection Report

Attachment B. Illinois State Water Survey Water Quality Trend Analysis for the Fox River Watershed

Part A. Changes to Best Management Practices

Information regarding the status of BMPs and measurable goals is provided in the following table.

Note: "X" indicates BMPs that were implemented in accordance with the MS4's SMPP
✓ indicates BMPs that were changed during the reporting year

A. Public Education and Outreach	
X	A.1 Distributed Paper Material
X	A.2 Speaking Engagement
X	A.3 Public Service Announcement
X	A.4 Community Event
X	A.5 Classroom Education Material
X	A.6 Other Public Education
B. Public Participation/Involvement	
X	B.1 Public Panel
	B.2 Educational Volunteer
X	B.3 Stakeholder Meeting
	B.4 Public Hearing
X	B.5 Volunteer Monitoring
	B.6 Program Coordination
X	B.7 Other Public Involvement
C. Illicit Discharge Detection and Elimination	
X	C.1 Storm Sewer Map Preparation
X	C.2 Regulatory Control Program
	C.3 Detection/Elimination Prioritization Plan
X	C.4 Illicit Discharge Tracing Procedures
X	C.5 Illicit Source Removal Procedures
X	C.6 Program Evaluation and Assessment
X	C.7 Visual Dry Weather Screening
X	C.8 Pollutant Field Testing
	C.9 Public Notification
	C.10 Other Illicit Discharge Controls

D. Construction Site Runoff Control	
X	D.1 Regulatory Control Program
X	D.2 Erosion and Sediment Control BMPs
X	D.3 Other Waste Control Program
X	D.4 Site Plan Review Procedures
	D.5 Public Information Handling Procedures
X	D.6 Site Inspection/Enforcement Procedures
X	D.7 Other Construction Site Runoff Controls
E. Post-Construction Runoff Control	
X	E.1 Community Control Strategy
X	E.2 Regulatory Control Program
	E.3 Long Term O&M Procedures
	E.4 Pre-Const Review of BMP Designs
X	E.5 Site Inspections During Construction
X	E.6 Post-Construction Inspections
	E.7 Other Post-Const Runoff Controls
F. Pollution Prevention/Good Housekeeping	
X	F.1 Employee Training Program
X	F.2 Inspection and Maintenance Program
	F.3 Municipal Operations Storm Water Control
X	F.4 Municipal Operations Waste Disposal
X	F.5 Flood Management/Assess Guidelines
X	F.6 Other Municipal Operations Controls

Part B. Status of Compliance with Permit Conditions

The City implements several stormwater Best Management Practices (BMP) to comply with the conditions of the MS4 Permit. In addition, Kane County implements stormwater BMPs and provides MS4 services for all residents of the County, including within St. Charles. This section summarizes the BMPs and MS4 related activities implemented by the City during the reporting year. The BMPs and services provided by the County are summarized in Part E.

BMPs were implemented within the six MS4 Permit program areas:

A. Public Education and Outreach
B. Public Participation/Involvement
C. Construction Site Runoff Control
D. Post-Construction Runoff Control
E. Illicit Discharge Detection and Elimination
F. Pollution Prevention/Good Housekeeping.

A. Public Education and Outreach

BMP No. A1 Distributed Paper Material

Measurable Goal(s):

- Distribute information sheets regarding stormwater BMPs, water quality BMPs, and proper hazardous waste use and disposal.
- Maintain a water quality/stormwater section on the City website.
- Maintain the City website, which offers links to additional educational information, and ways to contact City of St. Charles personnel.

Milestone:

- Continue performing the above-mentioned activities as they pertain to Public Education and Outreach.

BMP Status:

- MS4 informational materials are available from the City and are posted to the City's website -
- The City actively pursues educational sheets prepared by the County, IEPA, USEPA, Center for Watershed Protection, Chicago Metropolitan Agency for Planning "CMAP" (previously Northeastern Illinois Planning Commission "NIPC"), University of Wisconsin Extension, Solid Waste of Kane County (Kane County Environmental Management) and other agencies and organizations.
- The City lists the Public Works Engineering Division phone number on all City outreach publications (print and web) to encourage residents to contact the City with environmental concerns.

BMP No. A2 Speaking Engagement

Measurable Goal(s):

- The County provides educational presentations related to stormwater management on a regular basis through involvement in local watershed groups and other environmental committees, ensuring that a minimum of one public presentation is given per year.
- The County tracks the number of speaking engagements, locations, and topics presented.

BMP Status:

- See Part E.

BMP No. A3 Public Service Announcement

Measurable Goal(s):

- A public service announcement for the "Clean Water for Kane" campaign was developed in 2014 and continues to be made available to the community through the County website, special showings, and other digital media outlets

BMP Status:

- See Part E.

BMP No. A4 Community Event

Measurable Goal(s):

- The City attends and/or sponsors outreach events and scheduled meetings with the general public.
- Events are held on an as-needed or as-requested basis.
- Audiences may include homeowners associations, lake associations, businesses, and neighborhood groups.
- The County educates residents and other stakeholder groups on stormwater Best Management Practices through participation in environmental and watershed special events in the community, and regular community education/training events including the annual well and septic seminar hosted by the County Health Department.
- The County coordinates a minimum of one public educational workshop per year and participates in other community events.
- The County tracks the number of events, locations, and information distributed.

Milestone:

- Both the City and County to make available to the community the above-mentioned community events.

BMP Status:

- The City participated in annual Fox River Cleanup on 9/21/2024.
- The City hosted a presentation on 7th Ave. Creek water quality improvements for the Fox River Ecosystem Partnership
- See Part E.

BMP No. A5 Classroom Education Material

Measurable Goal(s):

- The City participates in classroom education at local schools with the County. The County prepares presentation materials with the support of the City.
- The County updates the classroom educational material database on an annual basis.

BMP Status:

- See Part E.

BMP No. A6 Other Public Education

Measurable Goal(s):

- The City maintains a web site that includes stormwater quality specific elements such as water quality, solid waste and hazardous material, stormwater, and general environmental health.
- The City updates the website and tracks the number of visitors to the website.
- The City provides a significant amount of information through links to other educational and informational sites.
- Install signage or stamped covers on storm water inlets.

Milestone:

- Provide the above-mentioned public education material.

BMP Status:

- The City has continued providing the public education material via the City website.
- All new inlets contain stamps stating that they drain to waterway

B. Public Participation/Involvement

BMP No. B.1 Public Panel

Measurable Goal(s):

- The City accepts comments on the Stormwater Management Program Plan (SMPP) through the City website, phone calls, or other media.
- The City evaluates comments and incorporates them, as appropriate, into the next revision of the SMPP.

Milestone:

- The City to accept comments on the SMPP and evaluate them for inclusion, as appropriate, in the next revision of the SMPP.

BMP Status:

- The City has continued accepting comments on the SMPP and evaluates comments for inclusion and incorporates comments into the next revision of the SMPP, as appropriate.

BMP No. B.3 Stakeholder Meeting

Measurable Goal(s):

- The City participates, and encourages the participation of local stakeholders, in Kane County stormwater program meetings or other sponsored watershed planning events.
- The City will adopt Watershed Plans per the direction and in coordination with Kane County.

Milestone:

- The City to be involved in watershed planning and management efforts with input from watershed stakeholders.

BMP Status:

- The City has continued to be involved in watershed planning and management efforts with input from watershed stakeholders.

BMP No. B.5 Volunteer Monitoring

Measurable Goal(s):

- Participate within the Fox River Watershed Monitoring Network, and the Fox River Study Group (FRSG) stream monitoring program.
- The County continues to take a multi-level approach to supporting stream monitoring efforts by holding a leadership role in watershed groups carrying out monitoring work, as well as by providing financial support for local volunteer monitoring programs and river monitoring via USGS stream gauges.
- The City supports the activities of the FRSG

Milestone:

- Continue to participate within the Fox River Watershed Monitoring Network, and the FRSG stream monitoring program.

BMP Status:

- Participated within the Fox River Watershed Monitoring Network, and the FRSG stream monitoring program.
- The City continues to support the FRSG
- See Part E for County activities.

BMP No. B.7 Other Public Involvement

Measurable Goal(s):

- Review potential environmental justice areas within the City and involve the public as warranted.

Milestone:

- Perform review of environmental justice areas once per permit period and involve the public as warranted.

BMP Status:

- The City utilized the IEPA and USEPA environmental screening tools and determined that no action was required at this time.
- The City will re-review during the next permit period.

C. Illicit Discharge Detection and Elimination

BMP No. C.1 Storm Sewer Map Preparation

Measurable Goal(s):

- Maintain and update the Outfall Inventory Map on an annual basis to incorporate permitted outfalls associated with new developments.
- The City performs an outfall inventory in an effort to search for new outfalls.

Milestone:

- The City to maintain and update its Outfall Inventory Map on an annual basis.
- The City to perform an outfall inventory on an annual basis.

BMP Status:
- The City continued to maintain and update its Outfall Inventory Map.
- The City continued to perform an outfall inventory on an annual basis.

BMP No. C.2 Regulatory Control Program

Measurable Goal(s):
- The County Watershed Development Ordinance allows the City to require inspection deposits, performance bonds, and to adopt/enforce violation procedures, which assist in achieving compliant construction sites.

Milestone:
- Enforce the Watershed Development Ordinance

BMP Status:
- The City continues to enforce the Watershed Development Ordinance

BMP No. C.4 Illicit Discharge Tracing Procedures

Measurable Goal(s):
- The City utilizes procedures to trace detected illicit discharges, which includes visual examination as well as methods of testing such as dye testing, smoke testing, and/or remote video inspections.

Milestone:
- The City to utilize procedures to trace detected illicit discharges.

BMP Status:
- The City continues to trace detected illicit discharges as detected.

BMP No. C.5 Illicit Source Removal Procedures

Measurable Goal(s):
- The City utilizes an eight step procedure to identify and remove an illicit discharge to the storm sewer system.

Milestone:
- The City to utilize procedures to remove illicit discharges to the storm sewer system.

BMP Status:
- The City continues to remove illicit discharges to the storm sewer system as detected.

BMP No. C.6 Program Evaluation and Assessment

Measurable Goal(s):
- The City evaluates the effectiveness of the illicit discharge detection and elimination program in an effort to determine the effectiveness of the program on a long-term basis and show ongoing improvement through a reduced number of outfalls having positive indicators of

potential pollutants. The City intends to have the majority of dry-weather pollution sources eliminated after several years of annual screening.

Milestone:

- The City to evaluate the effectiveness of the illicit discharge detection and elimination program annually.

BMP Status:

- The City evaluated the effectiveness of the illicit discharge detection and elimination program in an effort to determine the effectiveness of the program on a long-term basis and show ongoing improvement through a reduced number of outfalls having positive indicators of potential pollutants.

BMP No. C.7 Visual Dry Weather Screening

Measurable Goal(s):

- The City implements a Direct Connection Illicit Discharge Program consisting of three principal components: program planning, outfall screening, and follow-up investigation and program evaluation.
- The City determines if there are outfalls that require a follow up investigation, target sewer system areas for detailed investigation and then conducts field investigations to identify potential sources.

Milestone:

- The City to implement a Direct Connection Illicit Discharge Program
- The City to conduct dry weather screening.

BMP Status:

- The City continues to implement a Direct Connection Illicit Discharge program.
- The City continues to perform dry weather screening every year on priority outfalls and once every five years for all others. Inspections are managed and tracked through the City's GIS system.

BMP No. C.8 Pollutant Field Testing

Measurable Goal(s):

- Perform pollutant field testing to identify the nature of pollution and identify potential sources.

Milestone:

- Perform pollutant field testing as needed

BMP Status:

- The City continues to perform pollutant field testing as needed

D. Construction Site Runoff Control

BMP's No. D.1/D.2/D.3/D.4/D.6/D.7

Measurable Goal(s):

- The City enforces the Kane County Stormwater Ordinance and Technical Manual, which addresses requirements of the Construction Site Runoff Control Measures.

Milestone:

- The City to enforce the Kane County Stormwater Ordinance and Technical Manual.

BMP Status:

- The City is a Certified Community for the review, permitting, inspection and enforcement of the provisions of the Technical Manual. The City has adopted and enforces the Kane County Stormwater Ordinance and Technical Manual. The County Technical Manual addresses requirements of the Construction Site Runoff Control Measures.

E. Post-Construction Runoff Control

BMP's No. E.1/E.2/E.5/E.6

Measurable Goal(s):

- The City enforces the Kane County Stormwater Ordinance and Technical Manual, which addresses requirements of the Post-Construction Runoff Control Measures.

Milestone:

- The City to enforce the Kane County Stormwater Technical Manual.

BMP Status:

- The City, which is a Certified Community for the review, permitting, inspection and enforcement of the provisions of the Technical Manual, has adopted and enforces the Kane County Stormwater Ordinance and Technical Manual. The County Technical Manual addresses requirements of the Construction Site Runoff Control Measures.

F. Pollution Prevention/Good Housekeeping

BMP No. F.1 Employee Training Program

Measurable Goal(s):

- The City provides on-going education and training to staff to ensure that all of its employees have the knowledge and skills necessary to perform their functions effectively and efficiently.

Milestone:

- The City to provide on-going education and training to City staff. This can be achieved though webinars, training conferences, or in house training sessions.

BMP Status:

- Training was provided to City staff through County events, professional conferences, webinars, and in-house training sessions.

BMP No. F.2 Inspection and Maintenance Program

Measurable Goal(s):

- The City performs the following activities as part of its Inspection and Maintenance Program:
  - Street sweeping operations approximately 10 to 15 times per year, to reduce potential illicit discharges and to provide a clean environment,
  - The City's Detention/Retention Pond Checklist is used to determine inspection locations before and during a forecasted storm event. Observed obstructions are cleared and debris is hauled to the spoil waste area.
  - The City adheres to the Roadway Culvert/Bridge Checklist for inspection and maintenance of culverts and bridges.
  - The City maintains a Storm Sewer Atlas, which is used to track the inspection and cleaning of catch basins.
  - The City documents observed or reported erosion or sediment accumulation within swales and overland flow paths and performs remediation or initiates remediation through coordination with property owners, as necessary.

Milestone:

- The City to continue conducting inspections and performing its maintenance programs.

BMP Status:

- The City has continued providing inspection and maintenance.

BMP No. F.4 Municipal Operations Waste Disposal

Measurable Goal(s):

- The City performs the following activities as part of its Municipal Operations Waste Disposal:
  - Maintains its general facilities, municipal roads, associated maintenance yards, and other public areas.
  - Ensures that landscape contractors are provided with training and/or other information to ensure that they adhere to the City's SMPP.
  - Adheres to snow removal and ice control procedures that aim to use the minimal amount of salt and de-icing chemicals necessary for effective control,
  - Adheres to vehicle and equipment fueling procedures and practices designed to minimize or eliminate the discharge of pollutants to the stormwater management system,
  - Adheres to vehicle maintenance procedures and practices designed to minimize or eliminate the discharge of petroleum-based pollutants to the storm water management system,
  - The City's Waste Management program helps prevent the release of waste materials into the stormwater management system including receiving waters, and
  - The City's Water Conservation practices minimize water use and help to avoid erosion and/or the transport of pollutants into the stormwater management system.

Milestone:

- The City to continue following its procedures for Municipal Operations Waste Disposal.

BMP Status:
- The City has continued following its procedures for Municipal Operations Waste Disposal.

BMP No. F.5 Flood Management/Assessment Guidelines

Measurable Goal(s):
- The County implements the Kane County Hazard Mitigation Program.

BMP Status:
- See Part E

BMP No. F.6 Other Municipal Operations Controls

Measurable Goal(s):
- The City will implement road salt application and storage BMPs to minimize salt runoff into waterways, train staff on deicing and salt management procedures on an annual basis, and track the number of training events and participants each year.

Milestone:
- Implement road salt application and storage BMP procedures.

BMP Status:
- The City performed:
  - Ongoing training on salt application and storage procedures.
  - Salt storage under cover to minimize concentrated salt runoff into waterways.

Part C. Information and Data Collection Results

The City collects water quality samples annually and supplies the analysis results to the Fox River Study Group (FRSG). FRSG implements a regional water quality monitoring program and the City, as a member, has access to all of FRSG watershed scale monitoring information. The monitoring results inform both local MS4 program implementation and support regional water quality planning. Results are available from the FRSG website. https://www.foxriverstudygroup.org/resources In 2019 the Illinois State Water Survey Prairie Research Institute submitted a report on water quality trends in the Fox River that was commissioned by the FRSG. This report is attached.

Part D. Summary of Future Stormwater Activities

The City intends to implement the BMPs described in Part B of this report during the next implementation and reporting year. Any changes to the BMPs determined necessary or beneficial to the City program will be noted within the next annual report.

Part E. Notice of Relying on another Government Entity

Kane County implements stormwater BMPs throughout the County, and provides MS4 services for all residents of the County, including within St. Charles. Attachment A summarizes the BMPs and MS4 related services implemented by the County that supplement the City's program.

Part F. Construction Projects Conducted During the Reporting Year

Project Name	Project Size (acres)	Construction Start Date	Construction End Date
Fox Haven Square – St. Charles	7.54	9/30/2024	Ongoing
The Quad – St. Charles Chipotle	1.28	9/1/2024	Ongoing

Illinois Environmental Protection Agency

ANNUAL FACILITY INSPECTION REPORT

for NPDES Permit for Storm Water Discharges

from Municipal Separate Storm Sewer Systems (MS4)

Kane County, Illinois (NPDES Permit No. ILR400259)

March 1, 2024 - February 28, 2025

I. CHANGES TO BEST MANAGEMENT PRACTICES

There are no changes to the Best Management Practices for the six minimum control measures as described in the Notice of Intent for Kane County submitted on May 28, 2021.

II. STATUS OF COMPLIANCE WITH PERMIT CONDITIONS

Kane County submitted a Notice of Intent on May 28, 2021, which initiated a new 5-year permit cycle. The BMPs listed in the 2016 Notice of Intent were selected to meet NPDES Phase II program requirements and minimize nonpoint source pollution in Kane County, Illinois.

The implementation progress for each of these BMPs is summarized below in sections A—F. All BMPs described in Kane County's 2021 Notice of Intent have been implemented on or ahead of schedule, with the exception of select items noted in their descriptions below.

A. PUBLIC EDUCATION AND OUTREACH

1. BMP A.1—Distributed Paper Material

MEASURABLE GOALS	Include "Water Wise Corner" in the *Kane County Recycles Green Guide*, which is developed and distributed throughout Kane County on an annual basis. Revise "Water Wise Corner" every spring. Track the total number of recipients each year.
RESULTS	The bulk of distribution (16,000 print copies and further downloads) of the *Kane County Recycles Green Guide* for 2024 which included the "Clean Water for Kane" occurred in March-April 2024. A Recycling Program postcard with a QR code directing to the County Environmental and Water Resources website was printed and will be distributed in the spring of 2025.

KANE COUNTY'S 2025 RECYCLING EVENTS

MAJOR EVENTS

@ 540 S. RANDALL RD, ST CHARLES, IL
8AM – NOON

Spring Shred & More: Saturday, May 17
Confidential document shredding and reuse/recycling for clothing, textiles and home goods, books, bikes & paint

Recycling Extravaganza: Saturday, July 19
Recycling electronics, clothing & textiles, books, Styrofoam, batteries, bulbs, paint, bikes & more! (no shredding)

Fall Shred & More: Saturday, Sept. 27
Confidential document shredding and reuse/recycling for clothing, textiles and home goods, books, bikes & paint

OUR EVENTS WEBPAGE

FIRST SATURDAY POP-UPS

ELECTRONICS, CLOTHING/TEXTILES, BOOKS

Aurora Ace Hardware (994 N. Lake St., Aurora)
9am - noon on April 5, Sept. 6, Oct. 4, Nov. 1, Dec. 6

Carpenter Park (275 Maple Ave., Carpentersville)
9am - noon on May 3

North Aurora PD (200 S. Lincolnway St., N. Aurora)
9am - noon on June 7

South Elgin DPW (1000 Bowes Rd., South Elgin)
9am - noon on August 2

Recycling Program Office:
(630) 208-3841
recycle@kanecountyil.gov

Clean Water for Kane section of the
Kane County Recycles Green Guide for 2024

MON – FRI RECYCLING CENTERS

Residents can drop off a variety of items at Kane County Recycling Centers five days a week, no appointment necessary!

517 E. Fabyan Parkway, Geneva, IL; M-F, 8am - 4pm
900 Angle Tarn, West Dundee, IL; M-F, 7am - 3pm

These sites both accept household electronics, clothing, shoes and textiles, books, paper, cardboard, smoke and CO detectors, child car seats and strollers for recycling.

Fees apply for TVs and monitors ($25 or $35 depending on size), smoke and CO detectors ($1 each), child car seats and strollers ($15 each). Cash & card are accepted on site.

Kane County Recycling Program
719 S. Batavia Ave.,
Building A, Room 109
Geneva, IL 60134

PRSRT STD
U.S. POSTAGE
PAID
PERMIT NO. 693
SAINT CHARLES, IL

INTRODUCING RECYCLE COACH

Recycle Coach is a web tool and mobile app filled with local information to help Kane County residents recycle better. Can soup cartons be recycled through curbside collections? Where can you drop off Styrofoam to be recycled? The answers to these questions and more are in Recycle Coach! Use the QR code (right) to use Recycle Coach on our website or download for free through your chosen app store!

Demystifying Recycling, One Click at a Time!

recycle coach

KANE COUNTY RECYCLES

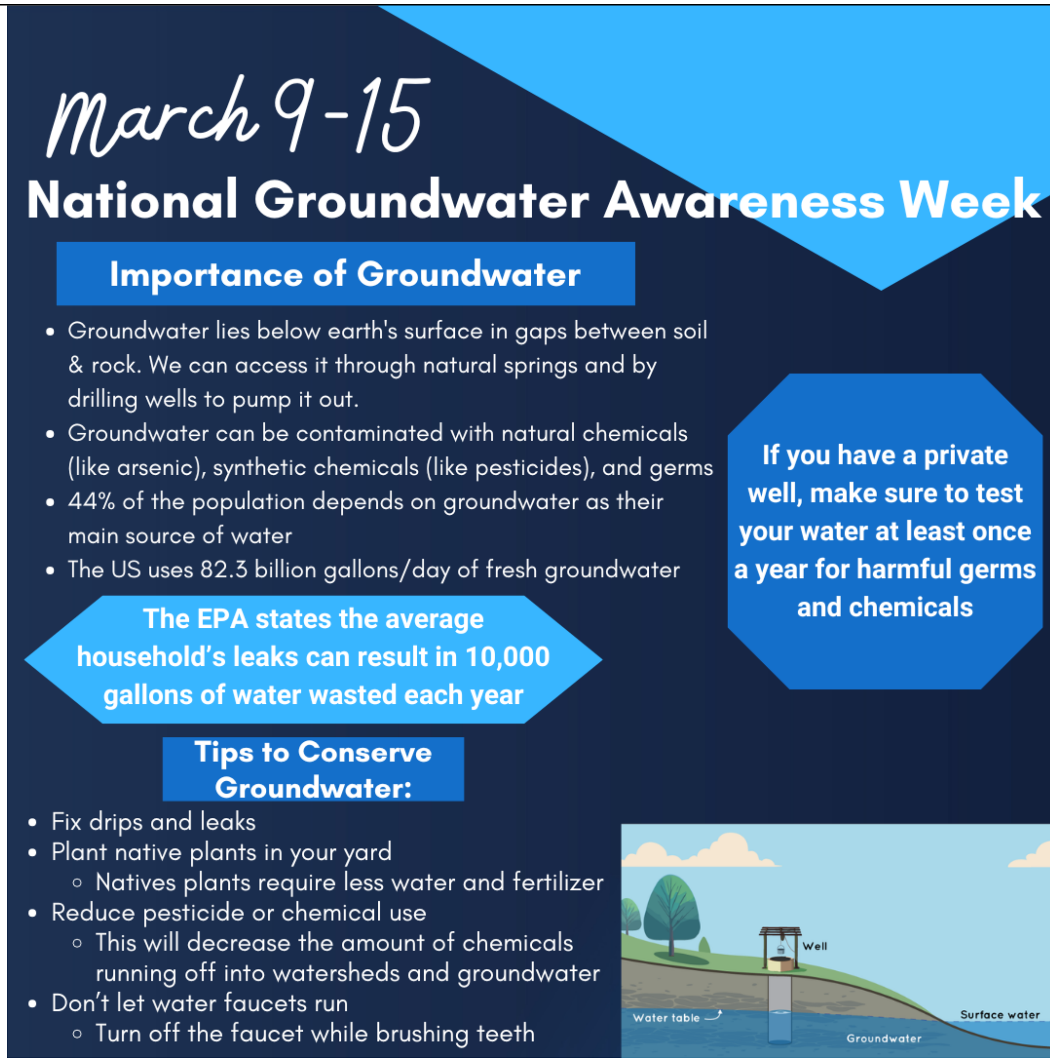
RECYCLE COACH ON THE COUNTY WEBSITE

2. BMP A.2—Speaking Engagement

MEASURABLE GOALS	Provide educational presentations related to stormwater management on a regular basis through involvement in local watershed groups and other environmental committees, ensuring that a minimum of one public presentation is given per year. Track the number of speaking engagements, locations, topics presented, and number of attendees at each engagement.
RESULTS	Kane County Government's Climate Action Implementation Plan (CAIP) focused on two major goals from August 2024. The actions below are ongoing and will continue over the next year. 1) Establish and promote a program supporting the installation of low-flow water fixtures in residential homes and commercial businesses as well as opportunities for real-time water and energy metering that may help customers better understand and reduce their water and energy consumption. Program may be integrated or coordinated with Energy Audit/Energy Efficiency Program(s) in the Buildings and Energy section of this plan. Goal: achieve 500 households and 40 businesses upgraded annually Research was done on rebate programs in other states and municipalities which included several zoom meetings to learn more. More specifically, we spoke with a representative from Orbit about their smart irrigation systems. Following this, we have contacted Wasco Sanitary District about a pilot project. The project will include a number of high-end water users. They will receive the B-hyve Smart Indoor/Outdoor Sprinkler Timer and Kane will track the water usage over the course of a year. This will also be in conjunction with education and outreach through news and social media. At this time we are seeking participants who are interested and developing a timeline for launch. Our second action we focused on this year was 2) Develop educational materials to support the goals of the Water and Wastewater section. Materials should create greater awareness and adoption of water conservation; expand public awareness of the value of watersheds, rain gardens and low-impact development to address storm water run-off; and covering the link between water resources and climate change and the risks to community residents and businesses. Social media posts regarding this initiative have been consistently ongoing. We have been conducting research on outreach and educational efforts across Kane County related to the action. Currently, we are assessing where gaps exist in these efforts in order to better identify the most impactful aspects that would contribute to raising greater awareness.

3. BMP A.3—Public Service Announcement

MEASURABLE GOALS	A public service announcement for the "Clean Water for Kane" campaign was developed in 2014, and is made available to the community through the Kane County website, special showings, and other digital media outlets. Track the number of PSA showings, locations, and audience reached each year.
RESULTS	During the permit year, the Clean Water for Kane website was updated and new information and links will be added in the upcoming months. The Clean Water for Kane information and flyers were presented at: 1. Greenfest in Aurora Illinois on June 8th 2024 https://www.auroragreenfest.com/ 2. National night out at Kane County Judicial Center on August 5th https://www.shawlocal.com/kane-county-chronicle/2024/08/05/national-night-out-returns-to-kane-county-tuesday-evening/ Kane County also has started a facebook page for sustainability posts. https://www.facebook.com/sustainkane/ For example, a post was made on March 8th to bring awareness to National Groundwater Awareness Week and an Instagram 9 page slide was on September 7th to bring awareness to World Rivers Day



National Groundwater Awareness Post

	 *First Page of 9 Slides Bringing Awareness to World River Day* *PSA on Kane County website*

4. BMP A.4—Community Event

MEASURABLE GOALS	Educate residents and other stakeholder groups on stormwater Best Management Practices through participation in environmental and watershed special events in the community, and regular community education/training events including the annual well and septic seminar hosted by the Kane County Health Department. Coordinate a minimum of one public educational workshop per year and participate in other community outreach events. Track the number of events, locations, information distributed, and number of participants for each event.
RESULTS	Kane County staff participated in the community events listed below during the permit year. Some community events were shifted online to "virtual events".

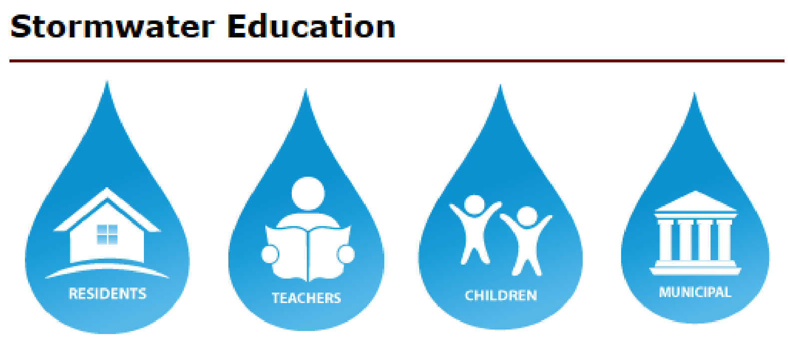
	Stormwater educational handouts were distributed at the community events held in person and virtual links to the *Clean Water for Kane* website were made available for virtual events. • One Earth Film Festival [04/23/2024, + 408 virtual and 37 in person registrants] • Kane County Rain Barrel Sale May 10th [5/19/2024, 65 sales] • Greenfest in Aurora Illinois on [07/09/2024 ~80 attendees] The Kane County Health Department did not hold its annual Well & Septic educational event due to staffing shortages.

5. **BMP A.5—Classroom Education Material**

MEASURABLE GOALS	Maintain a collection of stormwater-related educational materials for use in the classroom, and also reach students in the community through educational displays at libraries and other community venues. Update the classroom educational material database on an annual basis. Track the number of educational displays, locations, materials distributed, and number of students reached throughout the year.
RESULTS	During the permit year, the Kane County Department of Environmental and Water Resources updated the youth educational resource list available on the county website: https://www.countyofkane.org/FDER/Pages/environmentalResources/waterResources/children.aspx as well as the teacher educational resource list available on the county website: https://www.countyofkane.org/FDER/Pages/environmentalResources/waterResources/teachers.aspx A complete overhaul of the website with new links, videos and more information is planned for the upcoming months. The Department continued to provide educational materials—including water conservation coloring books and stickers, *Clean Water for Kane* rain gages, toilet leak detection tabs, pet waste tip cards, and outdoor water use brochures—to partner organizations, particularly the Forest Preserve District of Kane County and Friends of the Fox River for the Schweitzer Environmental Center. In addition, Flood awareness brochures were developed to support our Natural Hazard and Mitigation Plan and education efforts. https://www.kanecountyil.gov/sustainability/Pages/home.aspx Additionally, Kane County Department of Environmental and Water Resources allocated $1500 of FY24 funding to Friends of the Fox River (FOFR) for their Classroom Educational Programming and pledges funding for FY25.

	For all of Kane County, Friends of the Fox River organized student education through 28 field trips, 42 campus lessons and 18 afterschool programs, reaching a total of 1740 students.

6. **BMP A.6 – Other Public Education**

MEASURABLE GOALS	The Kane County Department of Environmental & Water Resources maintains a "Clean Water for Kane" website, and also develops seasonal stormwater-related informational articles that are distributed through the Kane County Connects e-newsletter, website, and social media pages. Update the "Clean Water for Kane" web pages on an annual basis. Track the number of stormwater-related articles in Kane County Connects, topics covered, and audience reach each year
RESULTS	During the permit year, the Kane County Department of Environmental & Water Resources updated the "Stormwater Education" pages on the County website. The site had 597 views during the permit year.  *Stormwater Education page of the Kane County website:* www.countyofkane.org/FDER/Pages/EnvironmentalResources/stormwaterEducation.aspx In addition, two water-related articles were published in *Kane County Connects*: • Kane County's Sprout 'n' Spout Rain Barrel and Compost Bin Program is Back! [4/08/24] https://kanecountyconnects.com/article/rainbarrel-sustainability-recycling-kanecounty-environment-conservation • *Conserve Water for Kane - Kane County Water Conservation, Education, and Technical Assistance Program* [7/11/24] https://kanecountyconnects.com/article/KaneCounty-Water-Conservation *Kane County Connects* reaches 21,500 newsletter subscribers and over 1.1K

	followers on social media.

7. **BMP A.6 – Other Public Education**

MEASURABLE GOALS	The Kane County Department of Environmental & Water Resources maintains a supply of "Kane County Streams" signs to be installed at road crossings throughout the County. Kane County will provide the signs to MS4 communities as requested for installation within their own municipal boundaries, and will maintain a database of signs manufactured and installed throughout the year.
RESULTS	During the permit year, no requests were made for additional stream signage and therefore no new signs were installed. Up to 100 signs will be installed during the next reporting period.

B. PUBLIC PARTICIPATION/INVOLVEMENT

1. **BMP B.3—Stakeholder Meeting**

MEASURABLE GOALS	Kane County is involved in watershed planning and management efforts that seek input from a variety of watershed stakeholders. Provide notice of stakeholder meetings on the Kane County website and distribute meeting information to stakeholder email lists. Track the number of watershed meetings hosted or co-hosted by the County, meeting locations, topics discussed, and participation numbers.
RESULTS	During the permit year, the following stakeholder meetings were held/attended by Kane County: • Tyler Creek Watershed Coalition meetings – 3/20/24, 6/26/24, 7/17/24, 9/18/24, 11/20/24, 2/18/25

2. BMP B.5—Volunteer Monitoring

MEASURABLE GOALS	Kane County continues to take a multi-level approach to supporting stream monitoring efforts by holding a leadership role in watershed groups carrying out monitoring work, as well as by providing financial support for local volunteer monitoring programs and river monitoring via USGS stream gages. Maintain Joint Funding Agreement with USGS and allocate funding for stream gages. Support local volunteer monitoring program. Track the number of leadership meetings attended and the funding provided on an annual basis.
RESULTS	Kane County staff served on the Board of Directors of the Fox River Study Group and as an advisor to the Fox River Ecosystem Partnership, attending the following meetings during the permit year: • Fox River Study Group Board meetings held via Zoom [3/28/24, 4/25/24; 5/23/24, 6/27/24, 7/25/24, 8/22/24, 9/26/24, 10/17/24, 10/31/24 (Annual Meeting), 11/21/24, 12/19/24, 1/23/25, 2/27/25] • Fox River Study Group Committee of the Whole meetings held via Zoom 7/11/24, 8/8/24, 9/12/24, 10/10/24, 11/14/24, 12/12/24, 1/9/25, 2/13/25] • Fox River Ecosystem Partnership meetings [3/14/24(Fox R. Summit), 5/8/24, 6/12/24, 7/10/24, 8/14/24, 9/11/24, 11/13/24, 1/8/25, 2/12/25] In addition, the Kane County Department of Environmental & Water Resources provided financial support of $500 to the Friends of the Fox River for their volunteer monitoring program in November 2024. Friends of the Fox River organized monthly creek sampling at Tyler, Otter and Ferson Creeks. A Joint Funding Agreement between Kane County and the U.S. Geological Survey was signed on 08/12/2024 and passed by Kane County Board on 09/10/2025 to cover the time period October 1, 2024, through Sept ember 30, 2025. Kane County has committed $74,060 of FY25 funding to support five stream gages and four precipitation gages.

3. BMP B.7—Other Public Involvement

MEASURABLE GOALS	Kane County will provide technical and financial support to the Friends of the Fox River and other local watershed groups to ensure that opportunities exist for public involvement in stream cleanup efforts. Allocate funding to support stream cleanups on an annual basis. Track the number of planning meetings or cleanup events attended by Kane County staff each year.
RESULTS	The Kane County Department of Environmental & Water Resources provided $500 in July 2024 to the Friends of the Fox River to support stream cleanups throughout the county. Friends of the Fox River organized 52 Watershed weekly publications with 2000 subscribers, 365 Facebook posts and nearly doubled their followers to 8000. Their website had 8083 views with 3666 active users and 4667 sessions. In addition. FOFR had 10 river cleanups in Kane County, throughout the permitting period as well ecological restoration events included 3 oak tree planting, and 6 mussel rescues. For the 6th annual "It's our Fox River Day" FOFR reported over 32 separate events with 600 participants and 800 volunteers for 17 river cleanups of trash from in and around the Fox River and its streams.

C. ILLICIT DISCHARGE DETECTION AND ELIMINATION

1. BMP C.1—Storm Sewer Map Preparation

MEASURABLE GOALS	Kane County will update its storm sewer mapping in GIS to include the location and size of all County-owned stormwater outfalls to receiving streams in the urbanized area, and will distribute up-to-date mapping and information across County departments including the Facilities, Transportation, and Emergency Management departments. Update the stormwater system map layer on an annual basis to incorporate new stormwater outfalls identified.
RESULTS	During the permit year, the KCDEWR has made substantial improvements to the County's stormwater mapping resources. The County's stormwater mapping resources are now countywide (unincorporated and municipalities) and include all known storm sewers, culverts, drain tiles, and detention basins. Storm sewer mapping has expanded from 3125 miles in the last reporting period to 3,176 miles in this reporting period. Mapped storm sewer, culvert & tile segments increased from 140,000 segments in 2024 to more than 165,000 in 2025. Additionally, storm structures such as catch basins, inlets, manholes, and flared end sections have been added to the mapping dataset to include the total from 125,000 structures to 171,000+ structures through the Feb 2025 reporting period. During the reporting period, mapped stormwater detention basins increased from 3,337 to 3,423. The KCDEWR worked with the County GIS Dept. to update the Kane County Stormwater Viewer, which is an on-line interactive map of all stormwater infrastructure and related water resources data for the entire county (floodplains, wetlands, hydric soils, etc.). The viewer can be found at the link below: https://experience.arcgis.com/experience/094fedf250d34bf19cb22881ddb2d66d/ The Stormwater Viewer also contains a high-resolution stormwater flow tracing tool that allows a user to accurately trace stormwater downstream to the major rivers (Fox River on the east; out to Kishwaukee River to the west). In 2024, the watershed delineation tool was also added which allows users to accurately map the upstream tributary area from any point in the county. These tools have a number of uses, but are particularly useful to persons conducting IDDE investigations and accidental spill mitigation. A Users Guide for how to access the stormwater map layers and use the tools is accessible on the Stormwater Viewer's start-up disclaimer page.

2. BMP C.2—Regulatory Control Program

MEASURABLE GOALS	Kane County will utilize regulatory authority to prohibit, inspect, and follow-up with enforcement for illegal discharges into the County's MS4 by following established procedures at the Kane County Health Department. Track the number of illicit discharges identified on an annual basis and document the actions taken to eliminate the discharges.
RESULTS	The Kane County Health Department has continued to enforce its regulatory authority to prohibit, inspect, and follow-up with enforcement for illegal discharges into the County's MS4. The Health Department investigated 24 septic system complaints. KC Environmental & Water Resources Dept investigated 6 potential illicit discharges during the reporting period.

KANE COUNTY ILLICIT DISCHARGE INCIDENT TRACKING

Period: March 2023 - February 20243

Date	Location	Issue	Outcome
4/26/24	35W260 Crescent Dr Dundee Township	Residential property with report of motor oil leaking from parked car.	KCDEWR investigated and noted two vehicles with small oil leak residue under them but did not observe any evidence of oil reaching the adjacent ditch as suggested by the complainant. Vehicle owner was advised to maintain and park vehicles on his driveway and not on the street that has no curb or gutter.
8/19/24	19N683 Niccon Trail Dundee Township	Landowner complaint about blue dye in Pokagon Creek passing through her property	KCDEWR investigated and determined the dye came from an approved aquatic herbicide application into an upstream reach of the creek under jurisdiction of the Village of Algonquin. The contractor (RES) was treating invasive Watercress in the section of stream that was recently stabilized by the Village.
9/10/24	1685 Sheffer Rd, Aurora Township	Residential property with report of sump pump discharge containing washing machine water.	KCDEWR investigated and determined washing machine water was likely being discharged through one of two sump pump discharges noted for the property. Landowner was contacted and required to re-route the suspected washing machine discharge to their septic system

	3/15/24	Mahoney Creek at Kirk Road **City of Batavia**	KCDWER/KDOT staff noted patches of foam coming from KDOT storm sewer outfall in City of Batavia jurisdiction stemming from a previous foam chemical spill in the City.	KCDEWR contacted KDOT and City of Batavia. City responded that they would contact the Flint Group, who caused the original unpermitted foam release, and they would have their spill cleanup contractor investigate and clean up any remaining foam residue in the creek.
	8/19/24	7th Ave Creek at Riverside & Moore Ave **City of St Charles**	Resident reported bleach smell in water flowing into creek.	KCDEWR contacted City of St Charles who determined that the discharge was from a water main leak (hence the chlorine smell) and had directed its public works department to respond.
	12/4/24	Fox River **City of Elgin**	Public reports & video of blue/green color emanating from a storm outfall under the City bus station just south/downstream of Highland Ave Bridge	KCDEWR contacted City of Elgin who, along with their Fire Department responded to the report.

3. BMP C.10—Other Illicit Discharge Controls

MEASURABLE GOALS	Kane County's Environmental Health staff are trained to identify potential illicit discharges to the County's MS4 and to follow the established procedures for eliminating the discharges. Conduct illicit discharge detection training for Environmental Health staff on an annual basis. Track the number of staff trained and total hours of training received.
RESULTS	Kane County Health Department did not hold any well & septic staff training sessions during the reporting period due to staffing shortages.

D. CONSTRUCTION SITE RUNOFF CONTROL

1. **BMP D.1—Regulatory Control Program**

MEASURABLE GOALS	The Kane County Stormwater Management Ordinance addresses all requirements of the Construction Site Runoff Control measures, D.1-D.7. Implement and enforce the Kane County Stormwater Ordinance, maintaining and updating program documentation annually.
RESULTS	During the permit year, 70 Stormwater Permit Applications were submitted to the County. All of these proposed projects were reviewed with consideration of Construction Site Runoff under the requirements of the Kane County Stormwater Management Ordinance. Permits are digitally tracked in the Kane County – CityView system, in addition to a digital copy, the County maintains a complete folder of the permits and plans for Stormwater Permit Applications.

E. POST-CONSTRUCTION RUNOFF CONTROL

1. BMP E.2—Regulatory Control Program

MEASURABLE GOALS	The Kane County Stormwater Management Ordinance addresses all requirements of the Post-Construction Runoff Control measures, E.1-E.7. Implement and enforce the Kane County Stormwater Ordinance, maintaining and updating program documentation annually.
RESULTS	During the reporting period, 60 Stormwater Permits were issued. Post-Construction Runoff Control measures were implemented on these projects under the requirements of the Kane County Stormwater Management Ordinance. This included 31 permits requiring a Stormwater BMP (structural feature to infiltrate first 1" of stormwater runoff from new impervious surfaces) and 12 permits requiring stormwater detention for the 100-year design storm event. Permits are digitally tracked in the Kane County – CityView, in addition to a digital copy the County maintains a complete set of the permits and plans for Stormwater Permit Applications.

F. POLLUTION PREVENTION/GOOD HOUSEKEEPING

1. BMP F.1—Employee Training Program

MEASURABLE GOALS	Kane County will provide stormwater management training opportunities to County staff as well as other MS4 communities by coordinating a regular "MS4 Corner" e-newsletter, as well as by hosting webcasts. Maintain an email contact list for MS4 community representatives, and distribute the e-newsletter on a minimum of a quarterly basis. Host stormwater informational webcasts as relevant, tracking the number of trainings provided and the number of attendees.
RESULTS	During the permit year, the Kane County Department of Environmental & Water Resources issued 3 issues of the "MS4 Corner" newsletter were created and distributed to the contact list during the reporting period [Distributed on: April/24, May/24 and Sept/24]. April 2024 Issue

2024 Stormwater Webcast Education

Mark your calendars – The Kane County Department of Environment and Water Resources will host 3 educational webcasts from the Center for Watershed Protection (CWP) during the 2024 year.

These FREE webcasts are open to all municipal staff and environmental partners in Kane County.

The webcasts will be again this year. Please email HinshawSarra@kanecountyIL.gov to receive information for accessing the webcasts and their recordings:

Webcast 4: Design with Maintenance in Mind
Wednesday May 15, 2024 at 1 PM Eastern Time

Speaker: Derek Berg, Director- Stormwater Regulatory Management – East, CONTECH Engineered Solutions LLC

	Description: TBD **Webcast 8: Agriculture and Watershed Management** **Wednesday October 23, 2024 at 1 PM Eastern Time** **Speakers:** Lisa Blazure and Amanda Cather **Description:** TBD **Webcast 9: Green Infrastructure** **Wednesday November 20, 2024 at 1 PM Eastern Time** **Speakers:** Michael Radabaugh, Stormwater Division KC Water **Description:** This presentation shows how KCMO set about remediation of private Green Infrastructure from unmaintained or undermaintained to functional as designed assets. Utilizing existing laws and enforcement mechanisms. Attendees will see the step-by-step process Kansas City uses for handling deficiencies in regard to the privately owned Green Infrastructure improving Stormwater Quality and Quantity handling. Better minimizing flooding downstream of unmaintained or undermaintained facilities. The presenter found that Kansas City had laws in place to solve flooding and erosion from upstream development post construction that were not being utilized and leveraged for the good of the Citizenry. "I'm from the City and I'm here to help."

	2024 Kane County Natural Hazard Mitigation Plan Kane County Office of Emergency Management and Kane County Department of Environmental and Water Resources, in conjunction with the participating cities and villages, completed the 5-year update of the Kane County Natural Hazard Mitigation Plan. **Purpose of the Hazard Mitigation Plan** • Ensure Kane County, Illinois and the participating cities and villages qualify for federal funding, before and after a disaster occurs. • Identify common threats and hazards the County faces. • Develop common mitigation strategies, ensuring a comprehensive and county-wide approach is used. • Develop intergovernmental partnerships within the County. • Gain public insight and share public information, increasing residents' knowledge and preparedness against the County's threats and hazards. If you would like to get in touch with the project team, please email Anne Wilford, CFM at WilfordAnne@KaneCountyIL.gov one earth FILM FESTIVAL The Fox River Ecosystem Partnership and Fox Watershed Partners are sponsoring the environmental film: Carbon: The Unauthorized Biography for the One Earth Film Festival. This is a virtual screening event will be held on April 23, 2004 at 6:00pm. Donations are welcome and you can get your free tickets here. Sarra Hinshaw Ph.D Sustainability Manager Kane County Environmental & Water Resources Department Ph: 630-208-8665 SUSTAIN KANE economy • environment • people During the permit year, Kane County hosted the following webcasts from the Center for Watershed Protection virtually: • *Design with Maintenance in Mind* [5/15/24]

	• *Agriculture and Watershed Management* [10/23/24] • *Green Infrastructure* [11/20/24] In addition, Kane County Environmental & Water Resources staff participated in the following training opportunities provided by other entities: • Illinois Association of Floodplain & Stormwater Management Annual Conference in Peoria IL [3/12/24-3/13/24; 3 staff attended]

2. BMP F.2—Inspection and Maintenance Program

MEASURABLE GOALS	Kane County will continue its established Operation and Maintenance Program – which includes the Department of Transportation clearing roadside swales once a year, and inspecting and cleaning catch basins and storm inlets quarterly. Kane County will also develop and adhere to an annual inspection and maintenance schedule for BMPs installed on County properties, and will utilize available tools to implement a BMP Inventory & Evaluation Program. Inspect and maintain roadside swales, catch basins and storm inlets, and BMPs on County properties according to schedule, documenting pollutant load reduction on an annual basis.
RESULTS	During 2024, the Kane County Department of Transportation swept approximately 150 miles of curbing and 42 bridge decks. Sweeping was done twice – once in the spring and once in the fall. KDOT cleaned out approximately 275 catch basins on south Randall Rd and Orchard Rd. KCDEWR continues to update its BMP Inventory & Evaluation spreadsheet (see section III) to track data for BMPs installed on Kane County owned properties.

3. BMP F.4—Municipal Operations Waste Disposal

MEASURABLE GOALS	Kane County will follow established procedures to maintain buildings, fleet vehicles, and equipment. Procedures include the proper disposal of wastes from municipal operations, in compliance with all local, State, and Federal regulations. Kane County departments will continue to recycle all types of used oil, antifreeze, oil filters, tires, batteries, scrap metal, and cardboard. Perform fleet inspections and recycle hazardous materials on an ongoing basis, documenting compliance with the procedures annually.
RESULTS	The Kane County Department of Transportation continues to follow established vehicle maintenance and proper waste disposal procedures, maintaining internal records of these activities using CFA (Computerized Fleet Analysis) Software for

	fleet tracking. KDOT vehicles are inspected according to the following schedule: • Heavy trucks (snow plows, etc.)—every 2000 miles or 180 days • Light trucks and cars—every 5000 miles or 90-180 days • Heavy off-road equipment—every 50 hours or 180 days • Light off-road equipment—every 50 hours or 180 days KDOT also took part in a county organized tire recycle program, recycling over 100 tires from either KDOT fleet vehicles or tires found in the county right-of-way.

4. **BMP F.5—Flood Management/Assessment Guidelines**

MEASURABLE GOALS	Kane County will continue to implement the Kane County Hazard Mitigation Program as outlined in the Plan. Host two Hazard Mitigation Committee meetings per year to coordinate ongoing implementation of the plan.
RESULTS	The Kane County 2024 Kane County Natural Hazard Mitigation Plan was finalized in March 2024. http://www.kcoem.org/Pages/mitigation.aspx 4 brochures were made to highlight extreme weather events including Winter Preparedness Flooding Awareness Extreme Heat Drought https://www.kanecountyil.gov/sustainability/Pages/home.aspx The Kane County Office of Emergency Management and Kane County Department of Environmental & Water Resources continue to coordinate the implementation of the *Kane County Natural Hazards Mitigation Plan*, which was first adopted in 2003 and updated in 2015. The Natural Hazards Mitigation Planning Committee along with a consultant, paid for through an HPMG grant fund awarded by FEMA to the County, has updated the 2015 Plan. The 2024 Plan was approved by FEMA on April 1, 2024 and adopted by the County Board on June 11, 2024. The Natural Hazard Mitigation Planning Committee held a meeting on November 15, 2024, which the public was invited to attend, along with the participating communities' planners, engineers and emergency management staff. In addition, the Kane County Department of Environmental & Water Resources worked on 6 cost-share project to reduce flooding on unincorporated residential properties: Sylvanna Drive Drainage Improvements Design 2025 Construction in 2026 Montague Forest: Juliet Dr – Design in 2025 Construction in 2026

	Lenschow Rd Drainage Improvements – Construction completed in 2024. Marney-Kelley Hampshire– design phase, construction 2025-2026 Countrylife Tile & Culvert Replacement – Kaneville Twp – construction 2024 & 2025 Wildwood West – Chisholm Trail construction completed Fall 2024

5. BMP F.6—Other Municipal Operations Controls

MEASURABLE GOALS	Kane County will implement Road Salt Application and Storage procedures to minimize salt washoff into the County's MS4. Train staff on deicing and salt management procedures on an annual basis. Track the number of training events and participants each year.
RESULTS	The Kane County Department of Transportation provides continual training on salt application and storage procedures via staff manuals. All KDOT winter truck staff attended the 2024 deicing workshop for sensible salting. Supervisors attended the APWA Winter maintenance supervisor workshop. KDOT calibrates trucks yearly to ensure the proper salt dispensing rate, equips each salt truck with a reference table the driver can use to determine the optimal rate of pounds of salt dispensed per lane mile, and stores salt indoors throughout the year to minimize concentrated salt wash off into the MS4. KDOT responded to 34 winter events using 6,500 tons of salt for the season. KDOT supervisors also utilize GPS software to track salt usage to minimize salt over-application.

2024 Deicing Workshops

Reminder - Deicing Workshops are happening now. Sign up today.
https://saltsmart.org/workshops/

The 2024 workshops aim to help personnel from municipalities and public works facilities implement Best Management Practices (BMPs) to reduce the amount of salt they use in snow fighting operations and to address NPDES Permit Requirements.

This year the workshops are offered both in person and online. All in-person workshops are from 8AM to Noon. Breakfast is included and begins at 7:30.

Public Roads

Tuesday, September 17th
IN PERSON - City of Aurora
1200 E. Indian Trail Road, Aurora
Register - 9/17

Tuesday, September 24th
IN PERSON - Lake County
500 W. Winchester Road, Libertyville,
2nd Floor Conference Rm
Register - 9/24

Thursday, October 3rd
IN PERSON - Village of Homewood
1023 191st St, Homewood
Register - 10/3

Parking Lots & Sidewalks

Thursday, September 26th
VIRTUAL
Register - 9/26

Tuesday, October 1st
IN PERSON - Streamwood Park District
700 W. Irving Park Road, Streamwood
Register - 10/1

Kane County Parking Lots and Sidewalks Deicing Workshop flyer

III. RESULTS OF INFORMATION COLLECTED AND ANALYZED

No monitoring data was collected and analyzed during the reporting period. Per Attachment B. of the 2016 Notice of Intent, Kane County has elected to implement a BMP Inventory & Evaluation Program in lieu of monitoring (Note: Kane County continues to participate in the Fox River Study Group, Inc., a non-profit organization who is performing on-going watershed-wide water quality monitoring and modeling to address impairments in the Fox River https://www.foxriverstudygroup.org/)

During the permit year, the "MS4 Non-Point Source Control Measure Tracking Tool" provided by the Fox River Study Group was used to calculate annual pollutant load reduction for the following BMPs on Kane County government-owned properties. Previously constructed BMPs (wet detention basins) were added into the inventory. Nine new structural BMPs were constructed on Kane County government-owned property in Mar 2024 – Feb 2025. These were wetland-style stormwater detention basins – 9 in Big Rock Township built for the Dauberman Road Extension Project (see table below).

MS4 Non-Point Source Control Measure Tracking Tool

Fox River Watershed, Illinois

MS4	Project Name	Project Cost	Project Type	Total Area Captured (acres)	% Urban High Density	% Low-Medium Density	% Urban Open Space	Area-Weighted UAL (lb/acre/yr)	Load (lb)	Removal Efficiency	Total Load Removed (lb/yr)	Cost per Pound P Removed ($/lb)
Kane county	KC Govt Center PICP Parking Lot	$250,000	Bioretention	0.99	100%	0%	0%	0.98	1.0	65%	0.6	$398,408
Kane county	KC Govt Center Rain Garden	$25,000	Bioretention	0.4	75%		25%	0.79	0.3	65%	0.2	$121,768
Kane county	KC Circuit Court Clerk Parking Lot Bioretention Basins (2)	$35,000	Bioretention	1.3	95%		5%	0.94	1.2	65%	0.8	$44,156
Kane county	KDOT Building Expansion Detention Basin	$25,000	Dry detention	1.1	75%		25%	0.79	0.9	26%	0.2	$110,698
Kane county	KDOT Storage Yard Detention Basin	$15,000	Dry detention	3.25	100%			0.98	3.2	26%	0.8	$18,204
Kane county	KC Judicial Center Pond	$250,000	Wet detention	250	20%		80%	0.38	95.4	68%	64.9	$3,854
Kane county	KDOT Detention at Big Timber & Tood Farm Rd in Elgin Twp	$25,000	Dry detention	27	90%		10%	0.90	24.3	26%	6.3	$3,953
Kane county	KC Multi-Use Facility Detention Basin	$430,000	Wet detention	6	75%		25%	0.79	4.7	68%	3.2	$133,467
Kane county	KDOT Stearns Rd Det 09-0009	$100,000	Wet detention	7.25	40%		60%	0.53	3.8	68%	2.6	$38,274
Kane county	KDOT Stearns Rd Det 09-0010	$250,000	Wet detention	17.8	40%		60%	0.53	9.4	68%	6.4	$38,973
Kane county	KDOT Stearns Rd Det 09-0011	$100,000	Dry detention	5.9	30%	30%	40%	0.53	3.1	26%	0.8	$122,444
Kane county	KDOT Stearns Rd Det 09-0012	$100,000	Wet detention	6.6	30%		70%	0.46	3.0	68%	2.0	$48,887
Kane county	KDOT Stearns Rd Det 09-0013	$150,000	Wet detention	11.4	40%		60%	0.53	6.0	68%	4.1	$36,511
Kane county	KDOT Stearns Rd Det 09-0014	$100,000	Wet detention	22.6	40%		60%	0.53	12.0	68%	8.1	$12,278
Kane county	KDOT Fabyan Pkwy Det 12-003	$50,000	Wet detention	3.8	100%			0.98	3.7	68%	2.5	$19,843
Kane county	KDOT Fabyan Pkwy Det 12-004	$75,000	Wet detention	2	50%		50%	0.60	1.2	68%	0.8	$91,278
Kane county	KDOT LM Pkwy Det 03-001	$150,000	Wet detention	18.5	50%		50%	0.60	11.2	68%	7.6	$19,736
Kane county	KDOT LM Pkwy Det 03-002	$100,000	Wet detention	6	85%		15%	0.86	5.2	68%	3.5	$28,373
Kane county	KDOT LM Pkwy Det 03-003	$150,000	Wet detention	17.3	75%		25%	0.79	13.7	68%	9.3	$16,147
Kane county	KDOT LM Pkwy Det 03-004	$75,000	Wet detention	5	75%		25%	0.79	3.9	68%	2.7	$27,935
Kane county	KDOT LM Pkwy Det 03-005	$50,000	Wet detention	3.8	75%		25%	0.79	3.0	68%	2.0	$24,504
Kane county	KDOT LM Pkwy Det 03-006	$150,000	Wet detention	19.5	30%		70%	0.46	8.9	68%	6.0	$24,820
Kane county	KDOT LM Pkwy Det 03-007	$150,000	Wet detention	18.5	85%		15%	0.86	16.0	68%	10.9	$13,803
Kane county	KDOT LM Pkwy Det 03-008	$200,000	Wet detention	13.4	70%		30%	0.75	10.1	68%	6.9	$29,166
Kane county	KDOT Dauberman Rd Det 13-001	$200,000	Wet detention	6.9	85%		15%	0.86	6.0	68%	4.1	$49,344
Kane county	KDOT Dauberman Rd Det 13-002	$200,000	Wet detention	5.75	85%		15%	0.86	5.0	68%	3.4	$59,213
Kane county	KDOT Dauberman Rd Det 13-003	$150,000	Wet detention	2.7	85%		15%	0.86	2.3	68%	1.6	$94,577
Kane county	KDOT Dauberman Rd Det 13-004	$225,000	Wet detention	5.2	85%		15%	0.86	4.5	68%	3.1	$73,661
Kane county	KDOT Bliss Rd Det 11-001	$100,000	Wet detention	10.1	85%		15%	0.86	8.7	68%	5.9	$16,855
Kane county	KDOT Bliss Rd Det 11-002	$100,000	Wet detention	9.7	85%		15%	0.86	8.4	68%	5.7	$17,550
Kane county	KDOT Dauberman Rd Det 13-005	$100,000	Wet detention	1.1	85%		15%	0.86	1.0	68%	0.6	$154,762
Kane county	KDOT Dauberman Rd Det 13-006	$100,000	Wet detention	1.15	85%		15%	0.86	1.0	68%	0.7	$148,033
Kane county	KDOT Dauberman Rd Det 13-007	$150,000	Wet detention	2.4	85%		15%	0.86	2.1	68%	1.4	$106,399
Kane county	KDOT Dauberman Rd Det 13-008	$100,000	Wet detention	0.7	85%		15%	0.86	0.6	68%	0.4	$243,198
Kane county	KDOT Dauberman Rd Det 13-009	$100,000	Wet detention	0.8	85%		15%	0.86	0.7	68%	0.5	$212,798
Kane county	KDOT Dauberman Rd Det 13-010	$100,000	Wet detention	0.65	85%		15%	0.86	0.6	68%	0.4	$261,905
Kane county	KDOT Dauberman Rd Det 13-011	$100,000	Wet detention	0.65	85%		15%	0.86	0.6	68%	0.4	$261,905
Kane county	KDOT Dauberman Rd Det 13-012	$175,000	Wet detention	1.3	85%		15%	0.86	1.1	68%	0.8	$229,167
Kane county	KDOT Dauberman Rd Det 13-013	$100,000	Wet detention	1	85%		15%	0.86	0.9	68%	0.6	$170,238

An electronic copy of this inventory is available upon request.

IV. SUMMARY OF ANTICIPATED ACTIVITIES DURING NEXT REPORTING CYCLE

- During the upcoming permit year, Kane County staff will continue work to implement the LEED for Cities and Communities monitoring and reporting platforms, which include components on water quality, ecosystem health, waste management, and resiliency. This will provide Kane County the opportunity to further articulate efforts being made to improve water quality and the connection of these efforts to other initiatives throughout the County.
- As many as 100 stream signs will be installed across Kane County.
- Smart irrigation meters will be installed in high end water users for a pilot project
  Additional middle and high school presentation are anticipated for fall 2025

V. RELIANCE ON ANOTHER GOVERNMENTAL ENTITY

Kane County is not relying on another governmental entity to satisfy NPDES permit obligations.

VI. CONSTRUCTION PROJECT LIST

The following Kane County road construction projects were active during the permit year of March 2024—February 2025:

Section Number	Project Name	Project Cost
24-00000-01-GM	2024 Pavement Preservation Patrol	$ 762,463.20
24-00000-02-GM	2024 HMA and PCC Crack Sealing Patrol	$ 264,663.80
24-00000-03-GM	2024 Paint Pavement Marking Patrol	$ 808,981.93
24-00000-04-GM	2024 Urethane Pavement Marking Patrol	$ 790,082.30
21-00215-29-CH	LMP C2B Roadway Completion	$ 3,105,000.00
22-00548-00-PV	Fabyan Western Intersection Improvement	$ 3,511,108.41
20-00437-01-BR	Harmony Culverts	$ 1,265,626.29
17-00493-00-CH	Orchard /30 Intersection Improvement	$ 3,616,283.14
14-00288-01-PV	Bliss Main Fabyan Roundabout	$ 11,899,395.65
14-00288-01-PV	Dauberman Rd	$ 21,981,770.87
20-00524-01-SP	Montgomery- Virgil Gilman Trail	$ 187,124.37
19-00524-00-SP	Plank Rd HSIP	$ 1,684,391.39
21-00531-00-CH	Countyside Widening	$ 366,529.81
24-00572-00-SM	Burlington/Bolcumn Roundabout Damage Repair	$ 97,484.16
23-00565-00-RS	2024 Resurfacing	$ 6,488,888.00
22-00551-00-DR	Jericho Rd Culverts	$ 279,773.00
23-000569-00-GR	Hughes Culvert	$ 271,183.44

ISWS CONTRACT REPORT 2023-03

Water Quality Trends for Selected Constituents in the Fox River Watershed: Stratton Dam to the Illinois River

Elias Getahun and Atticus Zavelle

December 2023

Prairie Research Institute
UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN

Water Quality Trends for Selected Constituents in the Fox River Watershed: Stratton Dam to the Illinois River

by

Elias Getahun and Atticus Zavelle

Illinois State Water Survey
Prairie Research Institute
University of Illinois Urbana-Champaign

Prepared for
Fox River Study Group

December 2023

Table of Contents

Page

1. Introduction 1
2. Updates on Fox River Environmental Database 5
   2.1 Data Compilation 5
   2.2 Data Wrangling 7
   2.3 FoxDB 8
3. Exploratory Data Analysis 9
   3.1 EDA Results by Water Quality Constituent 10
   3.2 EDA Results by Monitoring Site 27
4. Data Suitability Analysis for Water Quality Trends 32
   4.1 Data Suitability for Annual Trends 32
   4.2 Data Suitability for Seasonal Trends 33
5. Water Quality Trend Analysis 37
   5.1 Trend Analysis using SKT Method 37
   5.2 Trends Analysis using WRTDS Method 60
   5.3 Trends in Streamflow Statistics 67
6. Summary and Conclusions 73
7. Recommendations for Future Work 76

References 77

Appendices 78

Appendix A: Data Factsheets showing EDA Outputs by Water Quality Constituent and Monitoring Site

Appendix B: Annual and Seasonal Trend Maps and Slopes for Water Quality Constituents

Appendix C: Trends in Annual and Seasonal Flow-normalized Concentration and Fluxes for Chloride and Chlorophyll-A

Appendix D: Organizational Chart of Fox River Environmental Database (FoxDB)

List of Tables

Page

Table 1. Water quality standards and criteria 2
Table 2. Monitoring sites and selected water quality parameters 4
Table 3. Water quality parameters by record period and number of monitoring sites 9
Table 4. Mean and median values of the water quality parameters by monitoring site 11
Table 5. Summary statistics of chloride concentration by monitoring site 18
Table 6. Monitoring sites with water quality data for annal trends 33
Table 7. Monitoring sites with water quality data for winter trends 34
Table 8. Monitoring sites with water quality data for spring trends 35
Table 9. Monitoring sites with water quality data for summer trends 35
Table 10. Monitoring sites with water quality data for fall trends 36
Table 11. Number of evaluations for SKT Trend analysis 37
Table 12 Changes in flow-normalized concentrations of chloride and chlorophyll-A 63
Table 13 Changes in flow-normalized fluxes of chloride and chlorophyll-A 65
Table 14. Changes in annual and seasonal flow statistics 69

List of Figures

Page

Figure 1. Fox River watershed – Stratton Dam to Illinois River 3
Figure 2. Monitoring sites with chloride data and boxplots by waterbody 13
Figure 3. Chloride data availability by monitoring site and year 14
Figure 4. Strip chart of chloride concentration by monitoring site 15
Figure 5. Boxplots of chloride concentration by monitoring site 16
Figure 6. Boxplots of chloride concentration by waterbody 16
Figure 7. Boxplots of water temperature by monitoring site 19
Figure 8. Boxplots of water temperature by waterbody 20
Figure 9. Boxplots of pH by monitoring site 21
Figure 10. Boxplots of pH by waterbody 22
Figure 11. Boxplots of specific conductance at 25°C by monitoring site 23
Figure 12. Boxplots of specific conductance at 25°C by waterbody 23
Figure 13. Boxplots of turbidity by monitoring site 24
Figure 14. Boxplots of turbidity by waterbody 25
Figure 15. Boxplots of chlorophyll-A (corrected) by monitoring site 26
Figure 16. Boxplots of chlorophyll-A (corrected) by waterbody 26
Figure 17. Chloride concentration samples for Fox River at Montgomery 27
Figure 18. Monthly boxplots of chloride concentration for Fox River at Montgomery 28
Figure 19. Annual boxplots of chloride concentration for Fox River at Montgomery 28
Figure 20. Empirical CDF of chloride concentration for Fox River at Montgomery 29
Figure 21. Chloride concentration samples at Poplar Creek at Elgin 30
Figure 22. Monthly boxplots of chloride concentration for Poplar Creek at Elgin 30
Figure 23. Annual boxplots of chloride concentration for Poplar Creek at Elgin 31
Figure 24. Empirical CDF of chloride concentration for Poplar Creek at Elgin 31
Figure 25. Annual trends of chloride concentration 38
Figure 26. Winter trends of chloride concentration 41
Figure 27. Spring trends of chloride concentration 42
Figure 28. Summer trends of chloride concentration 43
Figure 29. Fall trends of chloride concentration 44
Figure 30. Annual trends of water temperature 46
Figure 31. Summer trends of water temperature 47
Figure 32. Annual trends of pH 49
Figure 33. Summer trends of pH 50
Figure 34. Annual trends of specific conductance at 25°C 52
Figure 35. Summer trends of specific conductance at 25°C 53
Figure 36. Annual trends of turbidity 55
Figure 37. Summer trends of turbidity 56
Figure 38. Annual trends of chlorophyll-A (corrected) 58
Figure 39. Summer trends of chlorophyll-A (corrected) 59

List of Figures (contd.)

Page

Figure 40. Chloride WRTDS model outputs for Fox River at Montgomery................................ 62

Figure 41. Annual mean and flow-normalized concentrations of chloride and chlorophyll-A for Fox River at Montgomery 64

Figure 42. Seasonal mean and flow-normalized concentration of chloride for Fox River at Montgomery 64

Figure 43. Annual mean and flow-normalized fluxes of chloride and chlorophyll-A for Fox River at Montgomery 66

Figure 44. Seasonal mean and flow-normalized flux of chloride for Fox River at Montgomery 67

Figure 45. Annual and seasonal flow statistics for Poplar Creek at Elgin 70

Figure 46. Annual and seasonal flow statistics for Fox River at Montgomery............................. 71

Figure 47. Annual and seasonal flow statistics for Blackberry Creek at Rt. 47 near Yorkville......72

Acknowledgments

The Fox River Study Group, Inc. (FRSG) funded this study, and the authors acknowledge FRSG's support and guidance. This contract report was edited by Lisa Shepard and reviewed by Drs. Momcilo Markus and Zhenxing Zhang. The Fox River Environmental Database (FoxDB) contains data from various agencies and organizations that enabled the water quality trend analysis for Fox River Watershed – Stratton Dam to Illinois River. The authors also acknowledge these agencies and organizations (listed alphabetically): Deuchler Environmental, Inc., Fox Metro Water Reclamation District, Fox River Study Group, Fox River Water Reclamation District, Friends of the Fox, Huff & Huff, Illinois Environmental Protection Agency, Illinois State Water Survey, Max McGraw Wildlife Foundation, McHenry County Health Department, Metropolitan Water Reclamation District of Greater Chicago, Northeastern Illinois Planning Commission, U.S. Environmental Protection Agency, and U.S. Geological Survey.

1. Introduction

To support sustainable policies and development across the Fox River watershed, the Fox River Study Group (FRSG), which is a diverse coalition of stakeholders, has been involved in collaborative effort towards creating a healthier Fox River for the last two decades. In 2019, the Illinois State Water Survey (ISWS) was commissioned by FRSG to conduct trend analysis of nutrient and nutrient-related water quality constituents collected at monitoring sites throughout the Fox River watershed and the study found that most of the water quality constituents were exhibiting a downward or no trend (Getahun et al., 2019). As part of FRSG's continued effort to assess the water quality conditions in the Fox River, ISWS was tasked with conducting trend of analysis of selected water quality constituents identified by FRSG. A compilation of water quality and related data collected by different agencies has been stored in the Fox River environmental database (FoxDB), which was originally created for FRSG and is still being maintained by Illinois State Water Survey (McConkey, et al. 2004). The FoxDB has been restructured for more efficient use and further been updated with current data.

The objective of this study is to determine the presence or absence of trends for selected water quality constituents in the FoxDB, which has time series data for monitoring sites on the Fox River mainstem and its tributaries. In cases where trends exist, rates of change were also estimated. The scope of this current study does not include establishing the cause for a trend, which requires a watershed scale investigation of hydrologic processes, aquatic biogeochemistry, land use changes, and anthropogenic activities affecting water quality in the watershed.

The water quality constituents identified by the FRSG for estimating trends are chloride, water temperature, pH, specific conductance, turbidity, and chlorophyll-A. For some of the parameters, the water quality standards and criteria are presented in Table 1 for the Illinois portion of the Fox River and its tributaries and have been extracted from Part 302 of Title 35 of the Illinois Administrative Code (https://pcb.illinois.gov/SLR/IPCBandIEPAEnvironmental-RegulationsTitle35) as provided by the Illinois Pollution Control Board. A total of 45 monitoring sites were identified in the Fox River mainstem and tributaries, as illustrated in Figure 1, with each site having at least three or more of the selected water quality constituents. The land use of the Fox River watershed is also shown in the figure and its major land uses are cultivated crops and developed areas, which account for 50 and 30% of the watershed, respectively. Most of the monitoring sites are in the developed areas of the Fox River watershed. A list of the monitoring sites including their location, site ID in the FoxDB, site name, and code are provided in Table 1. Exploratory data analysis (EDA) was performed on 208 water quality parameters across the 45 monitoring sites, characterizing the data. Through the EDA, the water quality data at each site were examined to identify data patterns, gaps, and trends. Summary statistics of the water quality parameters are computed for each site to provide information such as their typical value, spread, and skewness. The EDA results were generated as a data factsheet including a location map of the monitoring sites with specific water quality data and their median values, data availability plot, strip chart, boxplots by monitoring site and waterbody, and summary statistics. In addition, detailed EDA results that include data samples, annual and monthly boxplots, and the empirical cumulative distribution function (CDF) are provided. The EDA results provide useful information that can be used to evaluate the water quality status of Fox River and its tributaries with respect to water quality standards for specific use.

Water quality trend analysis was primarily completed using the Seasonal Kendall Test (SKT) as implemented in the EnvStats R-package for environmental statistics (Millard, 2013) based on the EDA and data suitability analysis conducted for estimating 5-, 10- and 25-year trends. The SKT method, which is a distribution-free test, is suitable for estimating monotonic trends in datasets that exhibit seasonality, autocorrelation, and missing values (Hirsch and Slack, 1984). A total of 1220 5-, 10- and 25-year trend evaluations were completed using the SKT method of which the annual and seasonal trend analysis account for 150 and 1070 evaluations, respectively, showing the disparity in data availability for the period of analysis. Trends in flow-normalized concentration and flux were also estimated for chloride and chlorophyll-A using the Weighted Regression on Time Discharge and Season (WRTDS) method, which is part of the EGRET (i.e., Exploration and Graphics for RivEr Trends) software, an R-package developed by the U.S. Geological Survey (USGS) (Hirsch et al., 2010; Hirsch et al., 2015). Four WRTDS models were developed for chlorophyll-A and chloride at three monitoring sites where continuous flow data, in addition to constituent concentration, are available. The WRTDS models were then used to estimate annual and seasonal trends in flow-normalized concentrations and fluxes for the 5- and 10-year periods. Selected streamflow statistics and their trends were also estimated for the three monitoring sites to provide some insight into the impact of hydrologic variability on constituent concentration and/or fluxes.

Table 1. Water quality standards and criteria

Water quality parameter	Existing water quality standards for Fox River and its tributaries in Illinois	Other water quality standards and criteria
Chloride (total)	Acute stadard for surface water: 500 mg/L; Water supply standard: 250 mg/L	
Water tempeurature	The maximum temperature rise above natural temperatures must not exceed 2.8 °C. Water temperatures at representative locations on the main river must not excceed the follwing maximum limits during 1% of the 12-month period ending with any month: 16°C for Dec-Mar; 32°C for Apr-Nov.	
pH	6.5 to 9.0	
Specific conductance	None	
Turbidity	None	
Chlorophyll-A	None	Ecoegional criterium for Region VI Corn Belt and Northern Great Plains: 2.7 µg/L

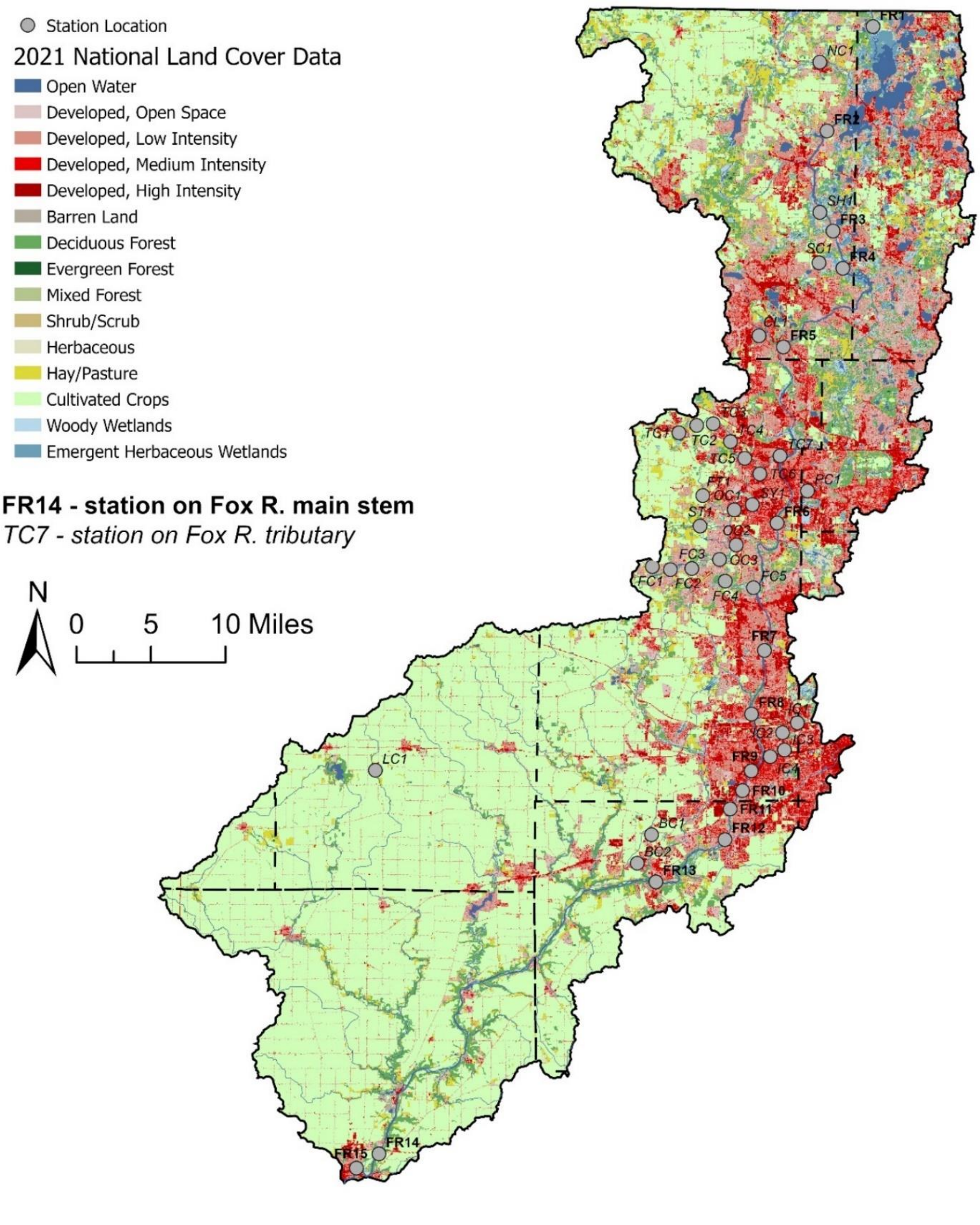


Figure 1. Fox River watershed – Stratton Dam to Illinois River

Table 2. Monitoring sites and selected water quality parameters

Monitoring site name	Name code	ID in FoxDB	Latitude	Longitude
Fox River at Rt. 173 near Channel Lake *	**FR1**	**197**	**42.47**	**-88.17**
Nippersink Creek near Spring Grove	NC1	236	42.44	-88.24
Fox River at Chapel Rd, Johnsburg	**FR2**	**184**	**42.37**	**-88.23**
Sleepy Hollow Creek at Stilling Ln.	SH1	266	42.29	-88.24
Fox River at Burtons Br.	**FR3**	**23**	**42.27**	**-88.22**
Silver Creek at Lk shore Dr. & E. Park Ln.	SC1	688	42.24	-88.24
Fox River at Rawson Rd., E Oakwood Hills	**FR4**	**258**	**42.24**	**-88.21**
Crystal Lk Outlet-Rt 31, Algonquin	CL1	271	42.16	-88.29
Fox River at Algonquin	**FR5**	**24**	**42.16**	**-88.28**
Tyler Creek at Damisch	TC1	5046	42.08	-88.40
Tyler Creek at Highland	TC2	5049	42.08	-88.39
Tyler Creek at McCornack	TC3	5048	42.09	-88.38
Tyler Creek at Timber Trail	TC4	5045	42.07	-88.35
Tyler Creek at Old Randall	TC5	5044	42.05	-88.33
Tyler Creek at Spring Cove	TC6	5042	42.04	-88.31
Tyler Creek at Judson	TC7	5047	42.06	-88.29
Popular Creek at Elgin	PC1	25	42.02	-88.25
Fox River at South Elgin	**FR6**	**26**	**41.99**	**-88.29**
Sandy Creek	SY1	5043	42.01	-88.32
Otter Creek at Bowes Rd.	OC1	5033	42.00	-88.35
Fitchie Creek at Bowes Rd.	FT1	5034	42.00	-88.36
Stoney Creek at Stevens Rd.	ST1	5035	41.99	-88.36
Otter Creek at Burr	OC2	5036	41.96	-88.35
Otter Creek at Silver Glen Rd.	OC3	5037	41.96	-88.35
Ferson Creek at Hidden Springs	FC1	5041	41.94	-88.43
Ferson Creek at Burlington & Corran Rds.	FC2	5040	41.95	-88.40
Ferson Creek at Burr	FC3	5038	41.96	-88.36
Ferson Creek at Randall Rd.	FC4	5039	41.93	-88.33
Ferson Creek near St. Charles	FC5	79	41.92	-88.32
Fox River at Fabyan Pk-Geneva	**FR7**	**40**	**41.87**	**-88.30**
Fox River at Sullivan Br.	**FR8**	**471**	**41.78**	**-88.31**
Indian Creek at Reckinger Rd.	IC1	877	41.78	-88.28
Indian Creek ups Outfall	IC2	875	41.76	-88.29
Indian Creek dns Outfall	IC3	874	41.76	-88.29
Indian Creek u/s Rt. 25	IC4	276	41.76	-88.30
Fox River at North Ave. Br.	**FR9**	**485**	**41.75**	**-88.32**
Fox River at Ashland Ave.	**FR10**	**284**	**41.73**	**-88.33**
Fox River at Montgomery	**FR11**	**27**	**41.72**	**-88.33**
Fox River at Rt. 34, Oswego	**FR12**	**33**	**41.68**	**-88.35**
Fox River at Yorkville	**FR13**	**34**	**41.64**	**-88.44**
Blackberry Creek at Rt. 47 near Yorkville	BC1	28	41.67	-88.44
Blackberry Creek near Yorkville Side Rd.	BC2	287	41.64	-88.45
Little Indian Creek at dns Unversity Rd. Br.	LC1	6	41.74	-88.81
Fox River at Rt. 71	FR14	31	41.35	-88.82
Fox River at Ottawa	**FR15**	**612**	**41.34**	**-88.83**

*Sites are listed in upstream-to-downstream order and are shown in **bold** for Fox River mainstem.

2. Updates on Fox River Environmental Database

The FoxDB has been updated with current data, a process involving data compilation, data wrangling, and restructuring the FoxDB for a more efficient use. All agencies collecting water quality data in the Fox River watershed were contacted by the ISWS database manager during the data compilation stage. Data discovery, structuring, and cleaning were then completed as part of the data wrangling process. A discussion of the data compilation, data wrangling, and updating of the FoxDB is provided in the following sections.

2.1 Data Compilation

Data in the FoxDB have been collected and compiled by different Illinois State Water Survey personnel for over a decade. The earliest data in the database are from 1956 and were acquired from the United States Environmental Protection Agency's (USEPA) Legacy STORET database. The FoxDB data have been obtained from different federal, state, county, and city agencies or other governmental bodies as well as non-profit organizations and private engineering firms. The objectives of environmental and water quality data collection by the different entities vary, and thus they collect different water quality constituents adopting varying sampling regimes, in terms of frequency and length of time, that is consistent with their individual project objectives. The purpose of developing the FoxDB was to compile all these environmental and water quality data in one place using a consistent format, facilitating the practical utility of the data. The FoxDB allows users to query data based on different criteria such as record period, location, water quality parameter, and/or organization.

As part of this study, the FoxDB was updated with data obtained from different organizations; a brief discussion of data provided by these organizations for the current update is provided hereafter.

Fox River Study Group (FRSG)

The FRSG is a diverse coalition of stakeholders that includes local governments, public agencies, and nonprofit groups. The FRSG has been collecting water quality data from monitoring sites on the Fox River mainstem and its tributaries monthly for two decades. Its water sample collection started in April 2002 at 18 monitoring sites, 14 of which have been consistently sampled for the past 10 years. A total of 19 water quality parameters are collected by the FRSG and include water temperature, dissolved oxygen, pH, specific conductance, biological oxygen demand, total suspended solids, fecal coliforms, total kjeldahl nitrogen, ammonia nitrogen, nitrate nitrogen, organic nitrogen, corrected chlorophyll-A, uncorrected chlorophyll-A, estimated biomass, total phosphorus, dissolved phosphorus, chloride, and turbidity. The FRSG's long-term monitoring program provides over two decades of consistent monthly data that target parameters that are important to determine the stream's health, making it one of most useful datasets for estimating water quality trends.

Fox River Water Reclamation District (FRWRD) and Elgin Water Department

Since August 2011, the FRWRD laboratories and the Elgin Water Department have been monitoring water quality on the Fox River tributaries, including Tyler, Otter, and Ferson Creeks. The water quality samples are collected from a total of 17 monitoring sites on the tributaries. The data consists of ten water quality parameters, such as water temperature, pH, dissolved oxygen, biological oxygen demand, chloride, total suspended solids, fecal coliform, total phosphorus, ammonia nitrogen, and total nitrogen. Some of these parameters are relevant for analyzing trends in this study. This monitoring program has been running for over a decade with mostly monthly data collection that closely aligns with the FRSG monitoring program, resulting in effective datasets for determining trends.

Fox Metro Wastewater Reclamation District (FMWRD)

Deuchler Environmental Inc., which is now a division of Fehr Graham, collected monthly stream data for the FMWRD Long-term Control Plan from May 2007 to March 2021. Since August 2021, it began collecting data quarterly. Water quality data are being collected at seven monitoring sites located on the Fox River mainstem and Indian Creek. Data received from the FWMRD include water temperature, dissolved oxygen, pH, specific conductivity, carbonaceous biological oxygen demand, total suspended solids, fecal coliforms, total kjeldahl nitrogen, ammonia nitrogen, nitrate nitrogen, nitrite nitrogen, organic nitrogen, total phosphorus, dissolved phosphorus, chloride, fluoride, and chlorophyll-A. The water quality parameters and their length of records make this dataset critical for detecting trends.

Illinois Environmental Protection Agency (IEPA)

IEPA runs four different monitoring programs including the Ambient Water Quality Monitoring Network (AWQMN), the Harmful Algal Blooms (HABs) monitoring project, IEPA Special Study, and IEPA/IDNR (Illinois Department of Natural Resources) Intensive Monitoring. The IEPA data, which holds a wealth of information from projects with varying scopes, was acquired through a Freedom of Information Act (FOIA) request from Geosyntec and includes data from January 2016 to February 2021. The AWQMN dataset has 436 data points for 81 water quality parameters from 10 monitoring sites. The HABs monitoring project collected 70 microcystin samples at five monitoring sites between 2016 and 2020 and measured the water temperature of the samples. As part of the IEPA Special Study, seven sample parameters including different forms of nitrogen, suspended solids, phosphorus data, and temperature were collected from 32 sites at 69 unique times during summer 2017. The IEPA/IDNR Intensive Monitoring program data collected 72 different parameters at six sites in early August 2017. Apart from the AWQMN program, most of these projects are short-lived and may not be suitable for estimating trends but could provide snapshots of the stream health at a particular site and time. It also gives insights into whether a more robust sampling regime is needed.

United States Geological Survey (USGS)

Water quality data were obtained from the USGS's National Water Information System (NWIS) database. These data stretched across 21 sites and 1154 discrete times between July 2002 and December 2021. Included in this dataset are 612 different water quality parameters, resulting in a total of 11,662 data points. Water quality data in the NWIS database come from different projects with varying objectives and record lengths that can be aggregated to create long-term datasets.

Village of Carpentersville Effluent Flow and Water Quality Data

The wastewater division of the Village of Carpentersville provided effluent data from its wastewater treatment plant spanning January 2014 to December 2020. These data include daily effluent discharge for the entire sampling period as well as intermittent water quality data for 32 constituents. It is important to note that the characteristics of water quality samples from effluent discharge are significantly different from those upstream of a wastewater treatment facility.

Carpentersville Dam Pre-removal Data

In preparation for the Carpentersville Dam removal, the FRSG contracted Deuchler to conduct a study upstream of the dam prior to its planned removal in 2021. Samples were taken at discrete times from July to October 2020. The water quality parameters that were collected include biological oxygen demand, total suspended solids, total volatile suspended solids, total kjeldahl nitrogen, ammonia nitrogen, nitrate nitrogen, nitrite nitrogen, chlorophyll-A, total phosphorus, dissolved phosphorus, chloride, and turbidity. This dataset provides useful information to investigate the river's water quality before and after the dam removal.

2.2 Data Wrangling

Once ISWS obtained water quality and related data from the different agencies previously mentioned, the data wrangling started with a preliminary review of all data. For example, different agencies provide their data in different formats, and varying data review processes were applied to the different datasets. One of the most important aspects of the review process was determining whether a dataset has a distinct geographic location, time stamp, parameter, and unit of measurement. If there is any doubt regarding this critical information, the ISWS data manager contacted the agency providing the dataset for further clarification. The datasets were reviewed for any transcription errors and corrected before proceeding with the data formatting process, which entails dividing information contained in the dataset into two tables. The first table includes spatial location and temporal information of the data, which is given a unique identifier. The second table has a record of parameter values that are related to the first table with a common unique identifier. For example, if a Sonde measurement is taken at a specific bridge on the Fox River on October 31, 2018, at 8:15 A.M., the first table shows the date and time of the dataset that includes pH, dissolved oxygen, and water temperature with a unique identifier of say “FD261159”, and the second table contains values of each parameter with the same unique identifier. This basic architecture of the FoxDB allowed creating a relational database that can be easily queried and analyzed.

After the data formatting process was complete, the data went under a more stringent review process to identify outliers, typos, and erroneous transcription or date of record. Errors found at this stage could either be corrected or flagged by tracking them back to the original data or by contacting the data provider for further clarification. Data submitted to ISWS are expected to have gone through some sort of data review process by the collecting agencies. Although some bad data may still be qualified by the ISWS data manager, the veracity of the data in the FoxDB is primarily as good as the different agencies’ data collection and review processes.

2.3 FoxDB

The FoxDB was developed with the intention of providing all available water quality data collected on the Illinois portion of the Fox River and its tributaries in a more organized manner. The water quality data in the FoxDB include the following important information that is useful in making informed decisions on water quality control measures in the Fox River watershed below Stratton Dam. This includes but is not limited to the type of water quality constituent, its sampling method, location, time and date of sampling, and its units. Other pertinent information was also included as separate tables of the FoxDB. Scripts of Structured Query Language (SQL) are also provided with FoxDB to facilitate generation of tables based on user-specific queries such as data for a given period, data from a specific organization, etc. The organizational structure of the FoxDB with detailed description of tables, fields, and relations are provided in Appendix D.

3. Exploratory Data Analysis

Exploratory data analysis (EDA) was conducted for selected water quality parameters extracted from the FoxDB. EDA is the process of examining data through inductive procedures (e.g., graphics and descriptive statistics) to understand the underlying data structure including but not limited to temporal patterns such as seasonality and trends. The exploration process also provides insights into selecting appropriate methods for determining the presence or absence of trends. The EDA was completed for selected water quality constituents as identified by the Fox River Study Group (FRSG) including chloride, water temperature, pH, specific conductance, turbidity, and chlorophyll-A (corrected). The maximum period of analysis selected for this study was 25 years (i.e., 1997–2021), which aligns with the period of analysis for the previous trend analyses (1997–2016).

Based on data availability between 1997 and 2021, a total of six water quality parameters at 45 monitoring stations were considered. In this period of analysis, record length and frequency of the water quality data vary by parameter and monitoring site. All parameters are not available at all sites. For example, chloride, specific conductivity, water temperature, and pH data are available in 40 of the 45 monitoring sites at varying frequency and for different record periods. In contrast, only 14 monitoring sites have chlorophyll-A and turbidity data. For water quality parameters of interest, the longest record periods and number of monitoring sites that have data within the period of analysis are presented in Table 3. The record length varies by water quality constituent and site.

Table 3. Water quality parameters by record period and number of monitoring Sites

Parameter code	Parameter name	Longest period Of record	No. of sites
940	Chloride (mg/L)	01/1997 - 11/2021	44
10	Water temperature (°C)	01/1997 - 12/2021	45
406	pH (su)	01/1997 - 12/2021	45
95	Specific conductance (µmhos/cm)	01/1997 - 12/2021	28
82079	Turbidity (NTU)	08/2001 - 11/2021	21
32209	Chlorophyll-A, corr. (µg/L)	08/2001 - 11/2021	25

Graphics and tables were used to present EDA results as data factsheets aggregated by water quality parameter and for each monitoring site. The data factsheets provide insight into a given water quality parameter throughout the Fox River watershed. The EDA for each site further delves into the water quality data pattern and behavior at each of the monitoring sites through a presentation of time-series data samples and monthly and annual boxplots illustrating the seasonal and year-to-year variability of the water quality constituent, respectively. Quantile plots of the parameter were also generated to provide percentiles of the sample distribution, giving insight into the spread and skewness of the water quality constituent.

3.1 EDA Results by Water Quality Constituent

Data factsheets, which are the EDA results organized by water quality parameter, were generated for all six parameters using the datasets obtained from all 45 monitoring sites in the Fox River watershed. The water quality data factsheet generally includes a location map of the monitoring sites in the watershed for a particular parameter, including their respective median values, data availability by monitoring site, strip chart, and box plot of parameter values by site, boxplot by waterbodies such as river, creeks, and lakes, and descriptive statistics by site. In Table 4, the mean and median values of the water quality parameters at each monitoring site are presented for the period of analysis (1997–2021), providing the typical values of the datasets at each site. The monitoring sites are presented in upstream-to-downstream order for both the Fox River mainstem and its tributaries to detect longitudinal changes. Except for pH and water temperature, the mean values of the water quality parameters generally appear to be higher than their respective medians, which indicates that the datasets have a positively skewed distribution. The mean chloride concentration varies from 68.2 mg/L for Nippersink Creek (NC1) to 299.5 mg/L for Indian Creek (IC3). The Fox mainstem shows a rising mean chloride concentration along its flow from upstream to downstream. The mean water temperature for the mainstem is 13.2^{o}C–22.3^{o}C, whereas, for the tributaries, it is 9.7^{o}C–15.3^{o}C, indicating a warmer river mainstem. The mean and median pH values have little or no difference, indicating a symmetric distribution of the datasets. The mean specific conductance at 25^{o}C is between 728 and 936 micro-Siemens per centimeter (µS/cm) for most of the monitoring sites in the Fox River mainstem and its tributaries. All four monitoring sites on Indian Creek, however, have a mean specific conductance greater than 1000 µS/cm. The mean turbidity for all monitoring sites on the Fox River mainstem is 17.3–44.6 Nephelometric Turbidity Unit (NTU) whereas, for the tributaries, it ranges between 2.5 and 20.1 NTU, indicating more suspended sediment in the river mainstem. The Fox River mainstem appears to have a generally higher chlorophyll-A concentration than its tributaries. The mean concentration is 33.6–93.4 µg/L for the Fox River mainstem, whereas it is 5.2–29.1 µg/L for the tributaries.

Table 4. Mean and median values of the water quality parameters by monitoring site

Monitoring site name code	Mean / Median values					
	Chloride (mg/L)	Water temp. (oC)	pH (su)	Specific Cond. (µS/cm)	Turbidity (NTU)	Chlorophyll-A (µg/L)
FR1	103.3 / 95.2	13.6 / 14.3	8.1 / 8.1	827 / 826.5	23.8 / 22.9	51 / 32.3
NC1	68.2 / 67.6	12.7 / 12.7	8.1 / 8.1	728.8 / 729	20.1 / 16.2	29.1 / 27.2
FR2	104.1 / 103	14.4 / 14.5	8.5 / 8.5	813.2 / 810	17.3 / 16	71.8 / 58.7
SH1	158 / 157	11.7 / 11	8.1 / 8.1	936.3 / 903	17.2 / 14	21.7 / 13.4
FR3	108.6 / 93.8	14.3 / 15.8	8.3 / 8.3	764.7 / 773	23.8 / 21.3	79.5 / 71.4
SC1	215.5 / 222	12.7 / 13	8.2 / 8.2	895.8 / 943	2.5 / 1.7	5.2 / 4
FR4	110.9 / 107	15.1 / 15.5	8.2 / 8.3	753.5 / 773.5	17.6 / 15	75.9 / 60.8
CL1	292.4 / 277.5	13.8 / 14.1	8.2 / 8.2	1245.9 / 1220	10 / 5.6	24.3 / 16
FR5	124.5 / 110	13.9 / 14.7	8.2 / 8.3	836.1 / 791.5	20.2 / 18	78.8 / 64.9
TC1	142.8 / 138	10.1 / 9.4	7.7 / 7.6	-	-	-
TC2	94.4 / 88.8	9.9 / 9	7.8 / 7.8	-	-	-
TC3	118.6 / 110.3	9.8 / 9.4	7.8 / 7.9	-	-	-
TC4	158.9 / 135	10.3 / 10.6	7.8 / 7.8	-	-	-
TC5	174.3 / 156.1	10.1 / 10	8.2 / 8.2	-	-	-
TC6	174.7 / 166	11.3 / 10.8	8.1 / 8.1	-	-	-
TC7	187.3 / 177.4	10.5 / 10.6	8.3 / 8.3	-	-	-
PC1	245.6 / 208	12.7 / 12.5	7.9 / 7.9	1203.2 / 1147	19.8 / 7.7	-
FR6	136.7 / 126	15.1 / 17.6	8.3 / 8.3	931.4 / 879.8	18.7 / 16	74 / 56.1
SY1	165.5 / 162	11.2 / 10.6	8 / 8	-	-	-
OC1	252.7 / 262	11.4 / 12	8 / 8	-	-	-
FT1	135.1 / 135.1	10.2 / 10.6	8.2 / 8.2	-	-	-
ST1	96.3 / 97.5	10.8 / 10.8	8.2 / 8.2	-	-	-
OC2	153.8 / 130.1	10.7 / 11.9	8.1 / 8.1	-	-	-
OC3	181.7 / 171.5	10.6 / 10.6	8.1 / 8.1	-	-	-
FC1	177.3 / 169	9.8 / 10	8.1 / 8.1	-	-	-
FC2	145.1 / 149.1	12.5 / 13	8.3 / 8.3	-	-	-
FC3	147.9 / 145.9	10.8 / 10.5	8.1 / 8.1	-	-	-
FC4	158.6 / 157.6	11 / 11	8.2 / 8.2	-	-	-
FC5	142.4 / 140	12.4 / 12.5	8 / 8.1	1003.8 / 1016	12.7 / 7.1	12.8 / 8.9
FR7	138.8 / 134	14.2 / 14.7	8.2 / 8.3	907.9 / 901	18.9 / 16.7	89.6 / 69.4
FR8	135.5 / 131	21.6 / 22.9	8.5 / 8.5	821.7 / 844	-	35.8 / 31.1
IC1	206.7 / 169.5	12.7 / 13.6	8 / 8	1016.3 / 901.5	-	6.5 / 5
IC2	202 / 163	12.7 / 13.5	8 / 8.1	1043.2 / 899	-	6.7 / 4.5
IC3	299.5 / 259	13.5 / 13.8	8 / 8.1	1303.7 / 1200	-	6.9 / 5.2
IC4	257.3 / 230	13.8 / 15.3	7.8 / 7.9	1062.6 / 990	13.3 / 7.3	13.5 / 9.3
FR9	139.8 / 136	15.9 / 17.5	8.1 / 8.3	928.5 / 880	-	33.6 / 28.3
FR10	140.6 / 135	22.3 / 23.6	8.4 / 8.4	869.7 / 856.8	-	37.3 / 31.9
FR11	147.7 / 136	20.4 / 21.9	8.4 / 8.4	837.3 / 822	19.1 / 17	71.4 / 47.6
FR12	143.7 / 139	21.9 / 23	8.6 / 8.6	843.7 / 830	18.3 / 15	40 / 33.3
FR13	150.9 / 146	12.3 / 11.6	8.3 / 8.3	839.3 / 860	18.7 / 16	84 / 62.8
BC1	92 / 91	12.9 / 14.3	7.8 / 7.9	838.5 / 841	18.9 / 15	-
BC2	105.6 / 103	12.6 / 12.6	8 / 7.9	752.1 / 749	15.6 / 11	13.1 / 8
LC1	188.9 / 185	11.3 / 11	8.4 / 8.4	1211.1 / 1220	12.4 / 5.1	12.9 / 7.8
FR14	135.7 / 104	14.4 / 15.8	8.5 / 8.5	845 / 817	44.6 / 36.5	93.4 / 73.6
FR15	-	13.2 / 12.8	8.5 / 8.4	857.4 / 861.5	-	-

The EDA results by water quality parameter is primarily discussed using a data factsheet prepared for chloride concentration. For the remaining water quality constituents, boxplots by monitoring site and waterbody were presented to discuss the EDA results. Data factsheets for all six water quality parameters are provided in Appendix A.

Chloride

The data factsheet for chloride concentration is illustrated in Figures 2–5. Figure 5 shows a location map of the monitoring sites, along with their median chloride concentration values and a boxplot of the chloride concentration distribution aggregated by the Fox River mainstem and its tributaries. The boxplot gives a quick overview of the chloride concentration levels in the two major parts of the watershed (i.e., mainstem and tributaries). It reveals that the median chloride concentration in the tributaries is generally higher than in the Fox River mainstem, and it also surpasses the 75th percentile of the mainstem concentration. This suggests that the tributaries are more affected by urbanization, while the mainstem may benefit from dilution due to larger flows.

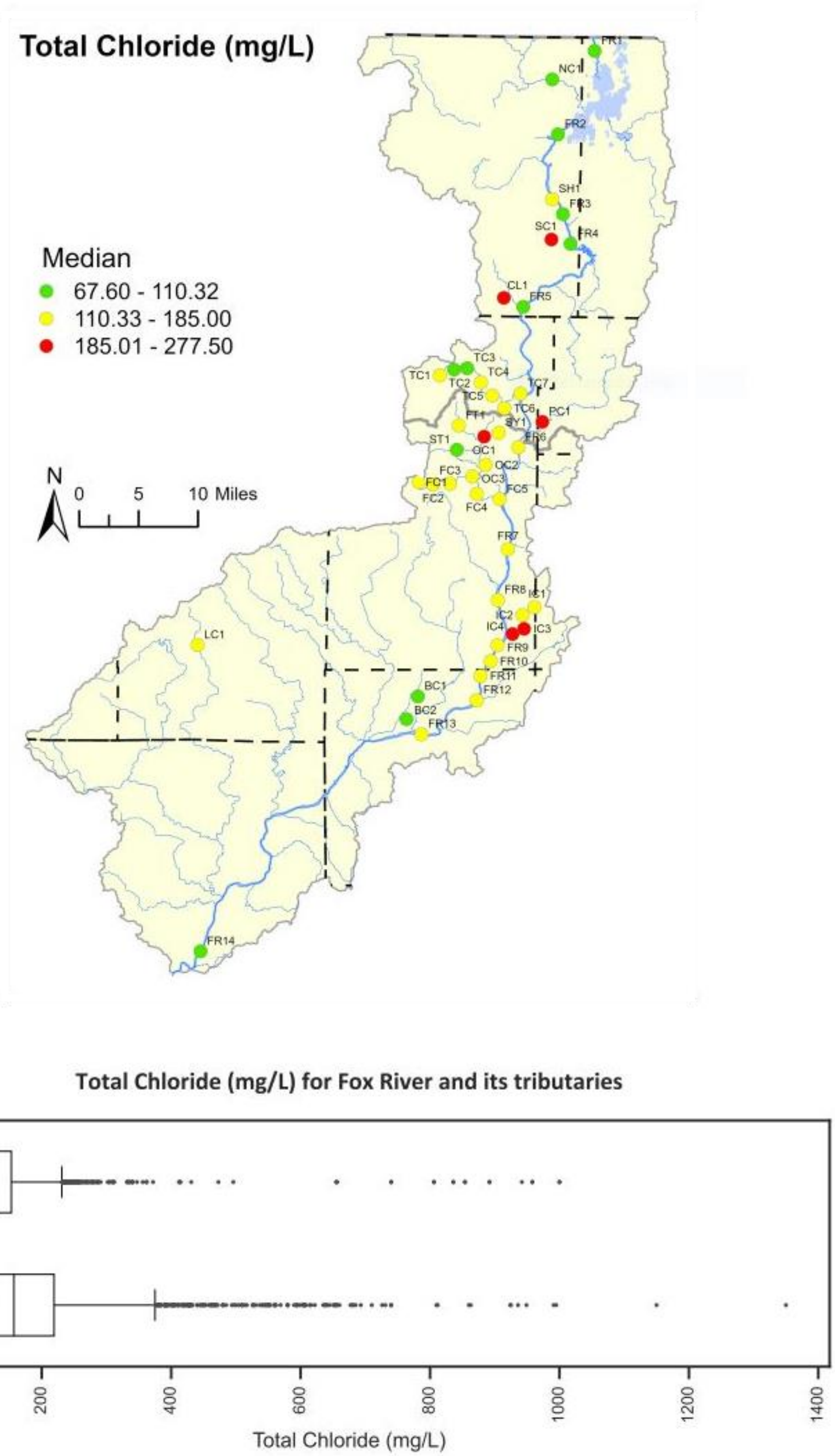


Figure 2. Monitoring sites with chloride data and boxplots by waterbody

In Figures 3 and 4, data availability and a strip chart of chloride concentration by monitoring site are plotted. Both plots show the 44 monitoring sites on the Fox River and its tributaries with chloride concentration data. The period of record for the chloride data spans from 1997 to 2021, covering the entire period of analysis for several monitoring sites, but most sites have data only after 2010. In the data factsheets, the monitoring sites are plotted using their code names as provided in Table 2 and in an upstream-to-downstream order for both the Fox River mainstem and its tributaries to visualize potential longitudinal changes in the water quality constituent. The strip chart of chloride concentration levels illustrates a one-dimensional scatter plot, indicating the density and distribution of concentration data samples at each monitoring site in the watershed. Outliers are removed from the strip chart to better illustrate chloride concentration samples in all monitoring sites. Most of the chloride samples within the period of analysis were collected by the FRSG (30.6%), FRWRD (22.6%), Deuchler (18.4%), and IEPA (17.1%). With a few exceptions, the chloride concentration level in the Fox River watershed is generally below 500 mg/L, which is the acute standard for surface water. Chloride concentration exceeded 1000 mg/L at IC3 and IC4 sites of Indian Creek, which can be considered as outliers.

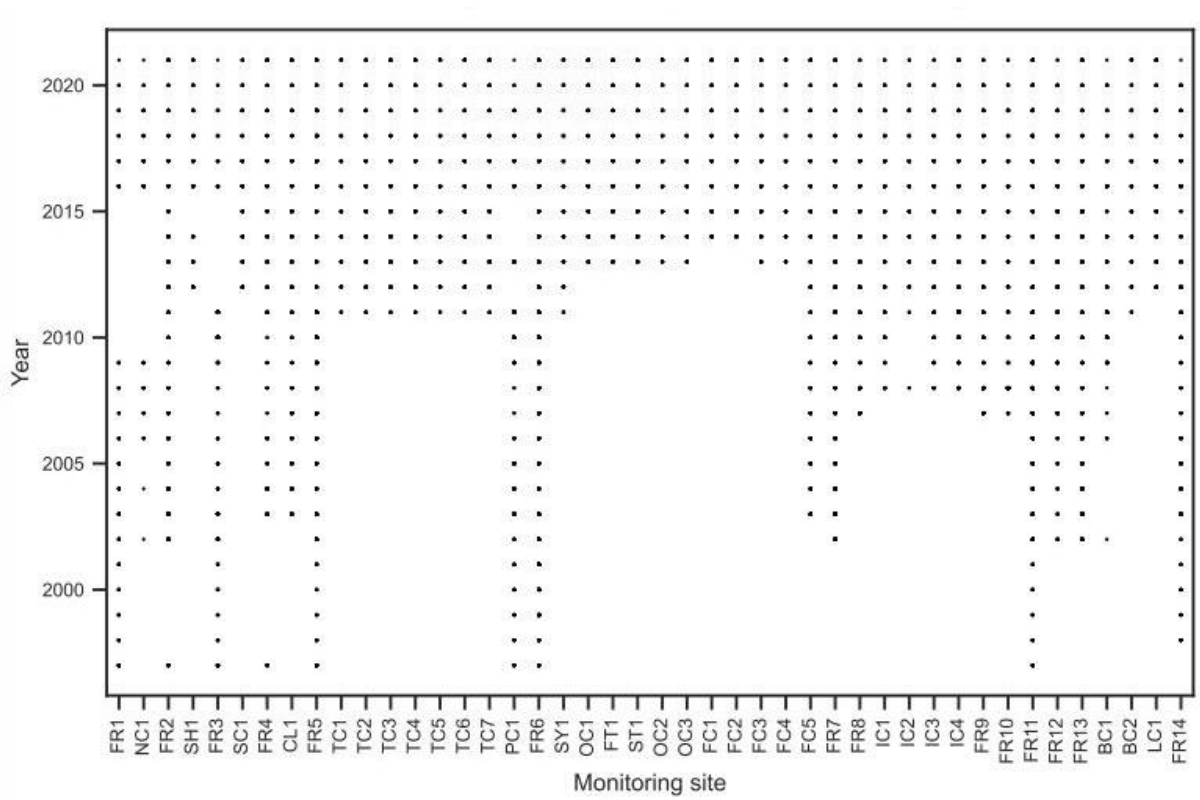


Figure 3. Chloride data availability by monitoring site and year

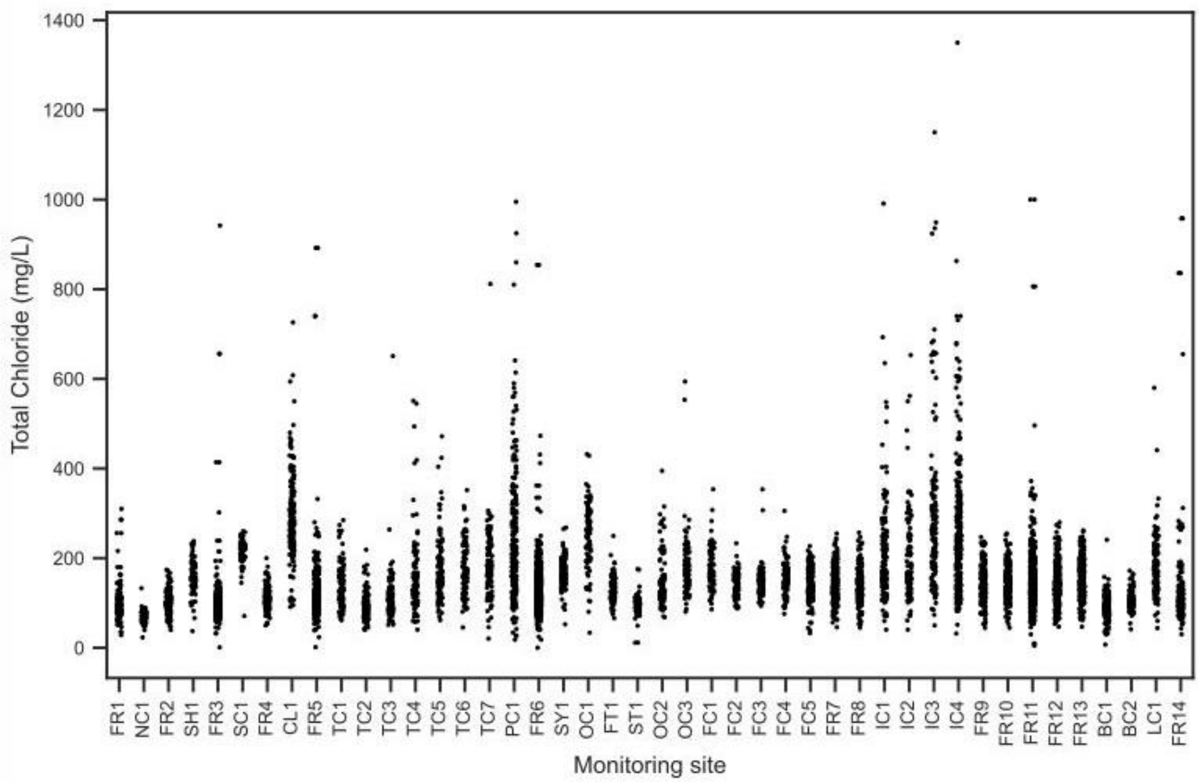


Figure 4. Strip chart of chloride concentration by monitoring site

Boxplots of chloride concentration levels by monitoring site and waterbody are illustrated in Figures 5 and 6 as part of a data factsheet for chloride. The site-specific boxplot provides information about chloride concentration levels in an upstream-to-downstream order, allowing identification of monitoring sites along the waterbody that have water quality issues. For example, CL1 (Crystal Lk Outlet-Rt 31, Algonquin) is the monitoring site with the highest median chloride concentration (i.e., 277.5 mg/L). In contrast, the lowest median concentration of 67.6 mg/L was obtained for Nippersink Creek near Spring Grove (NC1). The median chloride concentrations for the Fox River mainstem generally appear to show a longitudinal increase in an upstream-to-downstream direction from Fox River at Rt. 173 near Channel Lake (FR1) to the Fox River at Rt. 71 (FR11). Except for PC1, IC3, and IC4, the upper whisker values of the boxplot for all monitoring sites with chloride concentration data in the watershed are below the acute standard for surface water. Aggregating the chloride data for all monitoring sites by waterbody, concentration levels in the Fox River mainstem and its tributaries are illustrated in Figure 6, indicating that Crystal Creek and Nippersink Creek have the highest and lowest median concentration levels, respectively. Fox River has a median concentration level of 124 mg/L with some data often exceeding the acute standard for surface water of tributaries having similar median concentration levels. The distribution and spread of chloride concentration data illustrated by the boxplots for monitoring sites and waterbodies can help identify the location of water quality impairments, providing useful information to implement pollution control measures in the watershed.

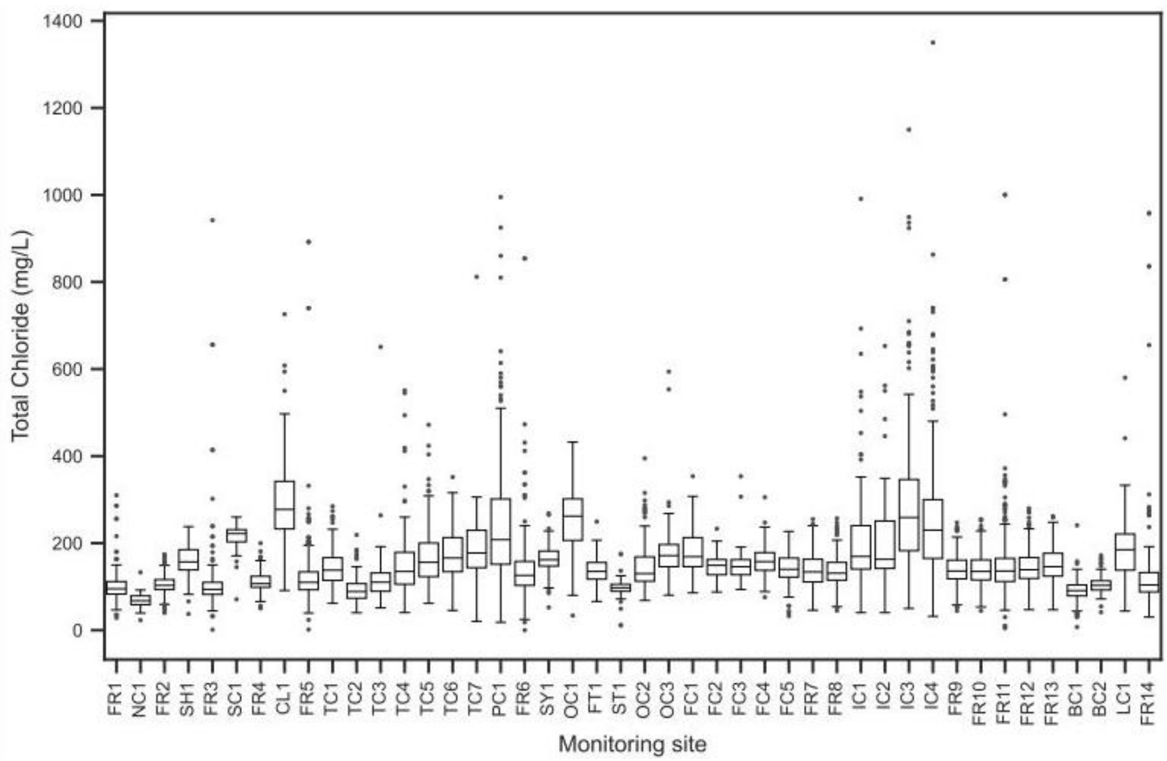


Figure 5**.** Boxplots of chloride concentration by monitoring site

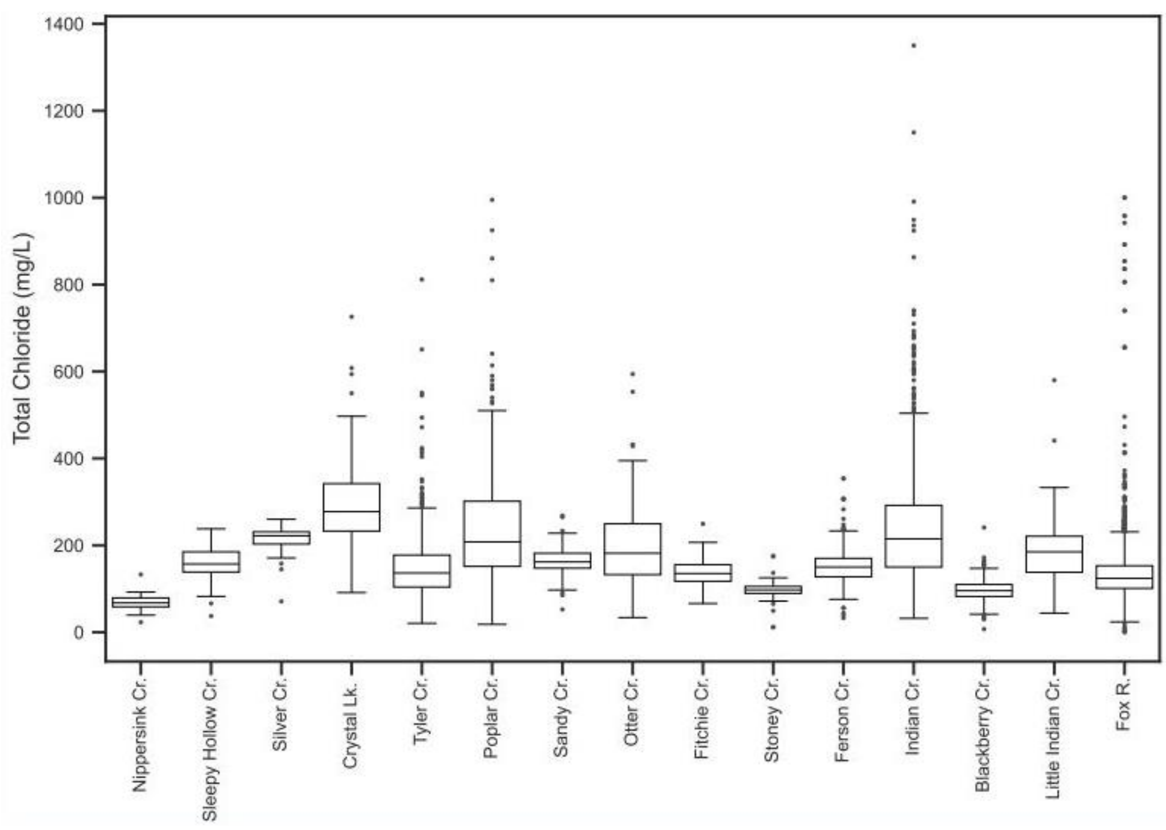


Figure 6. Boxplots of chloride concentration by waterbody

Summary statistics of the water quality constituent at each monitoring site are included as the last part of the data factsheet. Table 5, for example, shows the summary statistics of chloride concentrations for each site in the watershed. It includes station name codes, start and end dates of data samples within the period of analysis, data count, mean, median, maximum, minimum, standard deviation, first quartile (Q1), third quartile (Q3), skewness, and kurtosis. The data period and count provide information about the availability and frequency of data samples at each monitoring site. Polar Creek at Elgin (PC1) and most of the monitoring sites on the Fox River mainstem have chloride concentration data spanning from 1997 to 2021 with a varying number of samples. During this period, the largest number of data samples (355) were collected for the Fox River at Montgomery (FR11). In contrast, monitoring sites on Ferson Creek have the shortest period of records (2014 to 2021). Only 32 chloride samples were collected at Nippersink Creek near Spring Grove (NC1) between 2002 and 2021, making it the site with the lowest data count in the watershed. More samples were collected at other sites for a far shorter period. The summary statistics provide measures of central tendency (mean, median), variability (standard deviation, range, and interquartile range), symmetry (skewness), and peakedness (kurtosis) of the data at each of the monitoring sites. The median chloride concentration levels at all monitoring sites but SC1 and FC2 are less than their respective mean concentrations, which may be due to a seasonal variation of chloride concentration levels. This typically indicates that the distribution of the data is skewed to the right as it is evident in the positive value of the skewness in almost all sites. The median is generally a better measure of the central tendency in a skewed distribution, providing the “typical value.”

Table 5. Summary statistics of chloride concentration by monitoring site

Station_PIDlabel	Start Date	End Date	N	Mean	Median	Max	Min	StdDev	Kurtosis	1st Quart	3rd Quart	Skewness
FR1	1997-01-06	2021-02-02	142	103.31	95.16	310.00	28.50	44.23	7.73	83.00	111.75	2.40
NC1	2002-07-09	2021-02-02	65	68.19	67.60	133.00	23.20	15.60	4.03	58.50	79.00	0.76
FR2	1997-06-11	2021-11-16	200	104.11	103.00	174.00	39.90	22.48	0.98	93.35	116.25	0.15
SH1	2012-01-17	2021-11-16	79	158.01	157.00	238.00	37.30	38.06	0.73	138.50	185.00	-0.35
FR3	1997-01-07	2021-02-02	251	108.63	93.80	942.00	1.13	83.90	53.35	82.30	110.00	6.65
SC1	2012-02-21	2021-08-17	89	215.52	222.00	260.00	71.00	26.61	9.14	203.00	231.00	-2.12
FR4	1997-06-11	2021-11-16	140	110.94	107.00	200.00	50.10	23.91	1.51	98.70	124.00	0.52
CL1	2003-06-24	2021-11-16	164	292.44	277.50	726.00	91.30	98.23	2.50	232.75	342.00	0.97
FR5	1997-01-07	2021-11-16	421	124.49	110.00	892.00	1.51	78.84	58.70	93.00	134.00	6.80
TC1	2011-08-29	2021-11-15	107	142.75	137.96	284.91	61.78	46.54	0.87	114.46	166.67	0.78
TC2	2011-08-29	2021-11-15	103	94.39	88.77	218.93	40.09	31.67	2.41	73.48	106.97	1.28
TC3	2011-08-29	2021-11-15	106	118.58	110.32	650.80	51.25	61.96	52.29	89.44	131.53	6.25
TC4	2011-08-29	2021-11-15	110	158.93	134.97	550.83	40.49	89.46	7.52	105.67	178.99	2.48
TC5	2011-08-29	2021-11-15	109	174.25	156.05	471.85	61.68	73.39	3.26	123.06	200.34	1.58
TC6	2011-08-29	2021-11-15	107	174.70	165.95	351.84	45.49	57.37	0.33	134.46	212.83	0.63
TC7	2011-08-29	2021-11-15	111	187.31	177.44	811.75	20.55	84.26	26.58	143.61	229.47	3.65
PC1	1997-01-07	2021-01-11	251	245.58	208.00	995.00	18.20	146.95	5.41	151.59	301.50	1.88
FR6	1997-01-07	2021-11-16	577	136.66	126.00	854.00	0.17	66.03	49.69	103.00	158.00	5.28
SY1	2011-08-29	2021-11-15	107	165.45	161.95	268.32	52.43	32.65	2.07	147.45	181.79	0.10
OC1	2013-05-28	2021-11-15	92	252.68	262.02	432.07	33.76	71.98	0.55	206.37	301.75	-0.41
FT1	2013-05-28	2021-11-15	91	135.14	135.09	249.52	66.18	29.44	1.76	117.31	155.60	0.52
ST1	2013-05-28	2021-11-15	89	96.32	97.47	175.57	11.37	22.30	6.38	89.47	105.48	-0.32
OC2	2013-05-28	2021-11-15	91	153.76	130.06	394.88	68.39	62.73	1.92	112.62	168.45	1.44
OC3	2013-05-28	2021-11-15	92	181.66	171.46	594.12	80.56	72.77	17.39	145.99	196.88	3.51
FC1	2014-05-19	2021-11-15	83	177.29	168.95	353.79	85.94	47.45	1.58	146.10	212.73	0.88
FC2	2014-05-19	2021-11-15	83	145.12	149.05	233.13	87.77	26.60	0.54	127.36	162.45	0.18
FC3	2013-05-28	2021-11-15	92	147.89	145.85	353.63	93.67	34.85	16.67	127.46	162.15	3.21
FC4	2013-05-28	2021-11-15	93	158.55	157.55	305.51	75.78	37.32	1.91	137.56	178.24	0.58
FC5	2003-06-24	2021-11-16	186	142.39	140.00	227.00	32.70	34.41	0.51	122.00	165.75	-0.29
FR7	2002-04-30	2021-11-16	292	138.76	134.00	255.00	46.00	37.14	0.07	111.00	163.00	0.45
FR8	2007-08-27	2021-08-17	218	135.46	131.00	257.00	45.00	36.42	1.02	115.00	155.75	0.54
IC1	2008-05-14	2021-08-17	160	206.70	169.50	991.00	40.40	119.55	13.48	140.50	240.25	2.96
IC2	2008-05-14	2021-03-16	113	201.98	163.00	653.00	40.40	103.09	4.38	142.00	251.00	1.77
IC3	2008-05-14	2021-08-17	140	299.48	259.00	1150.00	50.00	184.33	4.93	182.75	346.25	2.00
IC4	2008-04-29	2021-11-16	301	257.29	230.00	1350.00	32.00	149.93	10.57	165.00	300.00	2.42
FR9	2007-08-27	2021-08-17	219	139.77	136.00	247.00	44.60	36.77	0.41	118.00	161.00	0.34
FR10	2007-08-27	2021-08-17	203	140.59	135.00	255.00	44.80	36.86	0.53	115.50	161.50	0.49
FR11	1997-01-24	2021-11-16	670	147.67	136.00	1000.00	4.81	77.55	58.17	112.00	165.00	6.18
FR12	2002-02-01	2021-03-16	339	143.71	139.00	280.00	47.10	40.32	0.58	119.00	167.00	0.56
FR13	2002-04-30	2021-11-16	258	150.86	146.00	262.00	47.00	39.87	0.08	124.25	176.75	0.29
BC1	2002-07-17	2021-01-25	206	91.95	91.00	241.00	7.26	24.94	6.25	79.00	104.00	0.83
BC2	2011-07-19	2021-11-16	111	105.62	103.00	172.00	41.50	21.29	1.45	92.50	113.50	0.59
LC1	2012-01-17	2021-11-16	105	188.94	185.00	580.00	44.00	73.61	7.47	138.00	221.00	1.75
FR14	1998-02-24	2021-01-27	182	135.72	104.00	958.00	30.20	130.45	25.99	88.00	132.50	4.90

Water Temperature

Water temperature in rivers and streams is a function of several factors including but is not limited to water sources, flow magnitude, air temperature, land use in the drainage area, vegetation along the riverbank, and industrial discharges. In the Fox River watershed, water temperature is one of the few water quality parameters that were monitored in all 45 monitoring sites located on the mainstem and tributaries that were considered in this study. The periods of water temperature records by monitoring site span from the 2014–2021 period for Ferson Creek at Hidden Springs (FC1) with less than 100 records to the 1997–2021 period for Fox River at South Elgin (FR6) with more than 75,000 data points, showing a varying frequency of sampling. Fox River at Sullivan Br. (FR8) is the site with the largest amount of data, with a record period of 2007–2021. As shown in Figure 7, the median values of water temperatures vary from 9.0°C at Tyler Creek at Highland (TC2) to 23.6°C at Fox River at Ashland Ave. (FR10), and all monitoring sites in the Fox River mainstem have a median water temperature greater than 11.0°C. Figure 8 illustrates water temperatures of the waterbodies in the Fox River watershed, aggregating the data from all monitoring sites for each waterbody segment. The median water temperature in the Fox River mainstem is 22.9°C, whereas in the tributaries it ranges from 10.6°C for Fitchie Creek to 14.2°C for Indian Creek, indicating a warmer mainstem river than its tributaries. According to USEPA's water quality standards, water temperature shall not exceed 16°C and 32°C in the months of December to March and April to November, respectively.

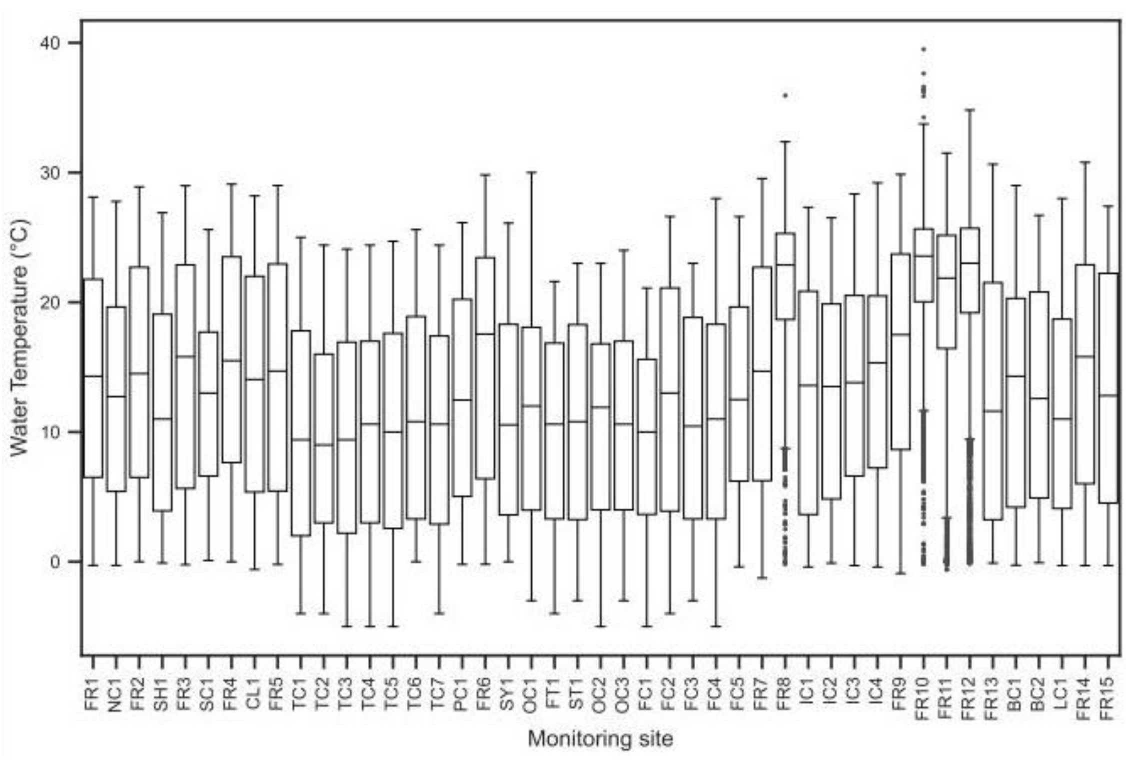


Figure 7. Boxplots of water temperature by monitoring site

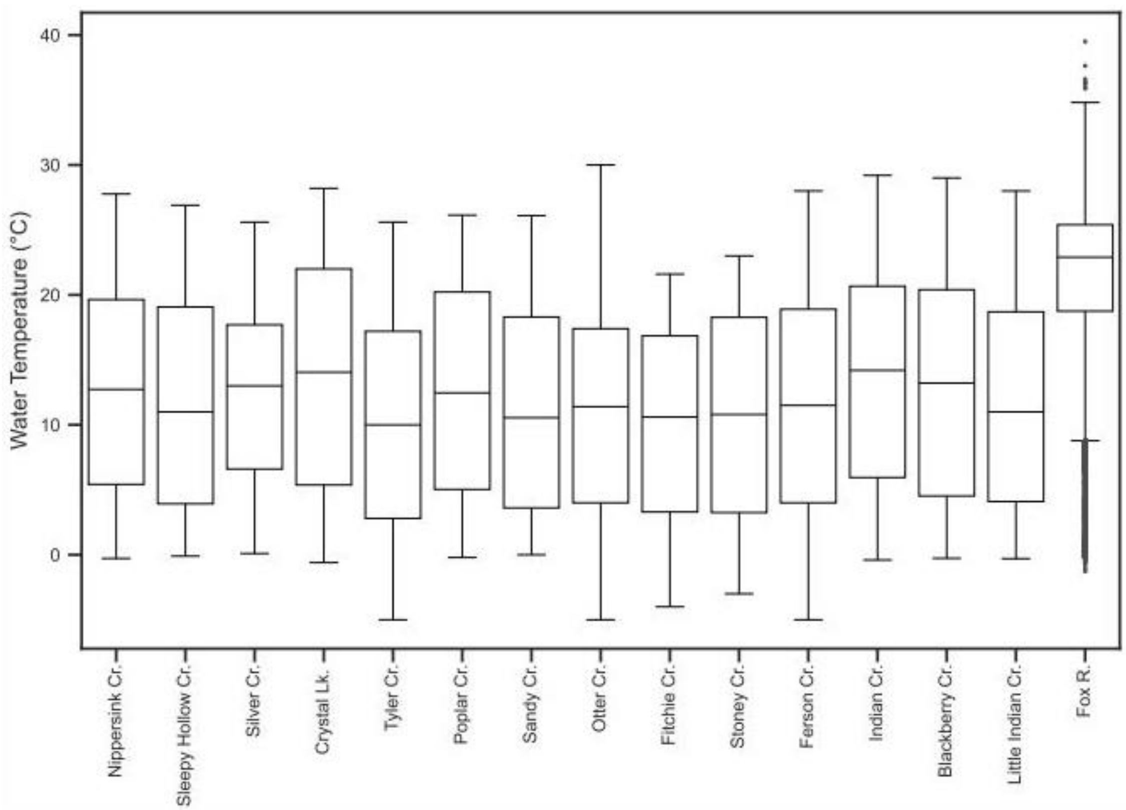


Figure 8. Boxplots of water temperature by waterbody

pH

The pH is monitored at 45 sites on the Fox River and its tributaries with varying sampling frequencies. Within the period of analysis (i.e., 1997–2021), the shortest and longest periods of pH records are 2014–2021 for Ferson Creek at Burlington & Corran Rds. (FC2) and 1997–2021 for Fox River at Montgomery (FR11), respectively. In Figure 9, the pH data for each monitoring site are illustrated using boxplots in an upstream-to-downstream order. The median pH values for all monitoring sites are within the range of the pH standard for the Fox River and its tributaries (i.e., 6.5 to 9.0). The site with the highest median pH of 8.6 is Fox River at Rt. 34, Oswego (FR12). The upper whiskers of the pH boxplots show values greater than 9.0 for all monitoring sites in the Fox River mainstem, except for Fox River at Rt. 173 near Channel Lake (FR1), indicating the existence of some pH standard violations in the upper range of the dataset. In contrast, the lower whiskers of the boxplots have pH values greater than 6.5. For most of the monitoring sites in the Fox River mainstem and for some sites in the tributaries, the pH data illustrated as outliers are not within the acute standard for surface water, indicating minimal pH standard violations.

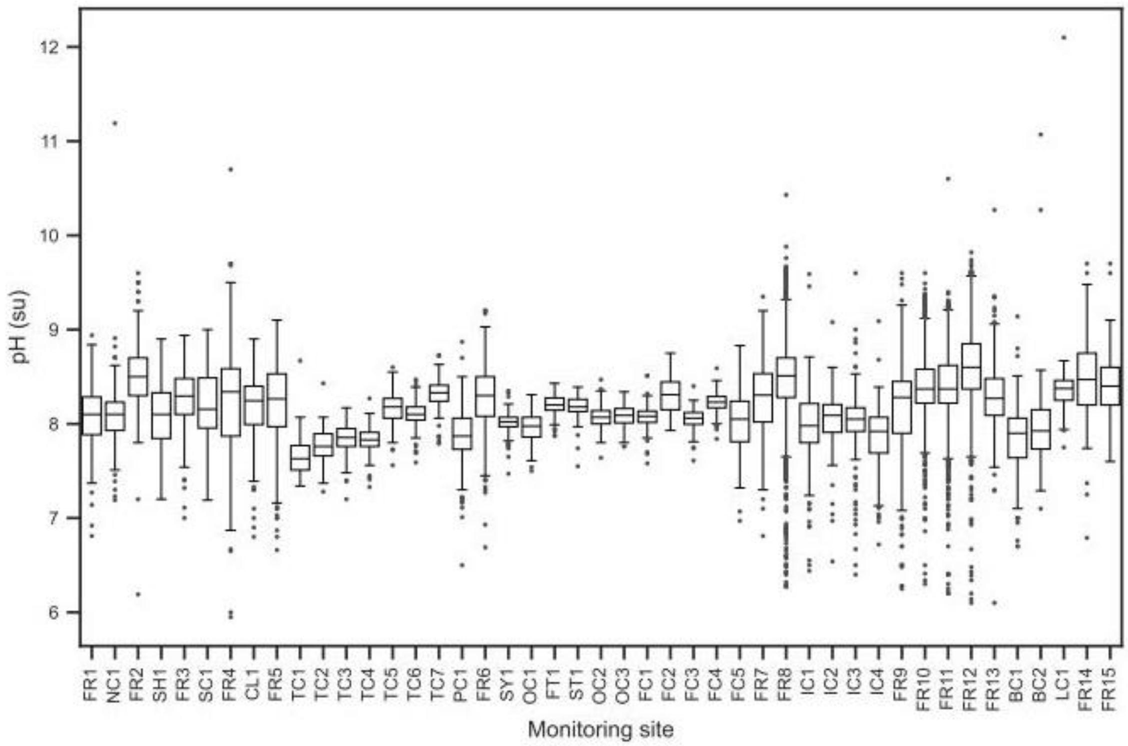


Figure 9. Boxplots of pH by monitoring site

Figure 10 illustrates the pH data distribution aggregated for the Fox River mainstem and its tributaries. The Fox River has the highest median pH levels and has more data samples violating the pH standard compared to the pH data for its tributaries. Fifty percent of the pH data for the Fox River has values greater than 8.0, as illustrated by the upper and lower hinges of the boxplots representing the 1st and 3rd quartiles, respectively. Except for Nippersink, Indian, Blackberry, and Little Indian Creeks, all pH samples of the remaining tributaries are within the pH standard. Only Fox River and Indian Creek registered pH levels less than 6.5, violating the lower limit of the pH standard.

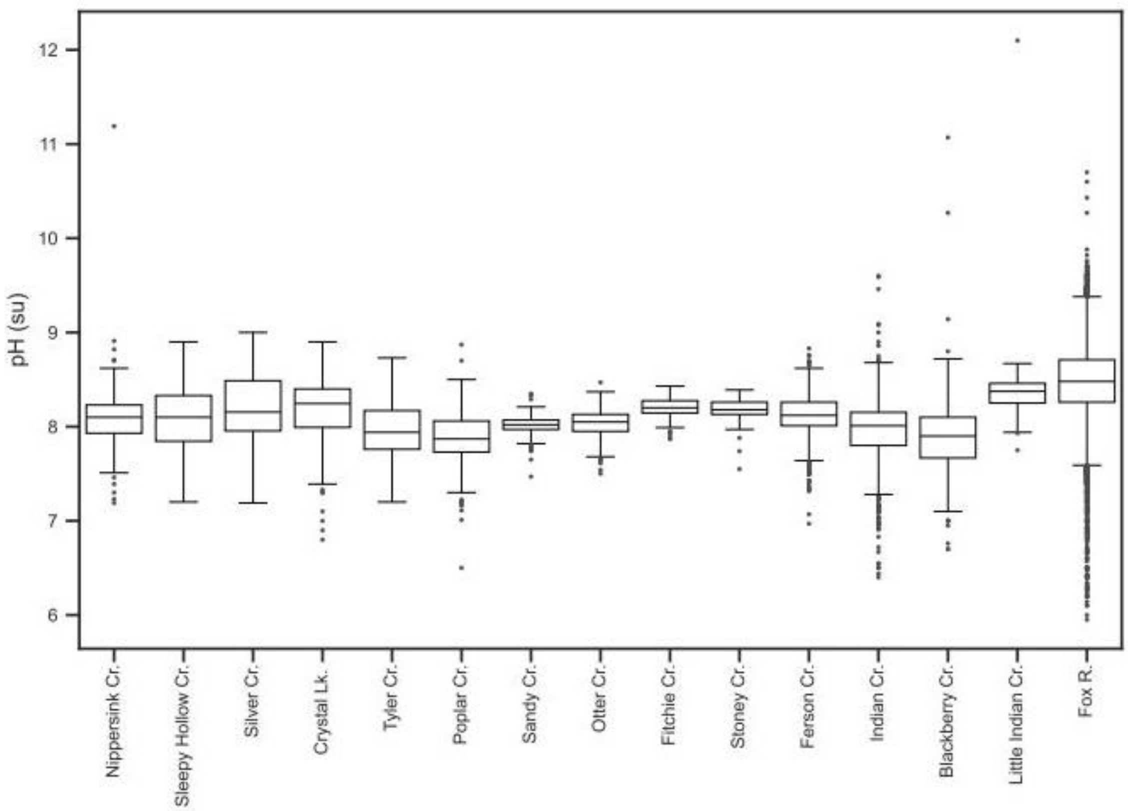


Figure 10. Boxplots of pH by waterbody

Specific Conductance

Specific conductance is a key parameter in water quality monitoring, measuring water's ability to conduct an electric current. The specific conductance of water depends on the concentration of particles such as chloride, sodium, potassium, and other ions that are present in the water, indicating dissolved particles in the water. Specific conductance is commonly expressed in units of micro-Siemens per centimeter (µS/cm) and its measurement varies with temperature. There are 28 monitoring sites with specific conductance corrected for temperature at 25°C, of which 16 sites are on the Fox River mainstem and the remaining are on the tributaries. Uncorrected specific conductance data are also available for nine monitoring sites. In this study, only the specific conductance data corrected for 25°C is considered so that comparisons can be made between the monitoring sites and between the waterbodies in the Fox River watershed. Figures 11 and 12 show specific conductance data by monitoring site and by waterbody, respectively. The median specific conductivity ranges from 729 micro-mhos per centimeter (µmhos/cm or µS/cm) for Nippersink Creek near Spring Grove (NC1) to 1220 µS/cm for Little Indian Creek at Uni Br. (IC1). Sites with specific conductivity greater than 1000 µS/cm are all in the tributaries, indicating an increased concentration of dissolved solids. The median specific conductivity for the Fox River mainstem is 844 µS/cm and, in contrast, it varies between 729 and 1220 µS/cm for its tributaries. Conductivity of rivers in the United States is 50–1500 µS/cm, and for those streams supporting good aquatic habitat, it ranges between 150 and 500 µS/cm (https://archive.epa.gov/water/archive/web/html/vms59.html).

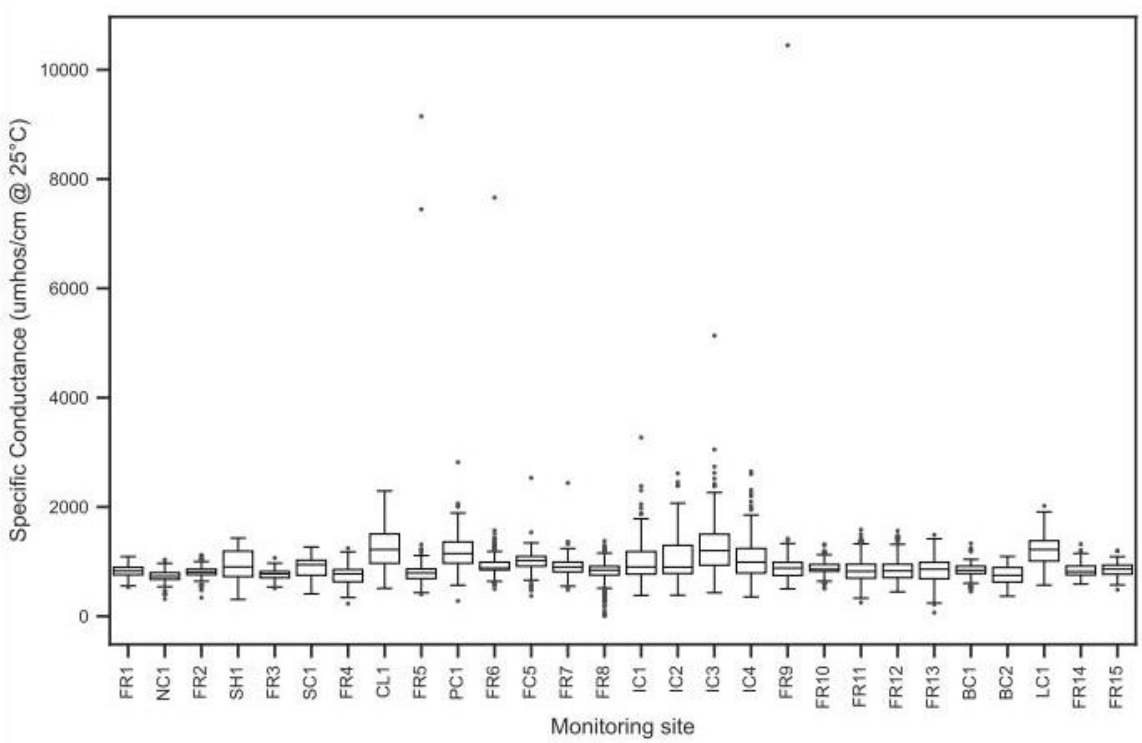


Figure 11. Boxplots of specific conductance at 25^{0}C by monitoring site

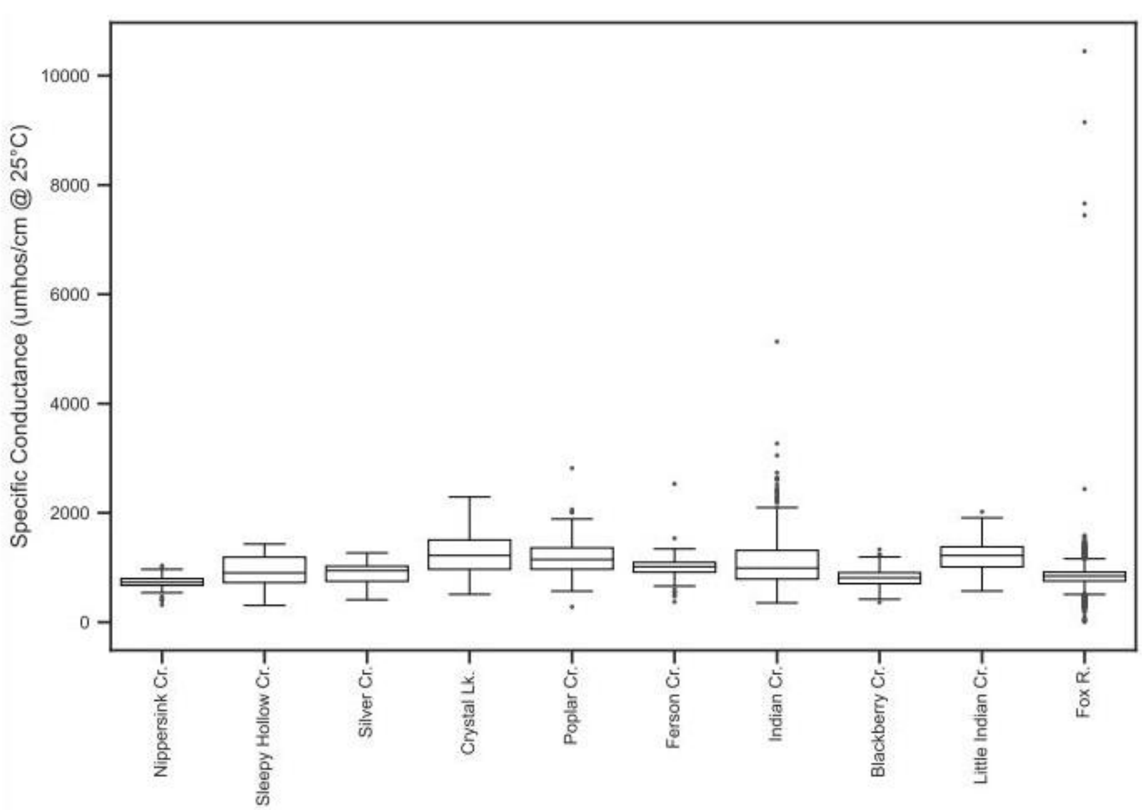


Figure 12. Boxplots of specific conductance at 25^{0}C by waterbody

Turbidity

Turbidity can be monitored directly using a turbidity sensor (nephelometry) or indirectly through water clarity measurement using a Secchi disk. In the Fox River and tributaries, 21 monitoring sites have turbidity data and 11 of those sites are on the Fox River mainstem. Fox River at South Elgin (FR6) has the longest period of turbidity data (2001–2021), whereas Fox River at Rt. 71 (FR14) has the shortest data period (2003–2009). Most of the monitoring sites on the Fox River mainstem have data spanning from 2002 to 2021. The boxplot shown in Figure 13 illustrates the turbidity distribution by monitoring site in the Fox River and its tributaries. The median turbidity is generally high for monitoring sites in the mainstem, and it is the highest (i.e., 36.5 NTU) for Fox River at Rt. 71 (FR14). Silver Creek at Lakeshore Dr. & E. Park Ln. (SC1) is the monitoring site with the lowest median turbidity of 1.7 NTU. In Figure 14, the data are aggregated by waterbody and plotted to illustrate the turbidity distribution for the Fox River mainstem and its tributaries. The figure shows that turbidity in the Fox River, Nippersink, Sleep Hollow, and Blackberry Creeks are significantly higher with median values ranging from 12.7 to 17.0 NTU. In general, the turbidity in the Fox River and all its tributaries appears to be below 60 NTU except for some outliers that may be related to high flow seasons. Most of the outliers are mostly less than 150 NTU, although a few sites reported turbidity values greater than 150 NTU (e.g., Fox River mainstem).

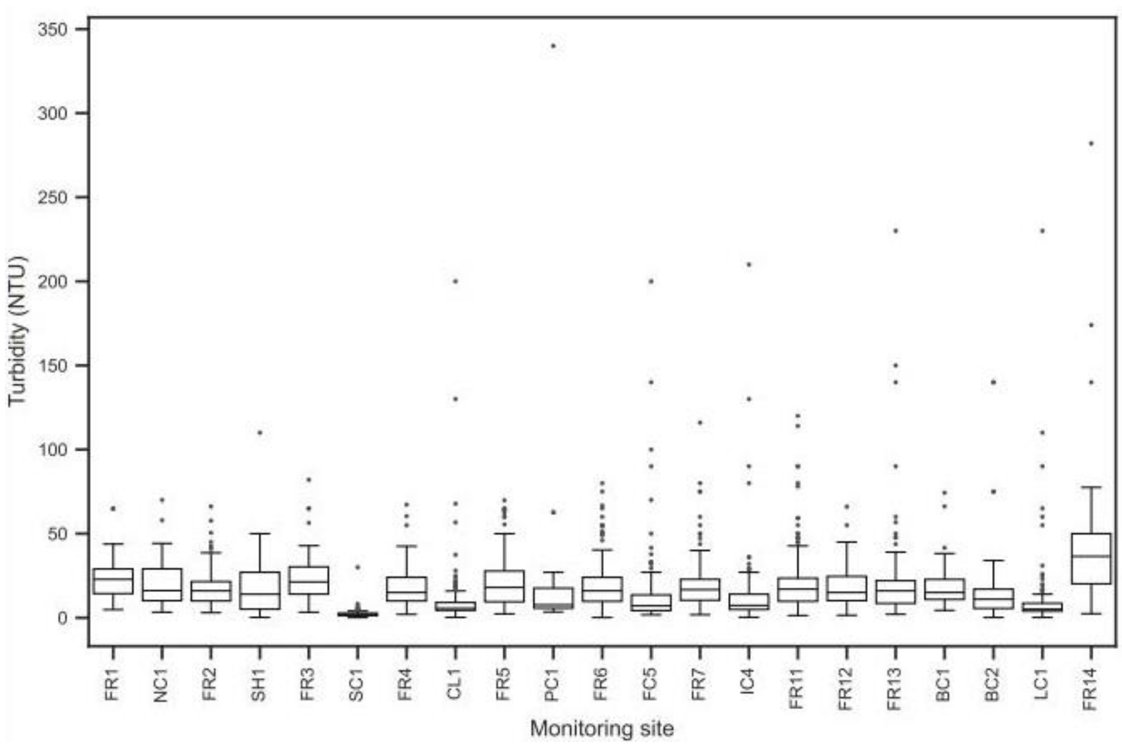


Figure 13. Boxplots of turbidity by monitoring site

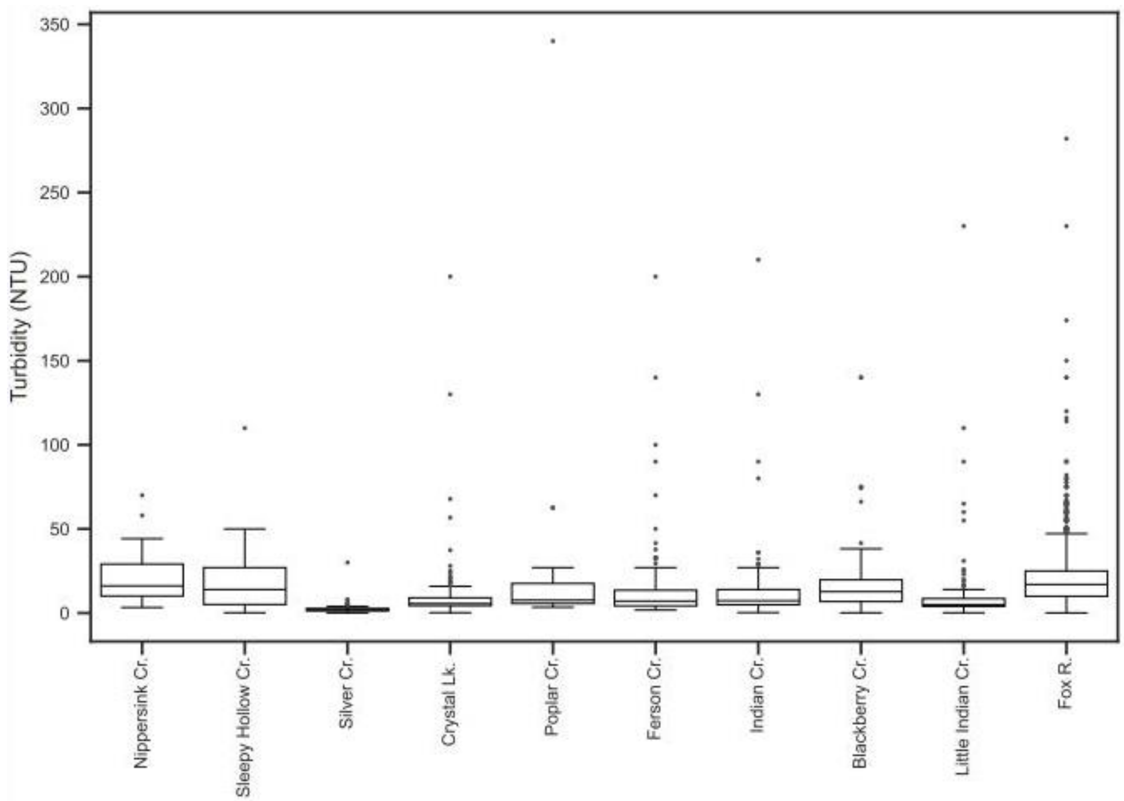


Figure 14. Boxplots of turbidity by waterbody

Chlorophyll-A

Chlorophyll-A was monitored at 25 sites in the Fox River watershed, of which 14 sites are on the Fox River mainstem. Both corrected and uncorrected chlorophyll-A were reported. The uncorrected chlorophyll-A represents its total concentration including all forms with or without photosynthetic potential, whereas the corrected chlorophyll-A is the concentration after adjusting the total concentration values by accounting for inactive forms of chlorophyll-A. In this study, only the corrected chlorophyll-A was considered. The chlorophyll-A record periods vary from 2008 to 2018 for Indian Creek at Reckinger Rd. (IC1) to 2001–2021 for the Fox River at South Elgin (FR6). In Figure 15, the chlorophyll-A concentration is illustrated for all monitoring sites in an upstream-to-downstream order. The median chlorophyll-A concentration in the watershed ranges from 4.0 µg/L at Silver Creek at Lakeshore Dr. & E. Park Ln. (SC1) to 73.6 µg/L at Fox River at Rt. 71 (FR14). The monitoring sites on the Fox River mainstem exhibited a much higher median concentration (28.3 to 73.6 µg/L) compared to concentrations for the tributaries (4.0 to 27.2 µg/L). The maximum chlorophyll-A concentration reported in the watershed is 445 µg/L, which was for the Fox River at South Elgin (FR6) in July 2005. The chlorophyll-A concentration data by waterbody is plotted in Figure 16, showing the concentration difference between the Fox River and its tributaries. The median concentration for the Fox River mainstem is 46.2 µg/L. In contrast, Nippersink Creek has the highest median concentration (i.e., 27.2 µg/L) of all the tributaries.

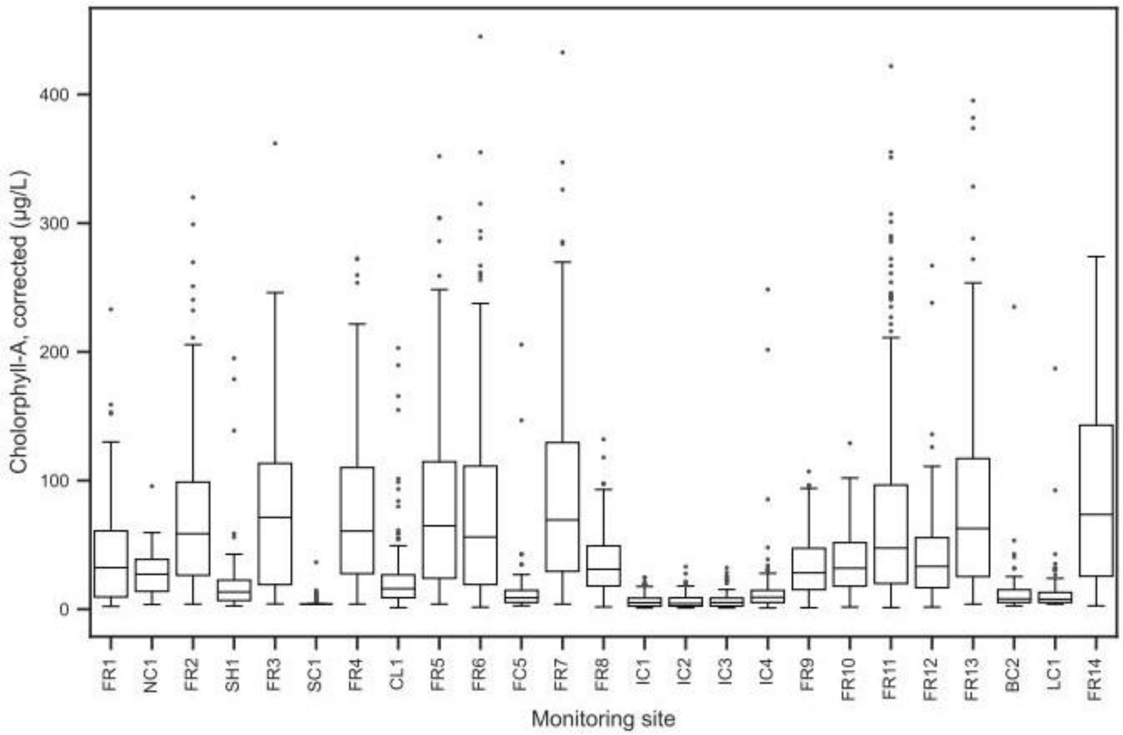


Figure 15. Boxplots of chlorophyll-A (corrected) by monitoring site

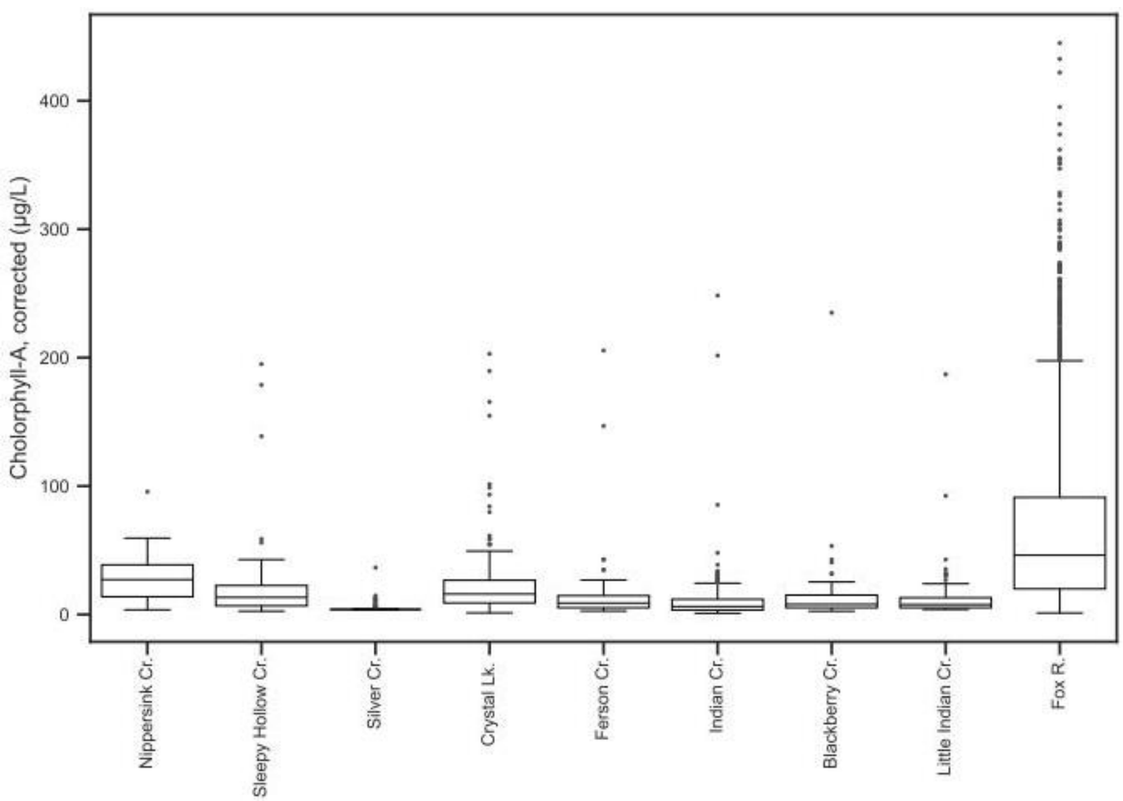


Figure 16. Boxplots of chlorophyll-A (corrected) by waterbody

3.2 EDA Results by Monitoring Site

The water quality constituent at each of the monitoring sites was further analyzed by plotting the timeseries data, its distribution, and annual and monthly variability during the period of analysis, providing more detailed information that was not included in the data factsheet. One monitoring site on the Fox River mainstem and another site on the tributary were selected to showcase the detailed EDA results for chloride concentration. The two monitoring sites are Fox River at Montgomery (FR1) and Poplar Creek at Elgin, which have chloride concentration data covering the entire period of analysis (i.e., 1997–2021). Chloride concentration at the two sites provides a snapshot of concentration levels in the Fox River mainstem and its tributaries. EDA results for all other water quality parameters and monitoring sites are included in Appendix A.

Fox River at Montgomery (FR11)

Chloride concentration levels for the Fox River at Montgomery (FR11) are presented in Figures 5–8, showing the data samples, monthly boxplots, annual boxplots, and the empirical cumulative distribution function (CDF), respectively. The chloride concentration time series data in Figure 17 indicates that data samples were regularly taken with slightly more frequency between 2008 and 2010. A total of 670 data samples were taken between 1997 and 2021, and the minimum and maximum concentration levels were 4.8 and 1000 mg/L, respectively, with a mean concentration of 147.7 mg/L. The median chloride concentration level at this site is 136 mg/L and is less than its mean value, indicating positively skewed data. Except for a few outliers, chloride concentration levels at FR11 are generally less than 400 mg/L.

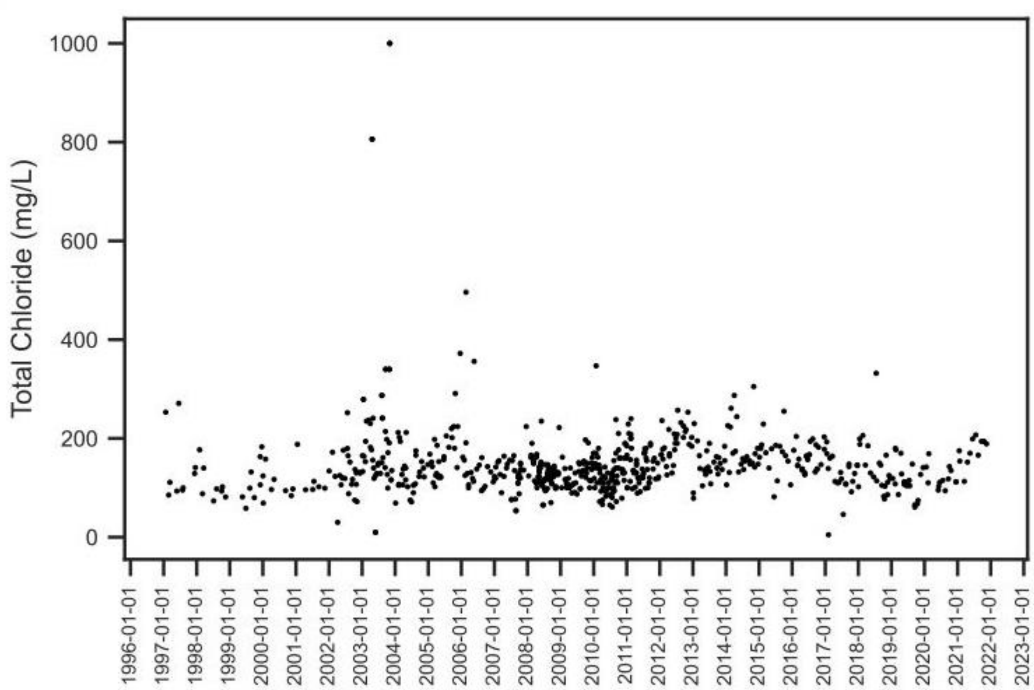


Figure 17. Chloride concentration samples for Fox River at Montgomery

The monthly and annual boxplots presented in Figures 18 and 19 show the seasonal and yearly variability of the chloride concentration at FR11, respectively. The monthly median concentration was the highest for the month of February (i.e., 181 mg/L), and elevated concentration levels of chloride were observed in the winter months of December, January, and February. This could be due to the application of road salt for deicing. Effluent discharges from industrial sources can also cause increased levels of chloride concentration in the river. The annual median chloride concentration has generally increased from 1997 to 2012 but decreased from 2012 to 2020 before it started to increase again in 2021.

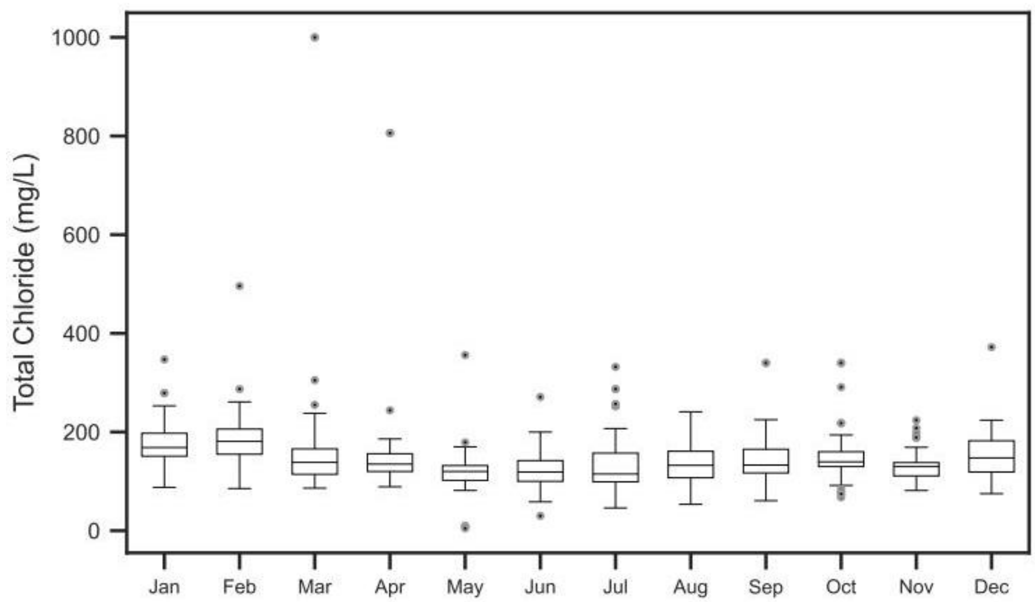


Figure 18. Monthly boxplots of chloride concentration for Fox River at Montgomery

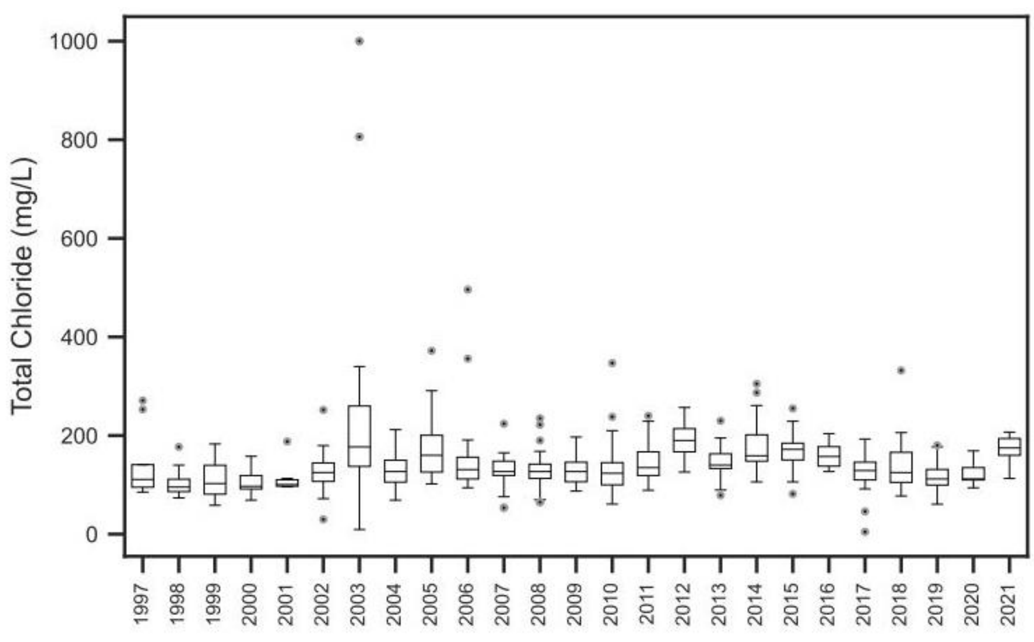


Figure 19. Annual boxplots of chloride concentration for Fox River at Montgomery

In Figure 20, the distribution of the chloride concentration data at FR11 is presented using the eCDF, which is the cumulative probability of non-exceedance. This eCDF or quantile plot provides the percentage or fraction of chloride concentration data that are above or below a certain concentration value such as a median or a water quality standard. The chloride concentration with cumulative frequencies of 0.25 and 0.75 are 112 and 165 mg/L, representing the 1st and 3rd quartiles, respectively, with an interquartile range of 53 mg/L. The quantile plot's steep rise to 250 mg/L indicates the chloride concentration data are highly skewed to the right (skewness = 6.2). More than 99 percent of the chloride concentration data at this monitoring site is below 500 mg/L, i.e., the acute standard for surface water). This indicates that the chloride concentration standard for surface water has less than a one percent chance of being exceeded at the Fox River at Montgomery (FR11).

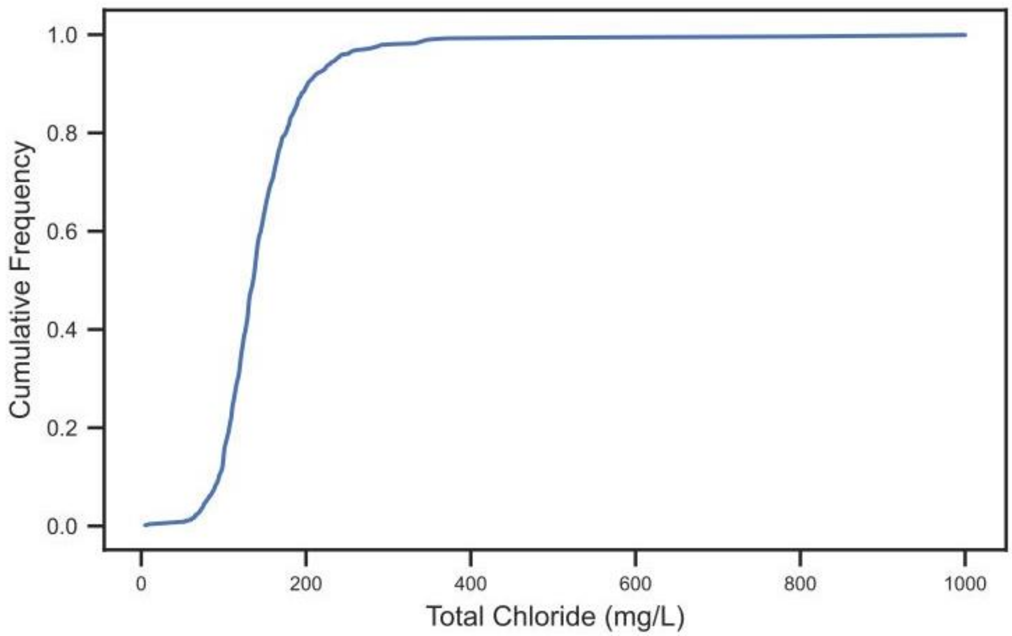


Figure 20. Empirical CDF of chloride concentration for Fox River at Montgomery

Poplar Creek at Elgin (PC1)

The chloride concentration at Poplar Creek at Elgin (PC1) appears to be less frequently sampled with only 251 data points for the period between 1997 and 2021. Figure 21 illustrates the time series data with relatively regular sampling with data gaps in 2012, 2014, and 2015. Chloride concentration levels at PC1 range from a minimum of 18.2 mg/L to a maximum of 995 mg/L, with an average of 245.6 mg/L. Its median concentration level is 208 mg/L, which is higher than the median concentration for the Fox River at Montgomery (i.e., 136 mg/L), indicating elevated chloride levels in the tributary compared to the river mainstem.

The chloride concentration level at PC1 is higher for the winter and spring months compared to summer and fall (Figure 22). Similarly, the month of February has the highest median chloride concentration of 405 mg/L for Poplar Creek at Elgin, which is more than twice as much as the median concentration for the Fox River at Montgomery. The chloride concentration appears to have decreased since 2011, as shown in Figure 23. The median concentration was higher in 2005 and 2007 (i.e., 293 and 295 mg/L, respectively) compared to other years. A single data sample that was taken in November 2021 shows a chloride concentration level of 322 mg/L.

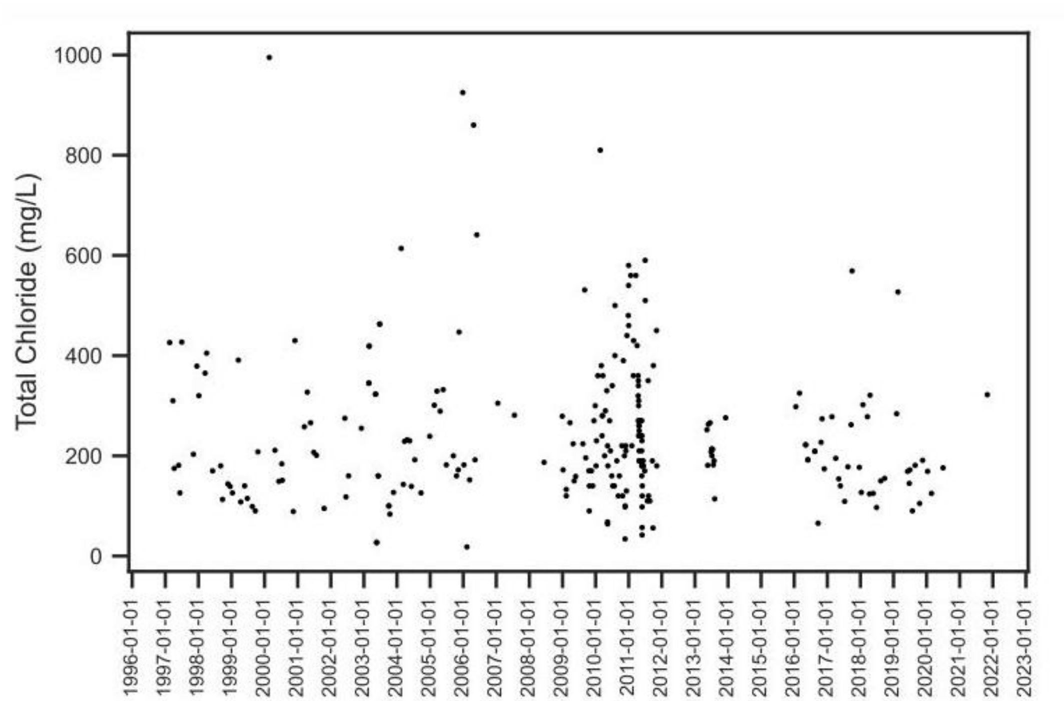


Figure 21. Chloride concentration samples at Poplar Creek at Elgin

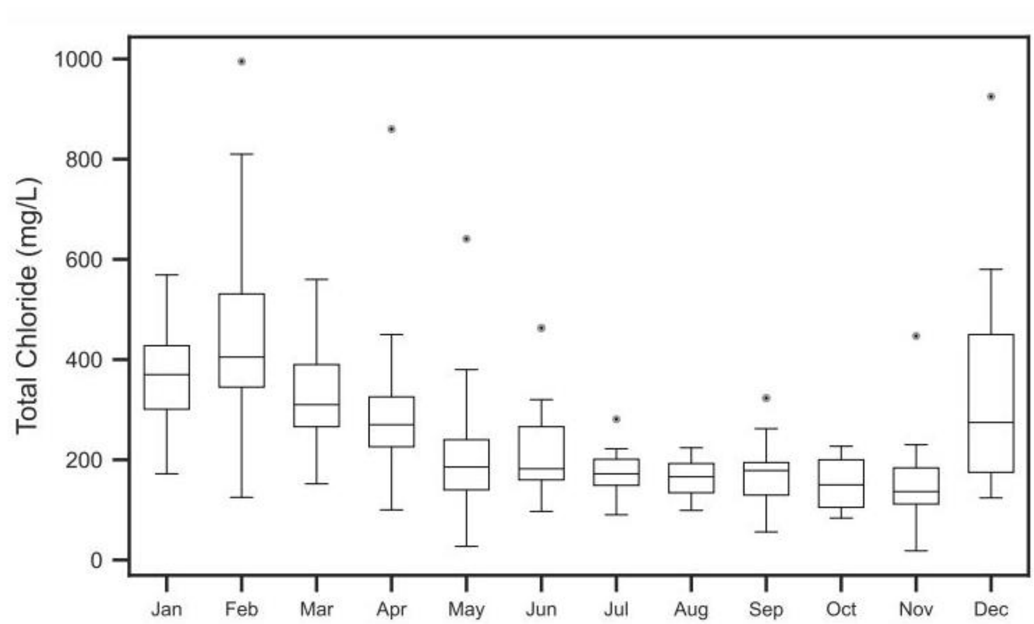


Figure 22. Monthly boxplots of chloride concentration at Poplar Creek at Elgin

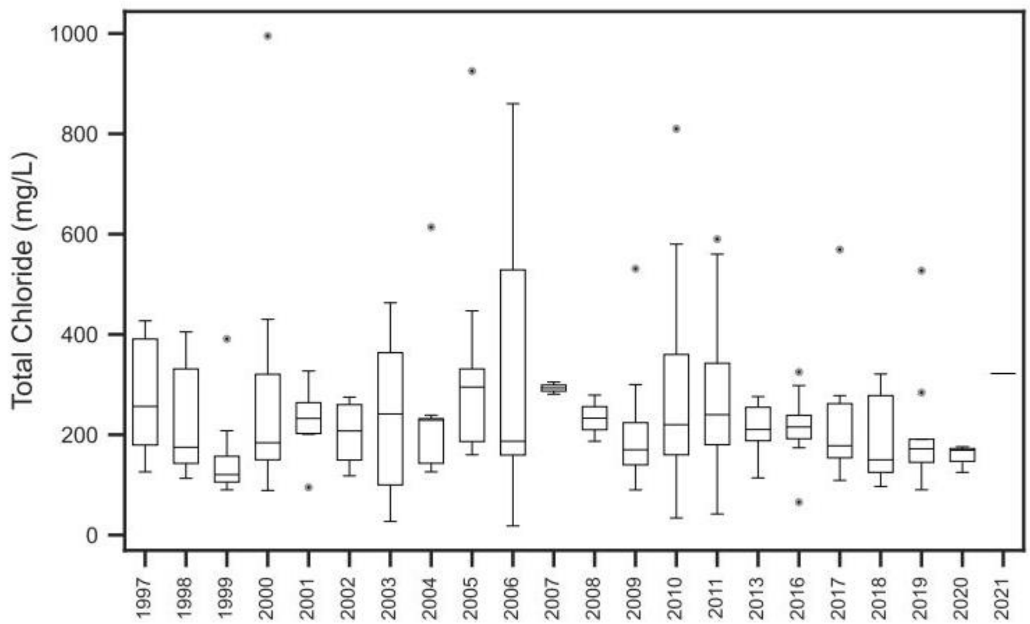


Figure 23. Annual boxplots of chloride concentration at Poplar Creek at Elgin

Figure 24 illustrates the empirical CDF for chloride concentration at PC1, indicating the percentile distribution of the data samples. Fifty percent of the concentration data is between 150 and 300 mg/L, which approximately represents the 25th and 75th percentiles, respectively. The interquartile range of 150 mg/L indicates a larger spread of the concentration data at this site. The chloride data at PC1 is also skewed to the right (skewness = 1.9). Nearly 90% of the time, the chloride concentration at PC1 is below the acute standard for surface water (i.e., 500 mg/L).

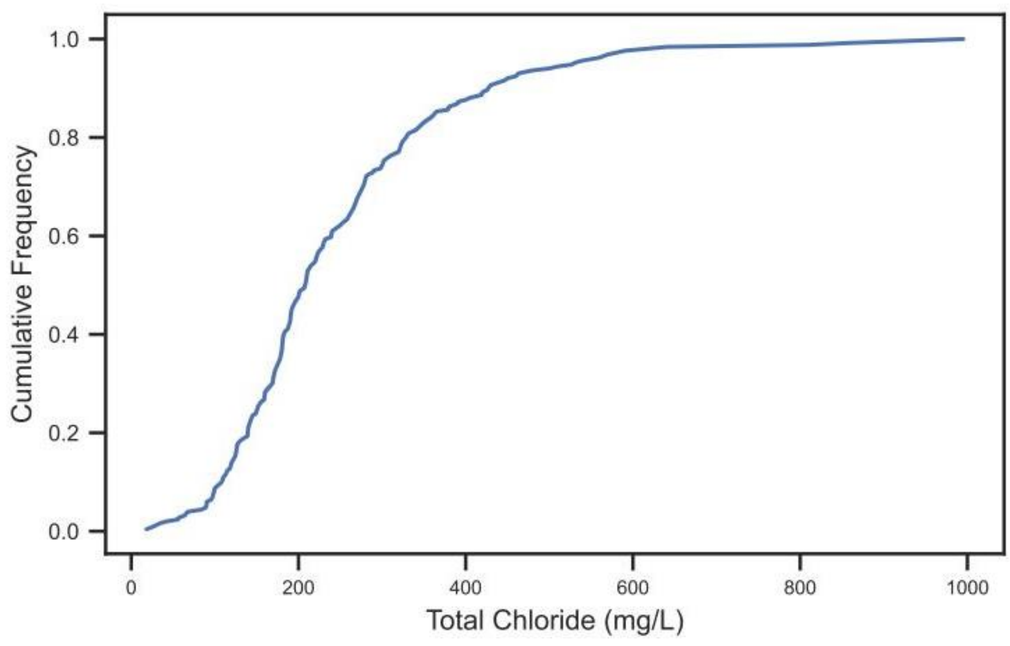


Figure 24. Empirical CDF of chloride concentration for Poplar Creek at Elgin

4. Data Suitability Analysis for Water Quality Trends

The primary method used to conduct water quality trend analysis is the Seasonal Kendall Test (SKT) as implemented in the EnvStats R package for environmental statistics. The data suitability analysis for trends was, therefore, determined based on the data requirement for conducting monotonic trend analysis using the SKT method. The Weighted Regression on Time, Discharge, and Season (WRTDS) method, which is a statistical modeling algorithm included in the Exploration and Graphics for RivEr Trends (EGRET) software, was also used as a secondary method to evaluate trends in flow-normalized concentration and fluxes. Long-term continuous discharge data for those monitoring sites with constituent concentration are required to develop WRTDS models of concentration-discharge relationships.

For a monotonic trend analysis, a monthly dataset of five years is recommended as the minimum data requirement in USEPA's Technotes 6 (Meals et al., 2011). The FoxDB was thus first queried for monitoring sites and water quality constituents of interest that have data spanning at least five years but not necessarily in all five years during the period of analysis (i.e., 1997–2021). The data suitability analysis was then conducted to identify those monitoring sites that have adequate data to estimate 5-, 10-, and 25-year trends ending in 2021. The periods for estimating 5-, 10-, and 25-year annual and seasonal trends are, therefore, 2017–2021, 2012–2021, and 1997–2021, respectively.

4.1 Data Suitability for Annual Trends

To determine the suitability of water quality data at a monitoring site for 5-, 10-, and 25-year annual trend analysis, data samples should be available in at least 80% of the trend period and one or more data samples for at least 75% of the months in each year of the trend period. For example, a monitoring site is said to be suitable for a 5-year annual trend analysis only if it has water quality data for four out of five years of data during the period between 2017 and 2021, and if it has data for 9 out of 12 months in each of those years. Furthermore, datasets qualifying for a 10- or 25-year trend analysis must also qualify for the 5- or 10-year trend analysis, respectively.

The monitoring sites with water quality data that are suitable for 5-, 10-, and 25-year annual trend analysis are presented in Table 6. The monitoring sites that have datasets qualifying for 10- and 25-year trends are shown in bold and as underlined, respectively. The Fox River at South Elgin (FR6) and Fox River at Montgomery (FR11) are the two monitoring sites with the greatest number of water quality constituents qualifying for 5-, 10-, and 25-year annual trends, which include total chloride, water temperature, pH, and specific conductance. Total chloride and pH data at 24 monitoring sites were suitable for conducting a 5-year annual trend; five of those sites are located on the Fox River mainstem (i.e., FR5, FR6, FR7, FR11, and FR13). Only 13 of the 24 monitoring sites have suitable chloride and pH data for estimating 10-year annual trends. Four monitoring sites on the Fox River mainstem have water quality data that are suitable for estimating 25-year annual trends, including Fox River at Algonquin

(FR5), Fox River at South Elgin (FR6), Fox River at Montgomery (FR11), and Fox River at Yorkville (F13).

Table 6. Monitoring sites with water quality data for annual trends

Water quality parameter	Monitoring sites for 5-, 10-, and 25-year annual trends*
Total Chloride (mg/L)	CL1 / **FR5** / **TC1** / **TC4** / **TC6** / **TC7** / **<u>FR6</u>** / **SY1** / OC1 / FT1 / ST1 / OC2 / OC3 / FC1 / FC2 / FC3 / FC4 / FC5 / **FR7** / **IC4** / **<u>FR11</u>** / **FR13** / **BC2** / **LC1**
Water Temperature (°C)	**<u>FR5</u>** / **<u>FR6</u>** / FC5 / **FR7** / **IC4** / **<u>FR11</u>** / **<u>FR13</u>** / **BC2** / **LC1**
pH (su)	CL1 / **FR5** / **TC1** / **TC4** / **TC6** / **TC7** / **<u>FR6</u>** / **SY1** / OC1 / FT1 / ST1 / OC2 / OC3 / FC1 / FC2 / FC3 / FC4 / FC5 / **FR7** / **IC4** / **<u>FR11</u>** / **FR13** / **BC2** / **LC1**
Specific Conductance (µmhos/cm @ 25°C)	**<u>FR6</u>** / FC5 / **FR7** / **IC4** / **<u>FR11</u>** / **FR13** / **BC2** / **LC1**
Turbidity (NTU)	CL1 / FR5 / FC5 / **FR7** / **IC4** / **FR11** / **FR13** / **BC2** / **LC1**
Chlorophyll-A, corrected (µg/L)	CL1 / FR5 / **FR6** / FC5 / **FR7** / **IC4** / **FR11** / **FR13** / **BC2** / **LC1**

*Monitoring sites with suitable data for 10- and 25-year trends are shown in **bold** and <u>underlined</u>, respectively.

4.2 Data Suitability for Seasonal Trends

The winter, spring, summer, and fall seasons are defined as December to February, March to May, June to August, and September to November. For a seasonal trend, the data suitability of a water quality parameter at a given monitoring site was determined by checking its availability for each season in at least 80% of the trend period for at least two of the three months in the season. A 5-year trend for the summer season can be estimated, for example, if the water quality data are available for at least June and July, June and August, or July and August in four of the five years. Data qualifying for a 10- or 25-year seasonal trend should also qualify for a 5- or 10-year trend, respectively.

Monitoring sites with water quality data suitable for winter trends are shown in Table 7. Winter datasets for chloride, pH, and water temperature are suitable for estimating 5- and 10-year trends on at least 35 and 13 monitoring sites, respectively. In contrast, chlorophyll-A, specific conductance, and turbidity have 8 to 17 monitoring sites with qualifying data for either 5- or 10-year winter trends. Only five monitoring sites have one or more water quality data suitable for a 25-year winter trend analysis and are all on Fox River mainstem sites (i.e., Fox River at Algonquin (FR5), Fox River at South Elgin (FR6), Fox River at Montgomery (FR11), Fox River at Rt. 34, Oswego (FR13), and Fox River at Yorkville (FR13)). Two of these sites (i.e., FR6 and FR11) have four water quality constituents that are suitable data for estimating 25-year winter trends including pH, specific conductance, chloride, and water temperature.

Table 7. Monitoring sites with water quality data for winter trends

<table>
<tr><th>Water quality parameter</th><th>Monitoring sites for 5-, 10-, and 25-year winter trends*</th></tr>
<tr><td>Total Chloride (mg/L)</td><td>FR1 / NC1 / SH1 / FR3 / SC1 / FR4 / <u>FR5</u> / TC1 / TC2 / TC3 / TC4 / TC5 / TC6 / TC7 / PC1 / <u>FR6</u> / SY1 / OC1 / FT1 / ST1 / OC2 / OC3 / FC1 / FC2 / FC3 / FC4 / FC5 / FR7 / FR8 / IC1 / IC2 / IC3 / IC4 / FR9 / FR10 / <u>FR11</u> / FR12 / FR13 / BC2 / LC1</td></tr>
<tr><td>Water Temperature (°C)</td><td>NC1 / SH1 / FR3 / SC1 / FR4 / <u>FR5</u> / TC1 / TC2 / TC5 / TC6 / PC1 / <u>FR6</u> / SY1 / OC1 / FT1 / ST1 / OC2 / OC3 / FC1 / FC2 / FC3 / FC4 / FR7 / FR8 / IC1 / IC2 / IC3 / IC4 / FR9 / FR10 / <u>FR11</u> / <u>FR12</u> / <u>FR13</u> / BC2 / LC1</td></tr>
<tr><td>pH (su)</td><td>NC1 / FR3 / <u>FR5</u> / TC1 / TC2 / TC3 / TC4 / TC5 / TC6 / TC7 / PC1 / <u>FR6</u> / SY1 / OC1 / FT1 / ST1 / OC2 / OC3 / FC1 / FC2 / FC3 / FC4 / FC5 / FR7 / FR8 / IC1 / IC2 / IC3 / IC4 / FR9 / FR10 / <u>FR11</u> / <u>FR12</u> / <u>FR13</u> / BC2 / LC1</td></tr>
<tr><td>Specific Conductance (µmhos/cm @ 25°C)</td><td>SH1 / SC1 / FR4 / <u>FR6</u> / FC5 / FR7 / FR8 / IC1 / IC2 / IC4 / FR9 / FR10 / <u>FR11</u> / FR12 / FR13 / BC2 / LC1</td></tr>
<tr><td>Turbidity (NTU)</td><td>SH1 / SC1 / FR4 / FR6 / FC5 / FR7 / IC4 / FR11 / FR13 / BC2 / LC1</td></tr>
<tr><td>Chlorophyll-A, corrected (µg/L)</td><td>SH1 / SC1 / FR4 / FR6 / FC5 / FR7 / IC4 / FR11 / FR13 / BC2 / LC1</td></tr>
</table>

*Monitoring sites with suitable data for 10- and 25-year trends are shown in **bold** and <u>underlined</u>, respectively.

Monitoring sites with water quality data for spring trends are presented in Table 8. The total number of sites for spring trends is generally smaller than the number of sites with qualifying data for winter trends. For 5-year spring trends, there are 31 monitoring sites for chloride and pH and only 21 sites for water temperature. Chloride has the highest number of monitoring sites (i.e., 20) for 10-year spring trends. As for winter trends, monitoring sites including FR5, FR6, FR11, and FR13 have one or more water quality data that are suitable for a 25-year spring trend.

In Table 9, a list of monitoing sites with suitable water quality data for summer trends is presented. The highest number of monitoring sites was obtained for estimating 5- and 25-year summer trends compared to any other season. This indicates that consistent sampling of the water quality consituents has been taking place in the summer season. There are at least 37 monitoring sites with chloride, pH, and water temperature data suitable for estimating 5-year summer trends, 11 of which are located on the Fox River mainstem. The remaining sites are on the tributaries. Tyler Creek has the highest number of monitoring sites. For all six water quality parameters, data for estimating 25-year summer trends are available at four sites, which are all on the Fox mainstem (i.e., FR6, FR11, FR12, and FR13).

Table 8. Monitoring sites with water quality data for spring trends

Water quality parameter	Monitoring sites for 5-, 10-, and 25-year spring trends*
Chlorophyll-A, corrected (µg/L)	**FR2** / SH1 / **SC1** / **FR4** / CL1 / FR5 / **FR6** / **FC5** / **FR7** / **IC4** / **FR11** / **FR13** / **BC2** / **LC1**
pH (su)	**FR2** / SH1 / SC1 / CL1 / **<u>FR5</u>** / **TC1** / **TC2** / **TC3** / **TC4** / **TC5** / **TC6** / **TC7** / **<u>FR6</u>** / **SY1** / OC1 / FT1 / ST1 / OC2 / OC3 / FC1 / FC2 / FC3 / FC4 / **FC5** / **FR7** / **IC4** / **<u>FR11</u>** / **<u>FR13</u>** / BC1 / **BC2** / **LC1**
Specific Conductance (µmhos/cm @ 25°C)	**FR2** / SH1 / **SC1** / **<u>FR6</u>** / **FC5** / **FR7** / **IC4** / **<u>FR11</u>** / **FR13** / BC1 / **BC2** / **LC1** / **FR15**
Total Chloride (mg/L)	**FR2** / SH1 / **SC1** / **FR4** / CL1 / **<u>FR5</u>** / **TC1** / **TC2** / **TC3** / **TC4** / **TC5** / **TC6** / **TC7** / **<u>FR6</u>** / **SY1** / OC1 / FT1 / ST1 / OC2 / OC3 / FC1 / FC2 / FC3 / FC4 / **FC5** / **FR7** / **IC4** / **<u>FR11</u>** / **FR13** / **BC2** / **LC1**
Turbidity (NTU)	**FR2** / SH1 / **SC1** / **FR4** / CL1 / FR5 / **FR6** / **FC5** / **FR7** / **IC4** / **FR11** / **FR13** / **BC2** / **LC1**
Water Temperature (°C)	**FR2** / SH1 / **SC1** / CL1 / **<u>FR5</u>** / **TC1** / **TC2** / TC3 / **TC4** / **TC5** / TC7 / **<u>FR6</u>** / **FC5** / **FR7** / **IC4** / **<u>FR11</u>** / **<u>FR13</u>** / BC1 / **BC2** / **LC1** / **FR15**

*Monitoring sites with suitable data for 10- and 25-year trends are shown in **bold** and <u>underlined</u>, respectively.

Table 9. Monitoring sites with water quality data for summer trends

Water quality parameter	Monitoring sites for 5-, 10-, and 25-year summer trends*
Total Chloride (mg/L)	FR2 / SH1 / SC1 / CL1 / **<u>FR5</u>** / **TC1** / **TC2** / **TC3** / **TC4** / **TC5** / **TC6** / **TC7** / **<u>FR6</u>** / **SY1** / OC1 / FT1 / ST1 / OC2 / OC3 / FC1 / FC2 / FC3 / FC4 / **FC5** / **<u>FR7</u>** / FR8 / **IC1** / IC2 / IC3 / **IC4** / **FR9** / FR10 / **<u>FR11</u>** / **FR12** / **<u>FR13</u>** / BC1 / **BC2** / **LC1** / FR14
Water Temperature (°C)	FR2 / SH1 / **SC1** / CL1 / **<u>FR5</u>** / TC1 / TC2 / TC3 / TC4 / **TC5** / **TC6** / TC7 / **<u>FR6</u>** / **SY1** / OC1 / FT1 / ST1 / OC2 / OC3 / FC1 / FC2 / FC3 / FC4 / FC5 / **FR7** / FR8 / **IC1** / IC2 / IC3 / **IC4** / **FR9** / FR10 / **<u>FR11</u>** / **<u>FR12</u>** / **<u>FR13</u>** / **BC2** / **LC1** / FR14 / FR15
pH (su)	FR2 / CL1 / **<u>FR5</u>** / **TC1** / **TC2** / **TC3** / **TC4** / **TC5** / **TC6** / **TC7** / **<u>FR6</u>** / **SY1** / OC1 / FT1 / ST1 / OC2 / OC3 / FC1 / FC2 / FC3 / FC4 / **FC5** / **<u>FR7</u>** / FR8 / IC1 / IC2 / IC3 / IC4 / **FR9** / FR10 / **<u>FR11</u>** / **<u>FR12</u>** / **<u>FR13</u>** / **BC2** / **LC1** / FR14 / FR15
Specific Conductance (µmhos/cm @ 25°C)	FR2 / SH1 / **SC1** / **<u>FR6</u>** / **FC5** / **<u>FR7</u>** / FR8 / IC1 / IC2 / IC3 / **IC4** / FR9 / FR10 / **<u>FR11</u>** / **FR12** / **<u>FR13</u>** / **BC2** / **LC1** / FR15
Turbidity (NTU)	FR2 / SH1 / SC1 /CL1 / FR5 / **<u>FR6</u>** / **FC5** / **<u>FR7</u>** / **IC4** / **<u>FR11</u>** / **<u>FR13</u>** / **BC2** / **LC1**
Chlorophyll-A, corrected (µg/L)	FR2 / SH1 / **SC1** / CL1 / FR5 / **<u>FR6</u>** / FC5 / **<u>FR7</u>** / **IC4** / **<u>FR11</u>** / **<u>FR13</u>** / **BC2** / **LC1**

*Monitoring sites with suitable data for 10- and 25-year trends are shown in **bold** and <u>underlined</u>, respectively.

The monitoring sites with qualifying data for fall trends are listed in Table 10 and include the least number of sites for 5-year trends as compared to any other season. Almost all sites with qualifying data for 5-year trends also have data for 10-year trends, indicating consistent long-term data collection in the fall season of the 2012–2021 period. Three monitoring sites on the Fox River mainstem (i.e., FR5, FR6, and FR11) have fall data for estimating 25-year trends for chloride, pH, and water temperature.

Fox River at South Elgin (FR6) and Fox River at Montgomery (FR11) are the only two long-term monitoring sites in the Fox River watershed that have one or more water quality data suitable for estimating 25-year seasonal or annual trends.

Table 10. Monitoring sites with water quality data for fall trends

Water quality parameter	Monitoring sites for 5-, 10- and 25-year fall trends*
Total Chloride (mg/L)	**FR4** / **CL1** / **FR5** / **TC1** / **TC2** / **TC3** / **TC4** / **TC5** / **TC6** / **TC7** / **FR6** / **SY1** / **OC1** / **FT1** / **ST1** / **OC2** / **OC3** / **FC1** / **FC2** / **FC3** / **FC4** / **FC5** / **FR7** / **IC4** / **FR11** / **FR13** / **BC1** / **BC2** / **LC1** / FR14
Water Temperature (°C)	**FR4** / **FR5** / **TC1** / **TC2** / **TC3** / **TC4** / **TC5** / **TC6** / **TC7** / **FR6** / **SY1** / **OC1** / **FT1** / **ST1** / **OC2** / **OC3** / **FC1** / **FC2** / **FC3** / **FC4** / **FC5** / **FR7** / **IC4** / **FR11** / **FR13** / **BC2** / **LC1** / FR14 / **FR15**
pH (su)	FR4 / **FR5** / **TC1** / **TC2** / **TC3** / **TC4** / **TC5** / **TC6** / **TC7** / **FR6** / **SY1** / **OC1** / **FT1** / **ST1** / **OC2** / **OC3** / **FC1** / **FC2** / **FC3** / **FC4** / **FC5** / **FR7** / **IC4** / **FR11** / **FR13** / **BC2** / **LC1**
Specific Conductance (µmhos/cm @ 25°C)	**FR4** / **FC5** / **FR7** / **IC4** / **FR11** / **FR13** / **BC2** / **LC1** / FR15
Turbidity (NTU)	**FR4** / **CL1** / **FR5** / **FC5** / **FR7** / **IC4** / **FR11** / **FR13** / **BC2** / **LC1**
Chlorophyll-A, corrected (µg/L)	**FR4** / **CL1** / **FR5** / **FC5** / **FR7** / **IC4** / **FR11** / **FR13** / **BC2** / **LC1**

*Monitoring sites with suitable data for 10- and 25-year trends are shown in **bold** and underlined, respectively.

5. Water Quality Trend Analysis

Trends analysis was completed for chloride, water temperature, pH, specific conductance, turbidity, and chlorophyll-A based on the results of the data suitability analysis performed to estimate 5-, 10-, and 25-year annual and seasonal trends. As indicated before, the primary method of trends analysis is the Seasonal Kendall Test (SKT) method. This method is a test to estimate monotonic trends in time series data that are expected to change in the same upward or downward direction for one or more seasons. It is a nonparametric trend test that can be used with data that are not normally distributed, serially correlated, and/or exhibit seasonality. The method can be used with time series data that have missing records and data with detection limits. Complementing the SKT method, the weighted Regression on Time, Discharge and Season (WRTDS) method was also used to estimate trends in chloride and chlorophyll-A concentrations and fluxes for those monitoring sites with long-term concentration and continuous flow data during the period of analysis. A detailed description of the SKT and WRTDS methods as applied in the water quality trend analysis of the Fox River watershed was provided in the previous report (Getahun et al., 2019).

5.1 Trend Analysis using SKT Method

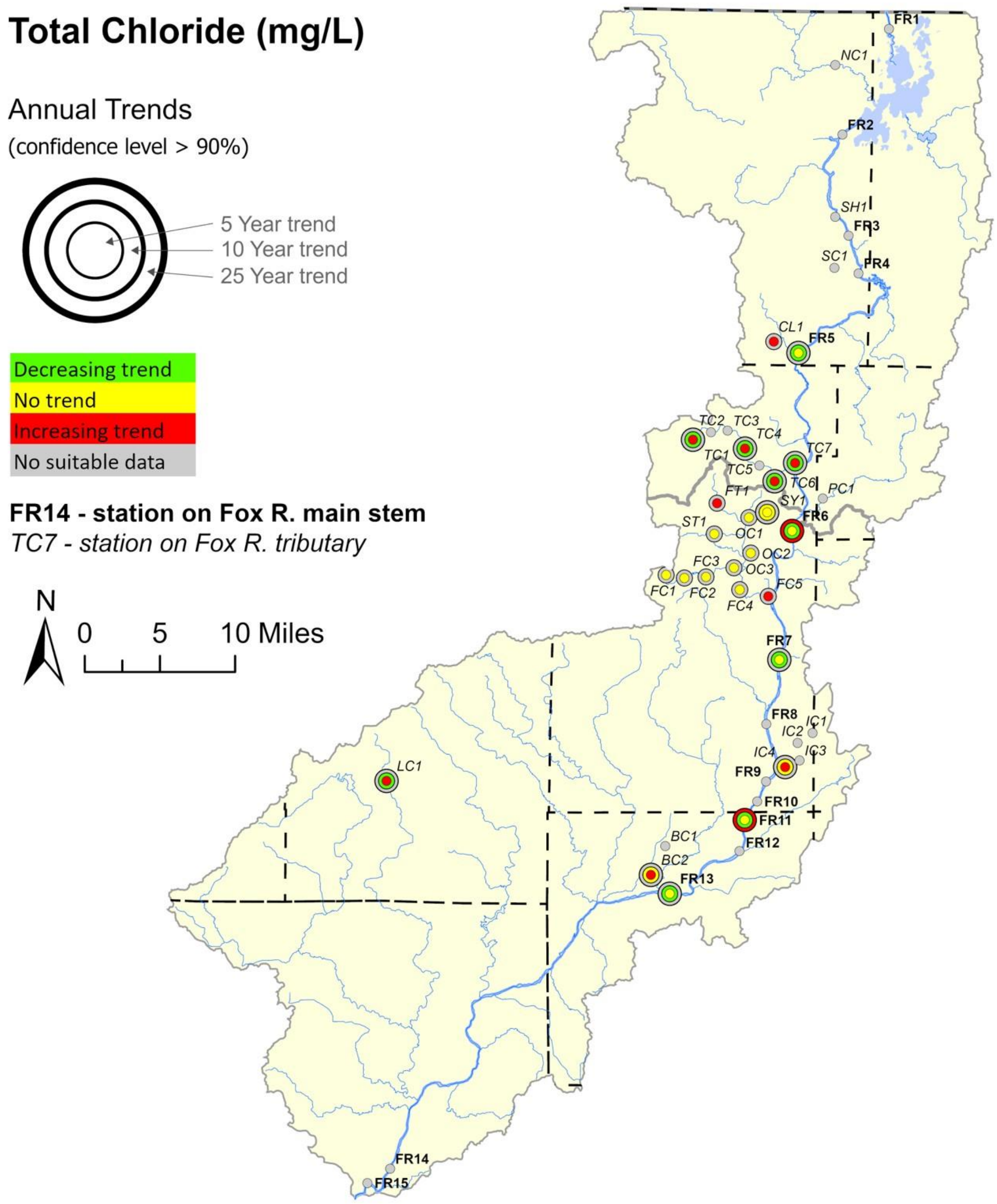
The annual and seasonal trend analyses were conducted for the six water quality parameters that were observed in a total of 45 monitoring sites. In Table 11, the number of trend evaluations by trend year and type is given and, in total, 1220 trend evaluations were completed, of which 633, 495, and 92 evaluations are for the 5-, 10-, and 25-year trend periods, respectively. In this trend analysis, an upward or downward trend is considered statistically significant if it has a confidence level of 90 percent.

Table 11. Number of evaluations for SKT trend analysis

Trend period	5-year	10-year	25-year
Annual	84	54	12
Winter	150	81	15
Spring	124	91	15
Summer	160	158	38
Fall	115	111	12
Total	633	495	92

Chloride Trends

Annual 5-, 10-, and 25-year trends were estimated for chloride concentrations at 24, 13, and 2 monitoring sites, respectively. In Figure 25, annual chloride trends that are statistically significant with a 90% confidence level are illustrated for the 5-, 10-, and 25-year period. The figure also shows monitoring sites that have no suitable data for estimating trends. Changes in chloride concentration (mg/L per year) are also provided for those monitoring sites with decreasing or increasing trends.



Annual trend slopes for chloride (mg/L per year)

Trend year	CL1	FR5	TC1	TC4	TC6	TC7	FR6	FT1	FC5	FR7	IC4	FR11
	Monitoring sites											
5	42.88	-	11.55	8.67	9.39	11.70	-	4.30	8.83	-	66.42	-
10	-	-4.92	-3.30	-7.98	-7.48	-5.58	-5.00	-	-	-3.50	-	-5.50
25	-	-	-	-	-	-	1.49	-	-	-	-	1.20

Trend year	FR13	BC2	LC1
	Monitoring sites (contd.)		
5	-	5.32	21.30
10	-4.93	-	-6.80
25	-	-	-

Figure 25. Annual trends of chloride concentration

For the 25-year period between 1997 and 2021, the chloride concentration at Fox River at South Elgin (FR6) and Fox River at Montgomery (FR11) showed increasing trends. These are the only two monitoring sites in the Fox River watershed with suitable chloride data for estimating 25-year annual trends. At FR6, the increase in chloride concentration was estimated to be 1.5 mg/L per year (i.e., 1.2% of the median concentration), and it was 1.2 mg/L per year (0.9%) for FR11. The median chloride concentrations at FR6 and FR11 are 126 and 136 mg/L, respectively, during the period of analysis (1997–2021). In contrast, for the 10-year period between 2012 and 2021, a decreasing annual trend was obtained for chloride concentrations at 10 monitoring sites that include FR5, TC1, TC4, TC6, TC7, FR6, FR7, FR11, FR13, and LC1. Note that FR6 and FR11 exhibited increasing 25-year trends but showed a decreasing trend in the past 10 years. The changes in chloride concentration for the 2012–2021 period at FR6 and FR11 are 5 mg/L and 5.5 mg/L per year, respectively, which is a 4% decrease at both monitoring sites. No 10-year annual trend was detected at the remaining three sites in the Fox tributaries, as illustrated in Figure 25. In the 5-year period between 2017 and 2021, the chloride concentration showed an upward trend for 10 monitoring sites, whereas no annual trend was observed for another 14 sites. Four of the sites with an increasing 5-year trend are located on Tyler Creek, and no trend was detected on the Fox River mainstem during the 5-year period between 2017 and 2021.

The seasonal trends of chloride concentration in the Fox River watershed are illustrated in Figures 26–29, showing the 5-, 10-, and 25-year trends for winter, spring, summer and fall seasons. At three monitoring sites on the Fox River mainstem (i.e., FR5, FR6, and FR11), 25-year chloride trends were also estimated for all seasons, and, for three more sites, 25-year summer trends were computed. Increasing trends of chloride concentration were detected at FR6 for all seasons except for winter where it showed no trend. The increase in chloride concentration at FR6 ranges from 1.4 mg/L in spring to 1.8 mg/L per year in summer and fall seasons, which is 1.2 to 1.5% of their respective seasonal median concentrations for the period of analysis. The summer, winter, spring, and fall median concentrations at FR6 are 150 mg/L, 118 mg/L, 117 mg/L, and 131 mg/L, respectively. In contrast, its overall median concentration at this site is 126 mg/L.

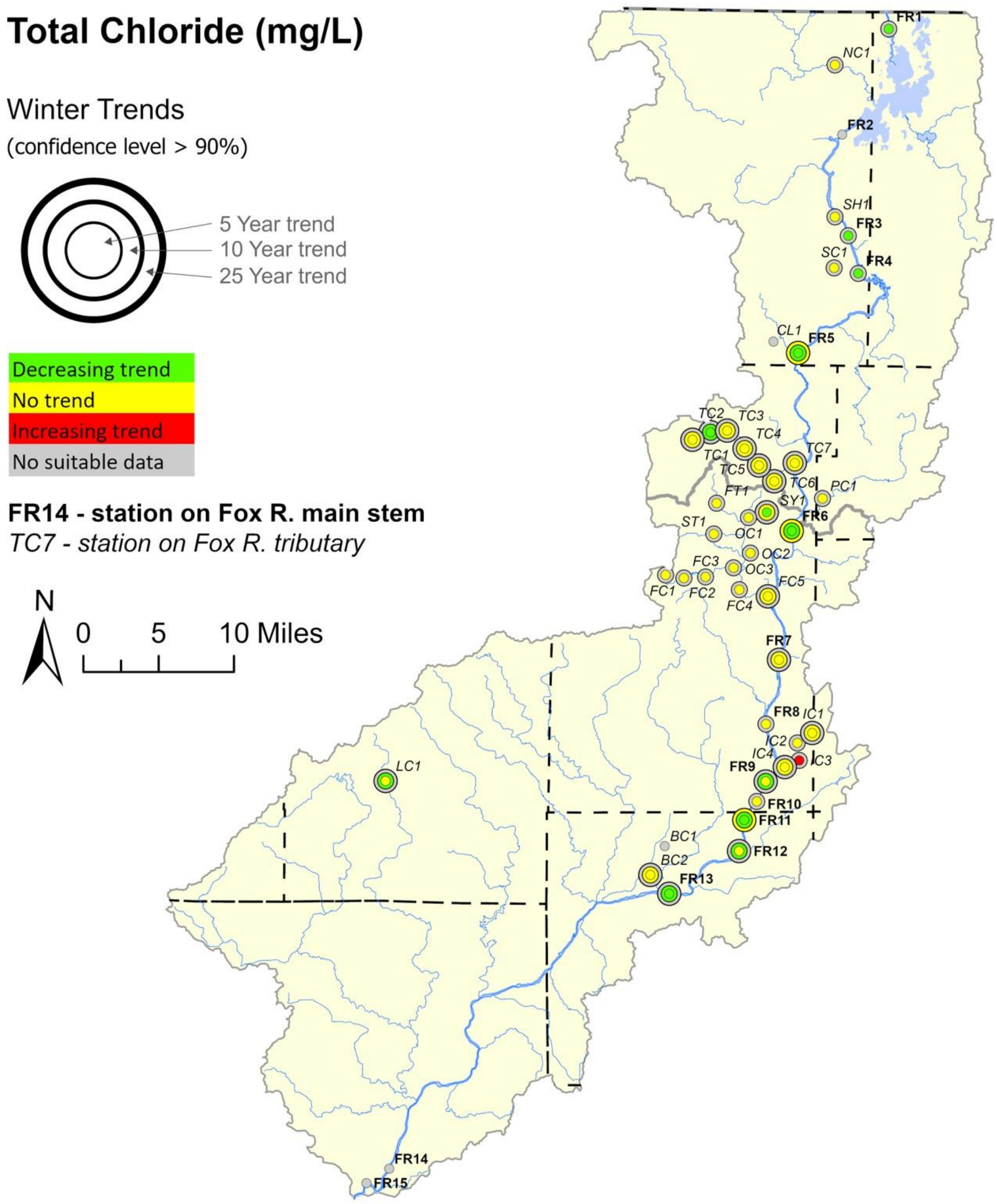
The 10-year winter and spring chloride trends were evaluated at 20 monitoring sites. No trend was observed for all but one site in spring and 12 sites in winter. Chloride concentration showed a decreasing trend for eight monitoring sites in winter and for only a single site (i.e., TC2) in spring during the 10-year period. Tyler Creek at Highland (TC2) also showed a downward trend of chloride concentration for all other seasons. For a total of 38 monitoring sites, 10-year summer trends were evaluated for chloride concentration and no trend was detected in 24 of 38 sites. However, decreasing concentration trends were observed at 13 sites. An upward summer trend (6.4%) was exhibited only for chloride concentration at Indian Creek U.S. Rt. 25 (IC4); its median chloride concentration for summer is 198 mg/L. Fall chloride concentration trended down at 18 monitoring sites, 11 of which are on the Fox River tributaries. Tyler Creek's seven sites all showed decreasing fall trends of chloride concentration. No fall trend was observed at 11 monitoring sites.

A 5-year seasonal trend analysis was conducted for winter, spring, summer, and fall chloride concentrations at 40, 31, 39, and 30 of the 45 monitoring sites in the Fox

River watershed, respectively. For the 5-year period between 2017 and 2021, increasing trends of chloride concentration were seen at eight monitoring sites in fall, seven sites in summer, two sites in spring, and a single site in the winter season. Fox River at South Elgin (FR6) is the only site on the Fox River mainstem that exhibited an increasing 5-year seasonal trend for chloride concentration, which was 12.4 mg/L per year in summer (i.e., 10.6% of its summer median concentration). Decreasing 5-year trends of chloride concentration were observed at nine monitoring sites in winter and only at one site in the spring and summer seasons. Chloride concentration exhibited no trend for 30 sites in winter, 28 sites in spring, 31 sites in summer, and 22 sites in the fall seasons.

The annual and seasonal trend analyses of chloride concentration in the Fox River watershed generally indicated that there is a slight increase in concentration in the 25-year period between 1997 and 2021. In contrast, chloride concentration shows either decreasing or no trend between 2012 and 2021 for almost all 40 monitoring sites in the watershed. Similarly, for the 5-year period between 2017 and 2021, decreasing or no annual and seasonal trends were observed at almost all monitoring sites except for the summer and fall seasons when at least seven monitoring sites showed increasing trends of chloride concentrations.

The 10-year annual and seasonal chloride concentrations appear to exhibit decreasing longitudinal trends along the Fox River except for spring. Similarly, the 10-year annual, fall and summer chloride concentration for Tyler Creek, which has 7 monitoring sites along the creek, showed a downward longitudinal trend. In contrast, an upward longitudinal trend was detected for the 5-year annual and fall chloride concentrations.

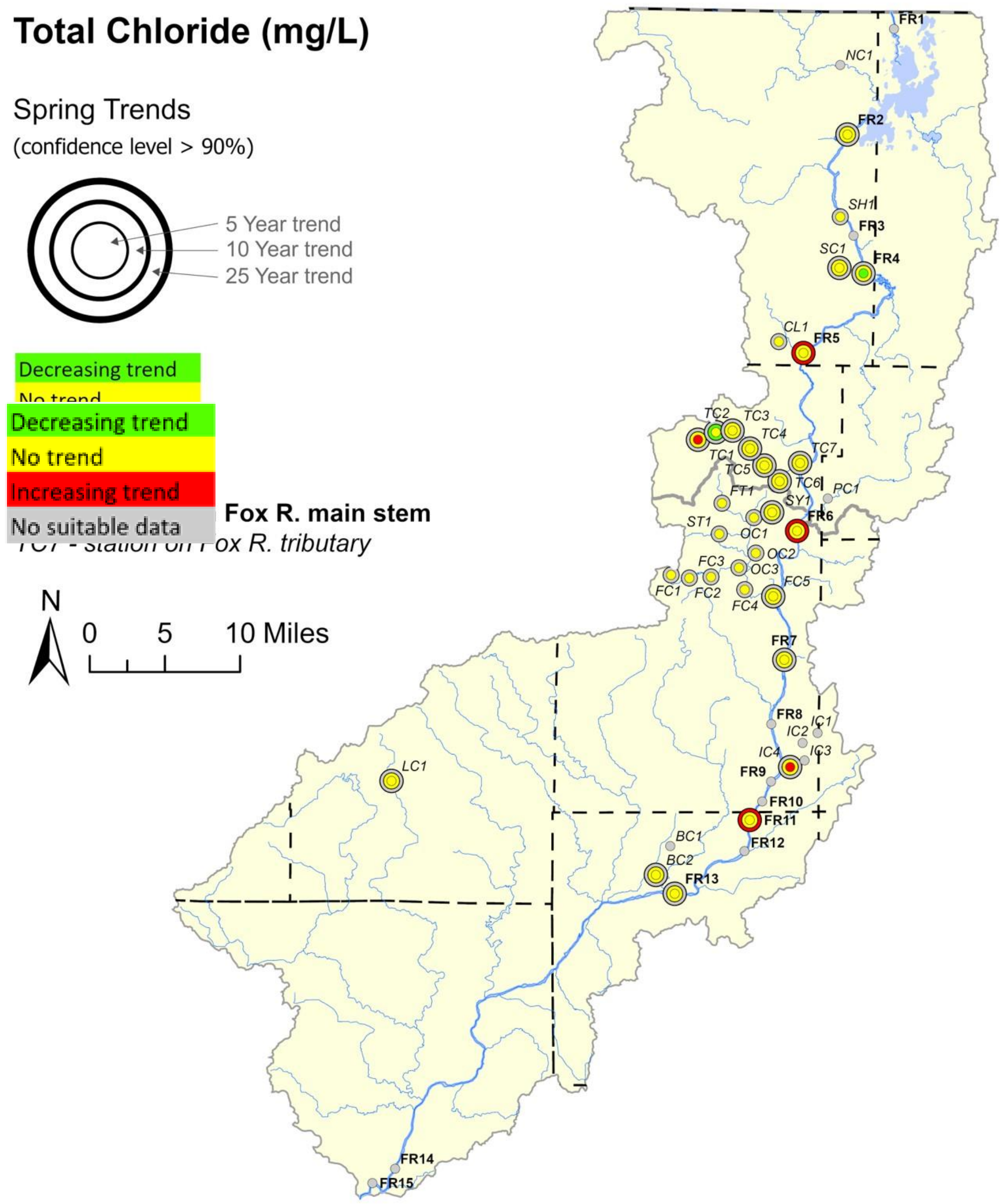


Winter trend slopes for chloride (mg/L per year)

Trend year	FR1	FR3	FR4	FR5	TC2	FR6	SY1	IC3	FR9	FR11	FR12	FR13
	Monitoring sites											
5	-15.06	-12.79	-4.67	-7.35	-7.65	-13.88	-8.97	50.50	-	-11.83	-	-13.67
10	-	-	-	-8.82	-5.21	-5.68	-	-	-5.00	-7.40	-6.50	-6.44
25	-	-	-	-	-	-	-	-	-	-	-	-

Trend year	LC1
	Monitoring sites (contd.)
5	-
10	-16.45
25	-

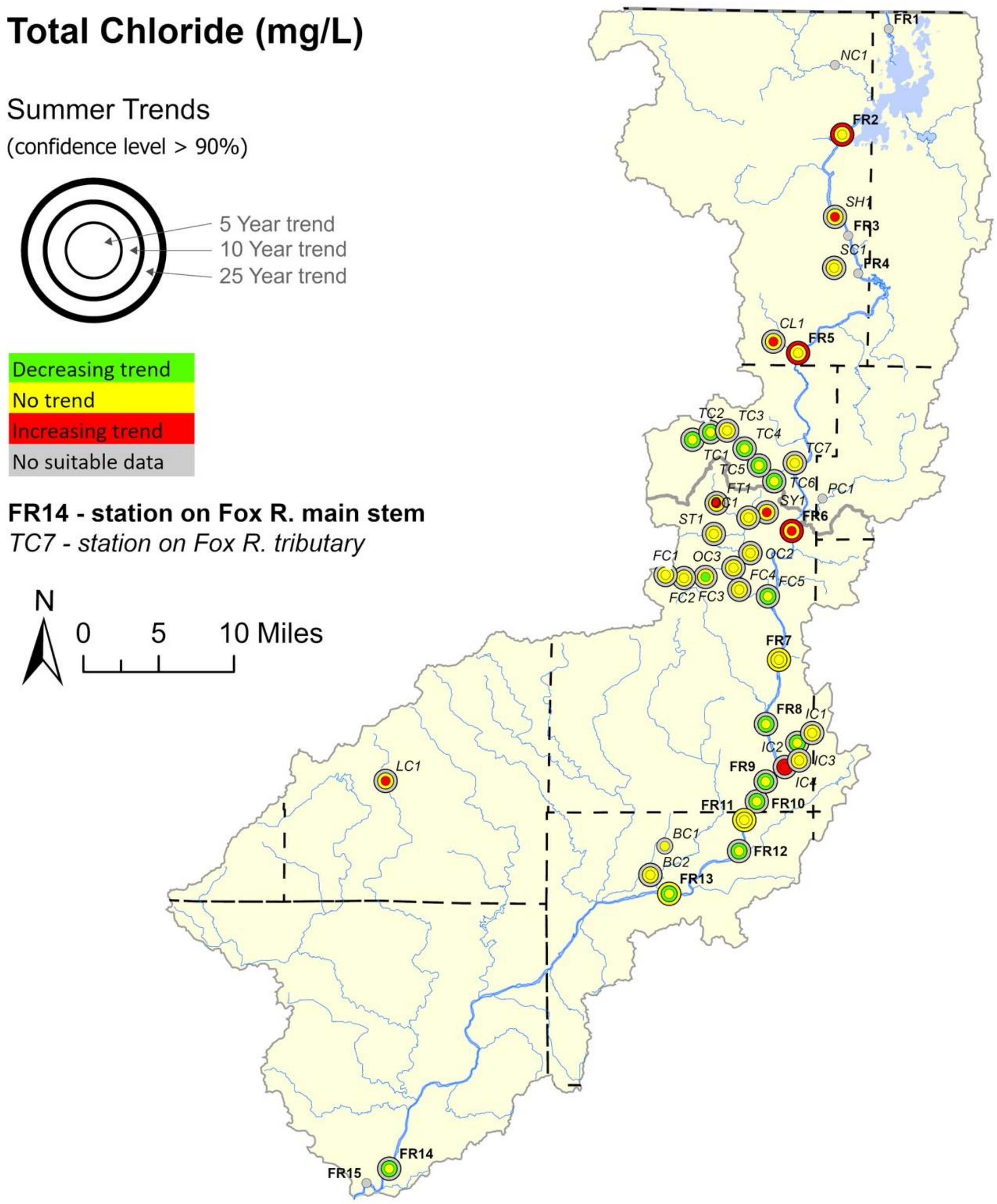
Figure 26. Winter trends of chloride concentration



Spring trend slopes for chloride (mg/L per year)

Trend year	FR4	FR5	TC1	TC2	FR6	IC4	FR11
	Monitoring sites						
5	-8.30	-	8.92	-	-	81.63	-
10	-	-	-	-3.61	-	-	-
25	-	1.00	-	-	1.42	-	1.77

Figure 27. Spring trends of chloride concentration

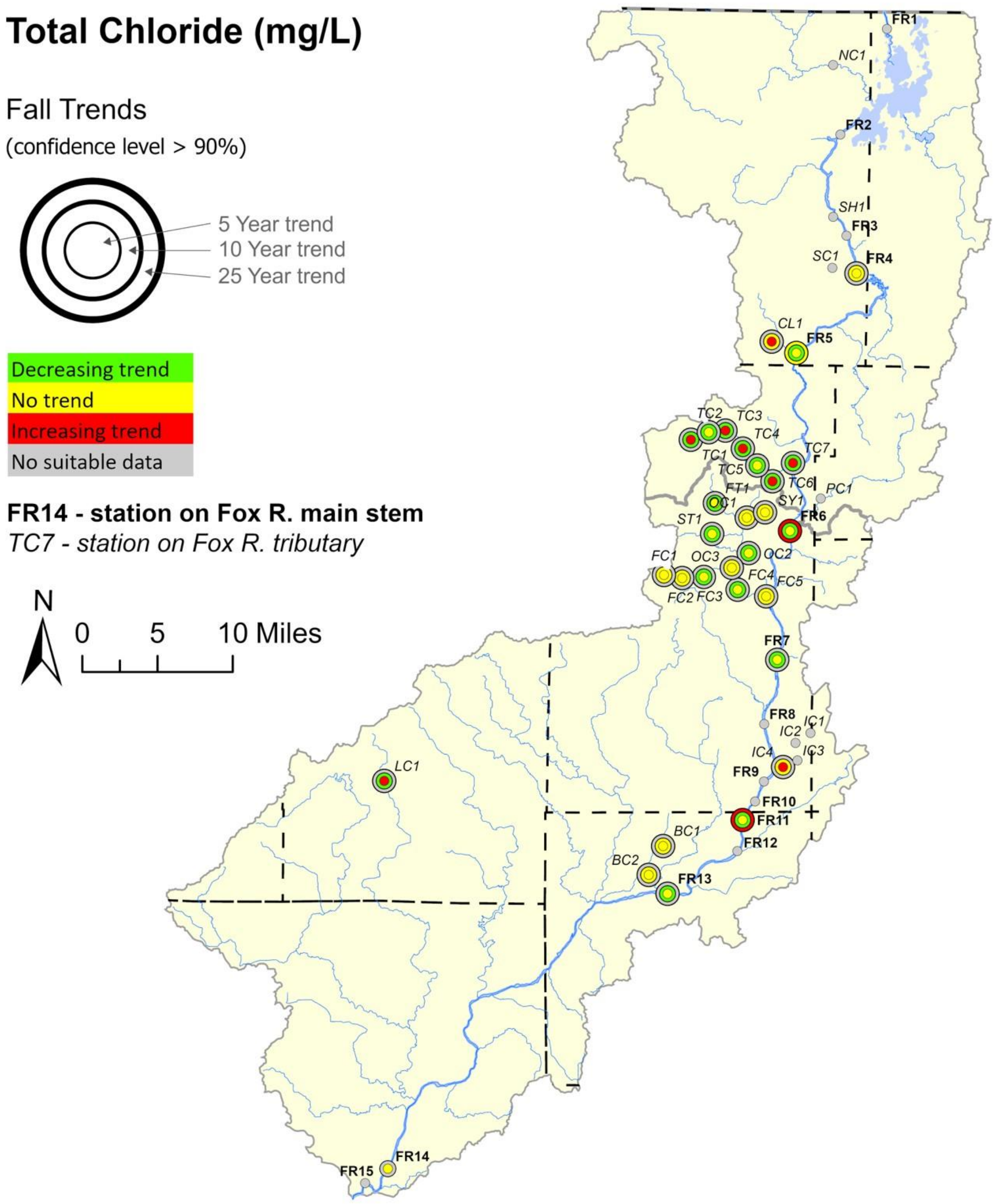


Summer trend slopes for chloride (mg/L per year)

Trend year	FR2	SH1	CL1	FR5	TC1	TC2	TC4	TC5	TC6	FR6	SY1	FT1
	Monitoring sites											
5	-	22.30	53.00	-	-	-	-	-	-	12.42	6.65	7.58
10	-	-	-	-	-7.87	-4.45	-8.94	-8.77	-11.33	-	-	-
25	0.93	-	-	2.08	-	-	-	-	-	1.78	-	-

Trend year	FC3	FC5	FR8	IC2	IC4	FR9	FR10	FR12	FR13	LC1	FR14
	Monitoring sites (contd.)										
5	-2.97	-	-	-	51.25	-	-	-	-	22.67	-
10	-	-5.00	-7.00	-11.42	12.76	-7.31	-8.85	-10.25	-4.00	-	-7.96
25	-	-	-	-	-	-	-	-	-	-	-

Figure 28. Summer trends of chloride concentration



Fall trend slopes for chloride (mg/L per year)

Trend year	CL1	FR5	TC1	TC2	TC3	TC4	TC5	TC6	TC7	FR6	FT1	ST1
	Monitoring sites											
5	60.33	-	24.04	-	16.63	22.03	-	12.69	36.89	-	-	-
10	-	-10.72	-5.21	-7.85	-10.21	-23.04	-17.28	-12.62	-8.84	-7.31	-5.52	-2.56
25	-	-	-	-	-	-	-	-	-	1.84	-	-

Trend year	OC2	FC3	FC4	FR7	IC4	FR11	FR13	LC1
	Monitoring sites (contd.)							
5	-	-	-	-	73.00	-	-	29.20
10	-12.12	-4.21	-6.33	-9.67	-	-7.58	-9.57	-10.33
25	-	-	-	-	-	1.43	-	-

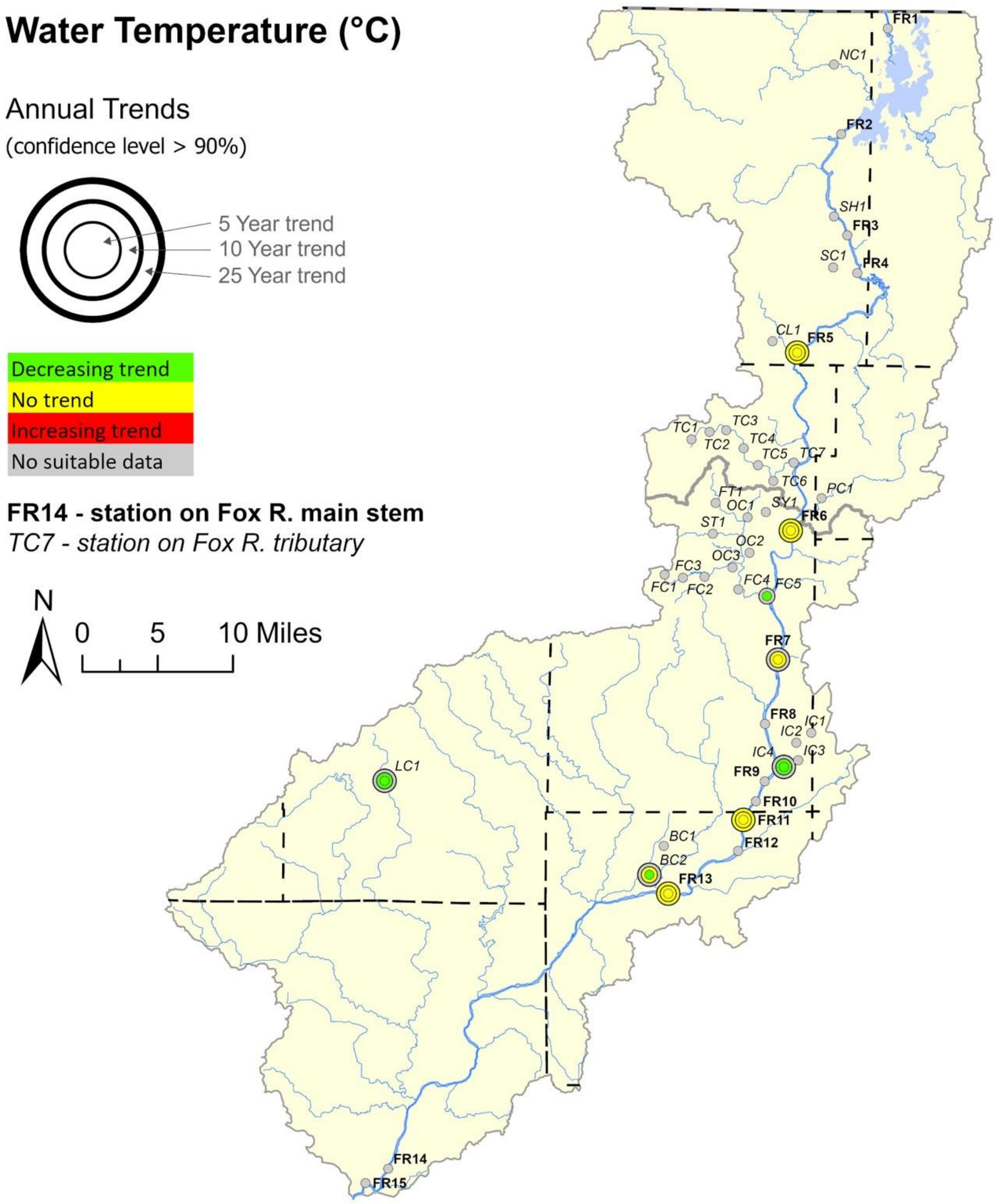
Figure 29. Fall trends of chloride concentration

Water Temperature Trends

Annual trends of water temperature in the Fox River and its tributaries were evaluated for 5-, 10-, and 25-year periods at 9 of the 45 monitoring sites with suitable data, as illustrated in Figure 30. A 25-year annual trend was estimated for water temperature at four monitoring sites, and none showed either an upward or a downward trend. No trend was detected at seven monitoring sites for the 10-year period, but a downward annual trend was observed at two sites. Little Indian Creek at downstream University Rd. Br. (LC1) is one of the two monitoring sites, and its water temperature shows a decrease of 0.18°C per year (i.e., 1.7% of the median water temperature at LC1). The 5-year annual trend was downward for four monitoring sites, but no trend was detected at five sites. Between 1997 and 2021, no upward trend was observed at any of the nine sites for the 5-, 10-, or 25- year period.

For all seasons, water temperature trends were evaluated for at least 21 monitoring sites. Summer trends were estimated at 39 sites and no trend was detected for the 5-, 10-, and 25-year periods at 39, 38, and 7 monitoring sites, respectively, as illustrated in Figure 31. Except for summer and fall seasons, water temperature generally showed no trend in almost all monitoring sites for the 5-, 10-, and 25-year periods. Summer water temperatures showed an upward trend at five monitoring sites for a 5-year period but only at a single site for a 10-year period. All sites with upward trends of water temperature are on the tributaries. A decreasing 10-year trend for the summer season was observed only at Indian Creek downstream Outfall (IC3). Eight monitoring sites, which are all on the tributaries, exhibited an upward 10-year trend for fall season; three of the sites are on Ferson Creek. A decreasing 5-year fall trend was obtained for Fox River at Rt. 71 (FR14) and Fox River at Ottawa (FR15). A 25-year fall trend was evaluated at four sites (i.e., FR5, FR6, FR11, and FR13) and none showed any fall trend. A downward spring trend was obtained for water temperature at 10 monitoring sites for the 5-year period and at only three sites for the 10-year period. Indian Creek U.S. Rt. 25 (IC4), for example, exhibited downward spring trends in the last 5- and 10-year periods with decreases in water temperature of 0.91°C and 0.37°C per year, respectively. The spring median temperature at IC4 is 11°C. For the 5- and 10-year periods, no winter trend was observed for water temperatures at 30 and 11 monitoring sites, respectively. Fox River at Fabyan Pk-Geneva (FR7) is the only site with decreasing winter trends for both 5- and 10-year periods. Water temperature generally shows a downward or no seasonal trend for the 5-year and 10-year periods, except for some tributaries in the fall season.

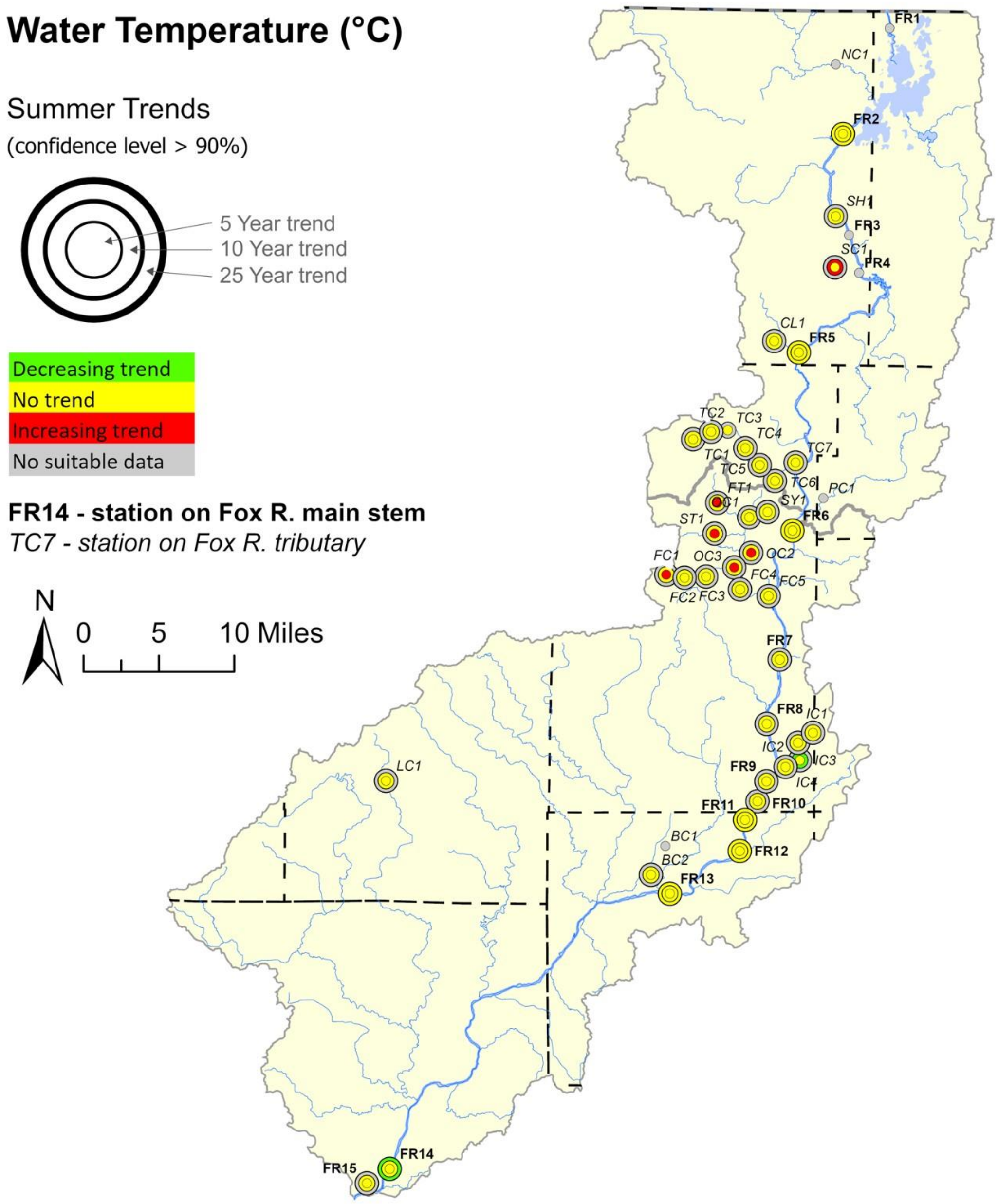
No longitudinal trend was detected for annual or seasonal water temperatures in the Fox River and its tributaries except for the fall water temperatures at Ferson Creek for the 10-year period, which showed an upward trend. Trend maps of water temperature for all seasons are included in Appendix B.



Annual trend slopes for water temperature (⁰C per year)

Trend year	FC5	IC4	BC2	LC1
	Monitoring sites			
5	-0.37	-0.33	-0.42	-0.25
10	-	-0.13	-	-0.18
25	-	-	-	-

Figure 30. Annual trends of water temperature



Summer trend slopes for water temperature (ºC per year)

Trend year	SC1	FT1	ST1	OC2	OC3	FC1	IC3	FR14
	Monitoring sites							
5	-	0.94	0.73	1.02	1.24	1.54	-	-
10	0.90	-	-	-	-	-	-0.39	-
25	-	-	-	-	-	-	-	-0.07

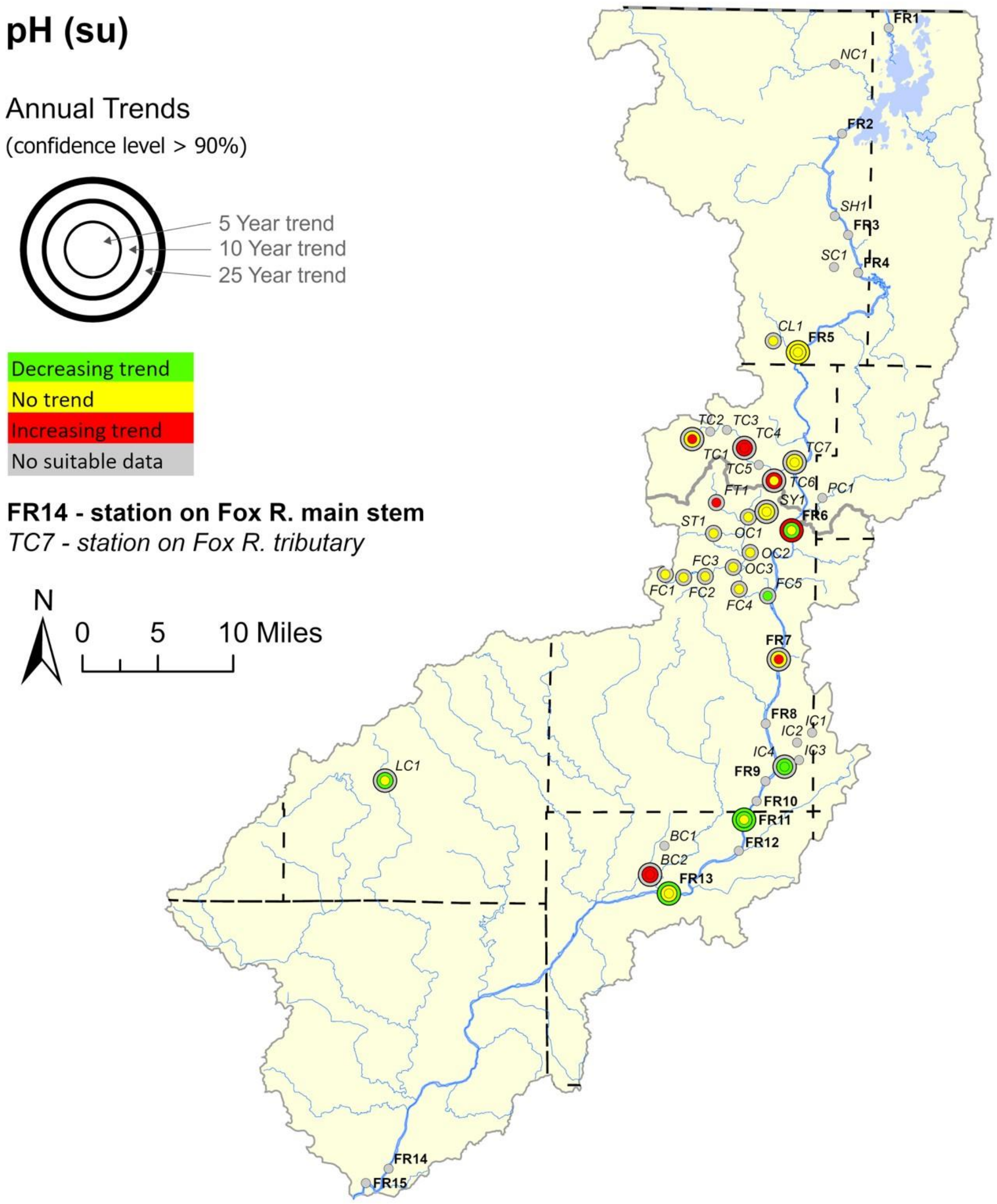
Figure 31. Summer trends of water temperature

pH Trends

Annual trends of pH were evaluated at 24 monitoring sites in the Fox River watershed as shown in Figure 32. A 5-year trend was estimated for all sites, but the 10- and 25-year trends were computed for 13 and 4 monitoring sites, respectively, based on the data suitability analysis. The 25-year pH data showed an increasing trend for FR6, no trend for FR5, and a decreasing trend for FR11 and FR13 sites. The upward trend slope for FR6 is 0.1% per year of its median pH, which is 8.3. In contrast, the 10-year pH data between 2012 and 2021 shows an upward trend (0.2%) for FR6. No trend was observed at this site for the 5-year period between 2017 and 2021. Three sites (i.e., TC4, TC5, and BC2), which are all sites on the tributaries, showed an upward 10-year trend with the highest slope of 0.04 per year for BC2 (0.5%). The 5-year pH data indicates that it exhibited no annual trend at 17 monitoring sites, a downward trend at two sites, and an upward trend at five sites, one of which is FR7. The median pH at FR7 is 8.3 and its upward trend slope is 0.09 per year, which is 1.0% of its median. Increasing 10-year trends were seen at five sites located on the tributaries. In contrast, upward 5- and 25-year trends were observed at two and three monitoring sites, respectively, which are all on the Fox River mainstem. The pH at the same sites showed no 10-year trend.

Summer pH trends for 37 monitoring sites in the Fox River watershed are presented in Figure 33. The 5- and 10-year summer trends were evaluated for all 37 monitoring sites, and no trend was detected at 33 and 28 sites for the 5-year and 10-year periods, respectively. The 5-year summer increase at Fox River at Chapel Rd, Johnsburg (FR2), which is one of the monitoring sites with an upward trend, is 0.25 per year (2.9% of its summer median). The winter, spring, and fall pH trends were evaluated at 36, 31, and 27 monitoring sites in the watershed, respectively. The winter pH showed an upward trend at five sites for the 5-year period and at only one site for the 10-year period. Three of the monitoring sites with a 5-year upward pH trend are FR9, FR10, and FR13. A downward 25-year trend was detected for winter pH at FR11, FR12, and FR13, which is about 0.1% per year of their respective winter median. The 5- and 10-year spring pH showed an upward trend at four and six monitoring sites, respectively, which are mostly on the tributaries. Four of these sites on Tyler Creek (TC1, TC2, TC3, and TC4) had trend slopes ranging from 0.2 to 0.4% per year of their respective median pH for spring (i.e., 7.6 to 7.8). FR2 and FR7 are the only two monitoring sites that showed an increasing 10-year trend for spring, and the pH at FR7 also exhibited a 5-year upward spring trend at 1.2% per year. A decreasing 25-year spring trend was detected at FR11, FR13, and BC1 sites, which are 0.3% per year of their respective median pH. FR11 and FR13 also showed a downward 25-year trend for the fall season. For the 5- and 10-year periods, an upward trend of fall pH was observed at three and five monitoring sites, respectively, all of which are located on the tributaries, most sites on Tyler Creek.

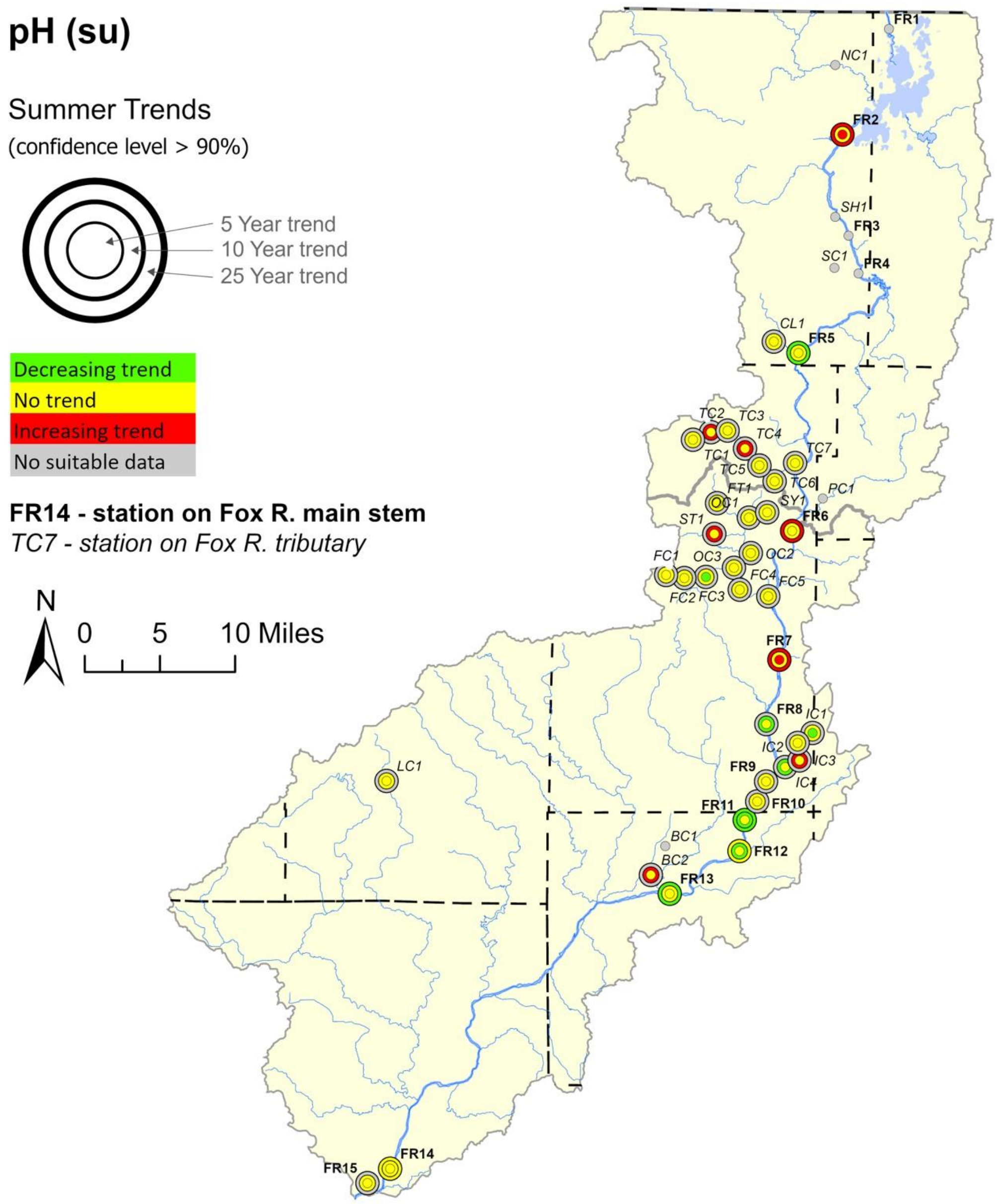
The pH showed no trend for the 5- and 10-year period for most of the monitoring sites in the Fox River and tributaries, but it showed an upward trend for the 25-year period 50% of the time. Except for summer, the 25-year annual and seasonal pH exhibited a downward trend for Fox River at Montgomery and a couple of downstream monitoring sites. However, no longitudinal trend was detected for either annual or seasonal pH along Fox River and its tributaries.



Annual trend slopes for pH (su per year)

Trend year	Monitoring sites											
	TC1	TC4	TC6	FR6	FT1	FC5	FR7	IC4	FR11	FR13	BC2	LC1
5	0.05	0.04	-	-	0.02	-0.12	0.09	-0.09	-	-	0.09	-
10	-	0.02	0.01	-0.02	-	-	-	-0.03	-0.04	-	0.04	-0.01
25	-	-	-	0.00	-	-	-	-	-0.02	-0.02	-	-

Figure 32. Annual trends of pH



Summer trend slopes for pH (su per year)

Trend year	FR2	FR5	TC2	TC4	FR6	ST1	FC3	FR7	FR8	IC1	IC3	IC4
5	0.25	-	-	-	-	-	-0.04	0.12	-	-0.07	-	-
10	-	-	0.04	0.02	-	0.02	-	-	-0.06	-	0.01	-0.03
25	0.02	-0.01	-	-	0.01	-	-	0.01	-	-	-	-

Monitoring sites (contd.)

Trend year	FR11	FR12	FR13	BC2
5	-	-	-	-
10	-0.08	-0.06	-	0.06
25	-0.01	-	-0.02	-

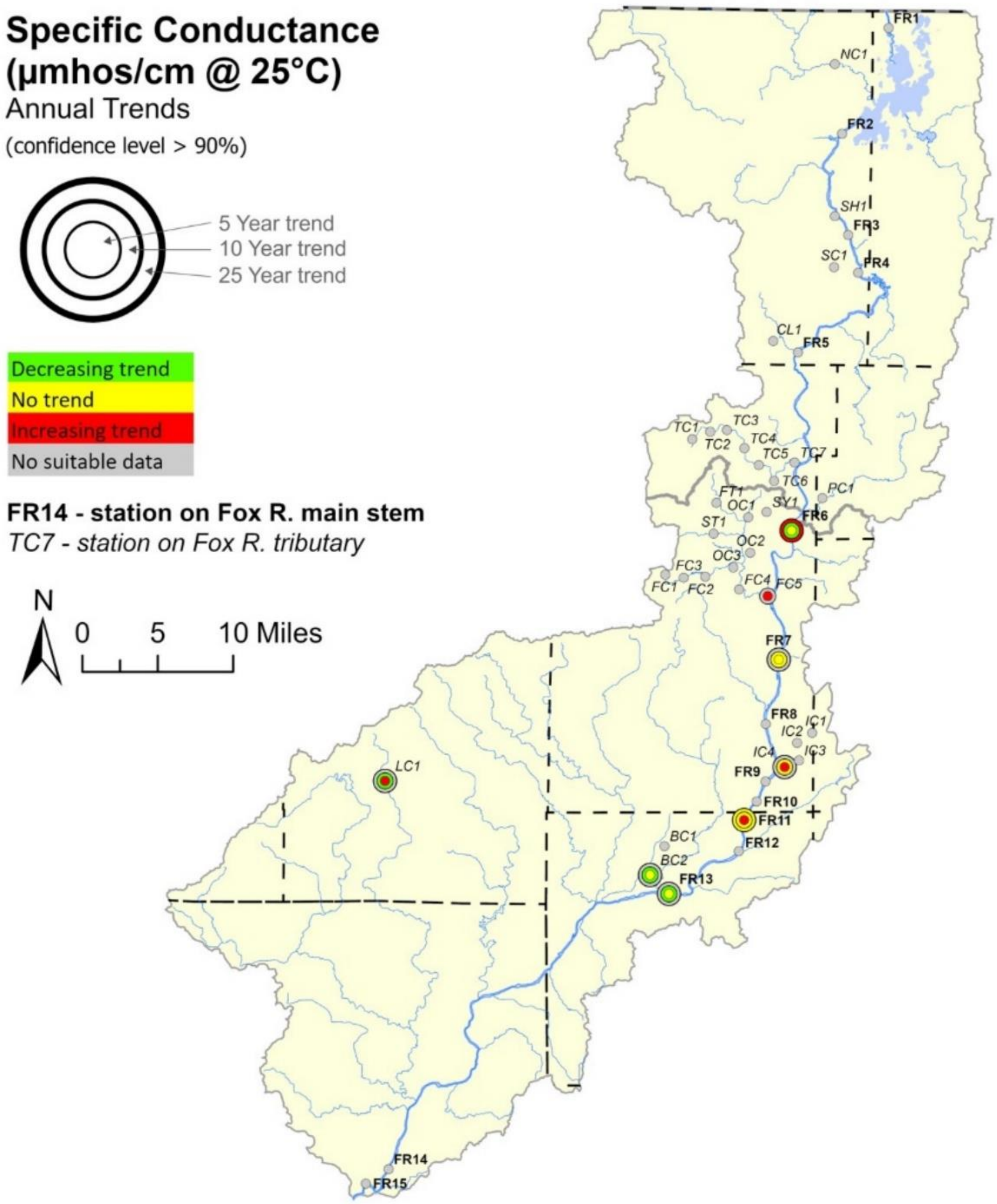
Figure 33. Summer trends of pH

Specific Conductance Trends

Annual trends of specific conductance corrected for 25°C are presented in Figure 34, and trend slopes are also provided for those monitoring sites with decreasing or increasing specific conductance during the 5-, 10-, and 25-year periods. A 25-year annual trend was evaluated for Fox River at South Elgin (FR6) and Fox River at Montogomery (FR11), which are the only two monitoring sites with suitable data for the 25-year period. Results showed an upward trend for FR6 but no trend for FR11. For the 25-year period between 1997 and 2021, the upward trend slope for the specific conductance at FR6 is 9.8 µmhos/cm per year, which is 1.1 % of the median conductivity for the site. The 5- and 10-year annual trends of specific conductivity were estimated at eight and seven monitoring sites, respectively. An increasing 5-year trend was observed at four of the monitoring sites, but the remaining four sites showed no trend. Fox River at Montgomery (FR11) is the only site on the Fox River mainstem that exhibited the upward annual trend (i.e., 46.3 µmhos/cm per year) for the 5-year period between 2017 and 2021. Indian Creek upstream Rt. 25 (IC4) showed the highest 5-year trend slope of 169.3 µmhos/cm per year, which is 17.1% of its median. Decreasing 10-year trends were detected at four sites, two of which are Fox River at South Elgin (FR6) and Fox River at Yorkville (FR13). The slopes of their respective downward trends at FR6 and FR13 are 10.0 and 23.4 µmhos/cm per year, respectively.

*S*easonal trends of specific conductance for the 25-year period between 1997 and 2021 were estimated at two monitoring sites for winter and spring at five sites for summer, and at a single site for fall. In Figure 35, summer trends of specific conductance are presented. Only Fox River at Montgomery (FR11) has suitable data for estimating 25-year trends for all seasons, exhibiting an upward trend of specific conductivity in summer, no trend in spring, and a downward trend in winter and fall. The trend slopes obtained for specific conductance at FR11 are 6.9 µmhos/cm and 12.9 µmhos/cm per year for the upward summer and winter trends, respectively. An upward 10-year trend was observed at Fox River at Rt. 34, Oswego (FR12) in winter and Fox River at Chapel Rd, Johnsburg (FR2) in spring. In summer, the specific conductance exhibited a downward 10-year trend at eight monitoring sites and showed no trend at 11 sites for the summer season. A 5-year seasonal trend was evaluated at 17 monitoring sites for winter, 13 sites for spring, 19 sites for summer, and 9 sites for fall. No seasonal trend of specific conductance was observed at most of the monitoring sites. Little Indian Creek at downstream University Rd. Br. (LC1), Ferson Creek near St. Charles (FC5), and Fox River at Sullivan Br. (FR8) showed increasing 5-year summer trends. In contrast, there were no summer trends at 16 of the 19 monitoring sites for the 5-year period. An upward spring trend for the 5-year period was obtained only for Indian Creek upstream Rt. 25 (IC4). In winter and spring, Fox River at Yorkville (FR13) exhibited a downward trend of specific conductance for the 5-year period between 2017 and 2021. Downward 5-year trends were also observed at Fox River at Rawson Rd., E Oakwood Hills (FR4) in winter and at Sleepy Hollow Creek at Stilling Ln. (SH1) in spring.

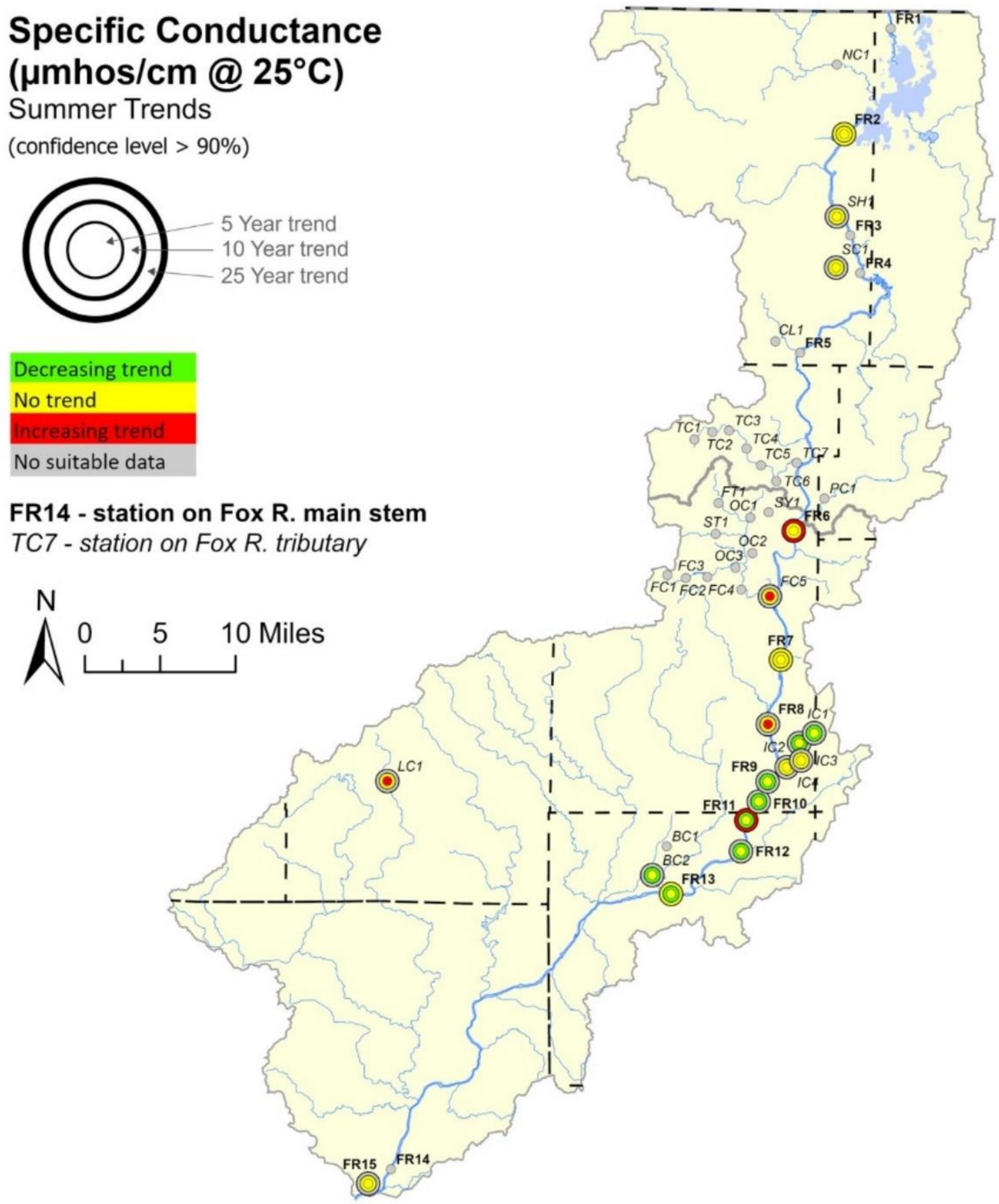
Summer specific conductance exhibited a decreasing longitudinal trend downstream of Fox River at Sullivan Br. (FR8) for the 10-year period.



Annual trend slopes for specific conductance (µmhos/cm @ 25ºC per year)

Trend year	Monitoring sites						
	FR6	FC5	IC4	FR11	FR13	BC2	LC1
5	-	53.88	169.25	46.25	-	-	80.00
10	-10.00	-	-	-	-23.42	-13.48	-20.00
25	9.83	-	-	-	-	-	-

Figure 34. Annual trends of specific conductance corrected for 25^0C



Summer trend slopes for specific conductance (µmhos/cm @ 25⁰C per year)

Trend year	FR6	FC5	FR8	IC1	IC2	FR9	FR10	FR11	FR12	FR13	BC2	LC1
	Monitoring sites											
5	-	59.00	55.88	-	-	-	-	-	-	-	-	100.00
10	-	-	-	-34.00	-32.00	-20.63	-21.18	-22.71	-27.79	-22.68	-13.01	-
25	9.38	-	-	-	-	-	-	6.91	-	-	-	-

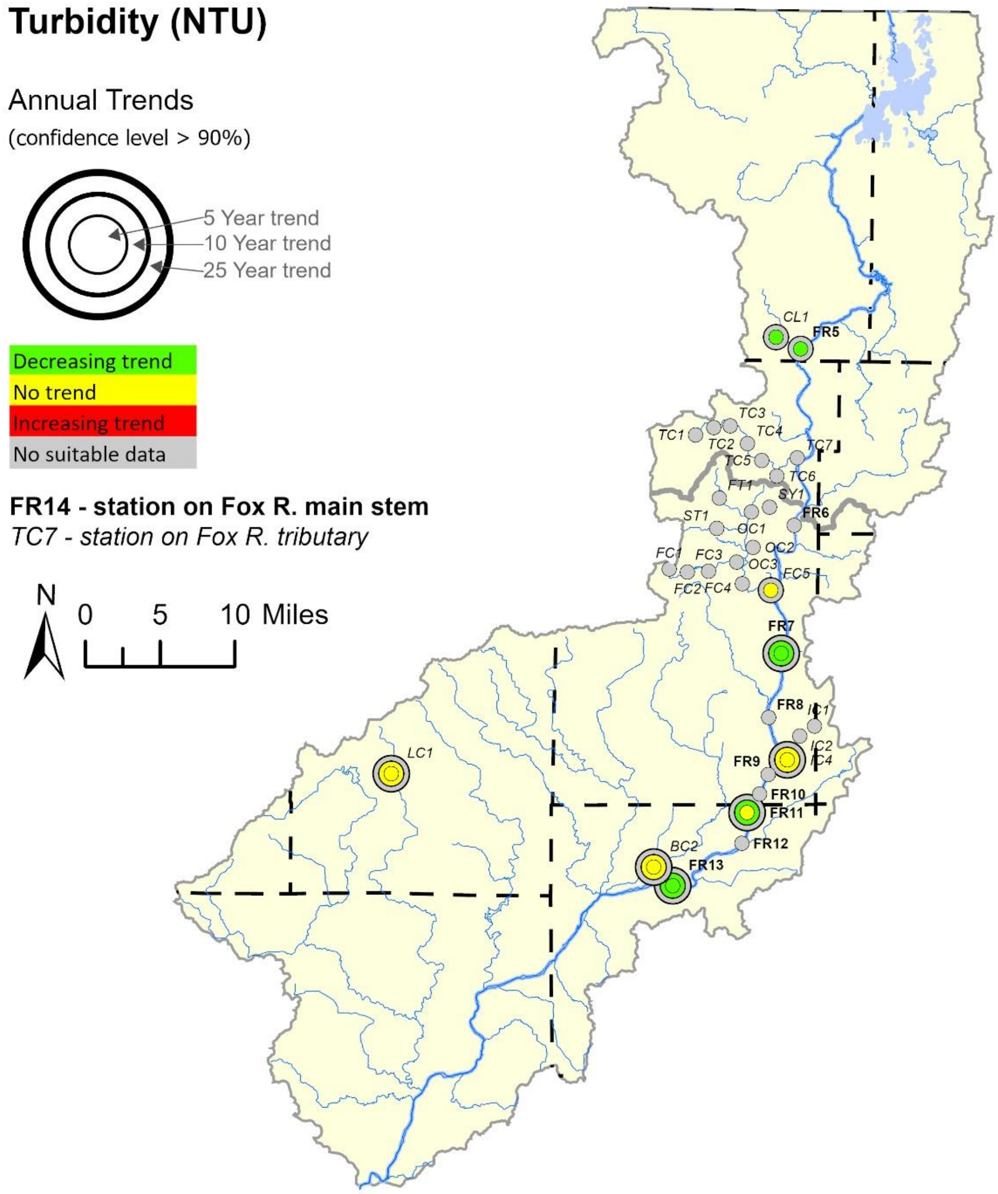
Figure 35. Summer trends of specific conductance corrected for 25^{0}C

Turbidity Trends

No suitable turbidity data were available for estimating a 25-year annual trend. The 5- and 10-year annual trends of turbidity in the Fox River and tributaries are illustrated in Figure 36 for the 2017–2021 and 2012–2021 periods. None of the monitoring sites exhibit an upward annual trend for both periods. Decreasing turbidity trends, however, were observed at four monitoring sites for the 5-year period and at three sites for the 10-year period. The downward trend slope at these sites was 0.57 to 1.5 NTU per year for the 5-year period, whereas it was 0.4 to 0.75 NTU per year for the 10-year period, indicating larger decreases in the 5-year period. Indian Creek upstream Rt. 25 (IC4) exhibited the highest percent change in turbidity for the 5-year period, which was 15.1% of the median turbidity of the site (i.e., 7.3). Fox River at Fabyan Pk-Geneva (FR7) and at Yorkville (FR13) sites showed a downward trend for both 5- and 10-year periods. In contrast, Fox River at Montgomery (FR11) exhibited an upward annual trend for the 10-year period but no trend for the 5-year period. Turbidity showed no trend for the 2017–2021 and 2012–2021 periods at five and three monitoring sites in the watershed, respectively.

Winter, spring, summer, and fall trends of turbidity were estimated at 11, 14, 13, and 10 monitoring sites, respectively, in the Fox River watershed. The winter turbidity showed no trend at any of the monitoring sites for either the 5- or 10-year period. Similarly, no 5-year trend was observed in spring for any site. In contrast, two sites (i.e., FR7 and FR13) showed a downward spring trend, whereas an upward trend was detected at IC4. For the fall season, decreasing turbidity trends were obtained at three and six monitoring sites in the watershed for the 5- and 10-year periods, respectively. Figure 37 shows summer turbidity trends for the 5-, 10-, and 25-year periods. A 25-year summer trend was evaluated at six monitoring sites, which are all located on the Fox River mainstem (i.e., FR2, FR5, FR6, FR7, FR11, and FR13) and all sites showed a downward trend. These monitoring sites also exhibited a downward 10-year trend except for FR13. The highest median turbidity of 29.8 NTU was obtained for Fox River at Algonquin (FR5) in the summer season and the downward trend slopes are 1.5 NTU per year for the 10-year and 1.0 NTU for the 25-year periods, respectively. An upward seasonal or annual trend of turbidity was not observed at any of the monitoring sites, except for Indian Creek upstream Rt. 25 (IC4).

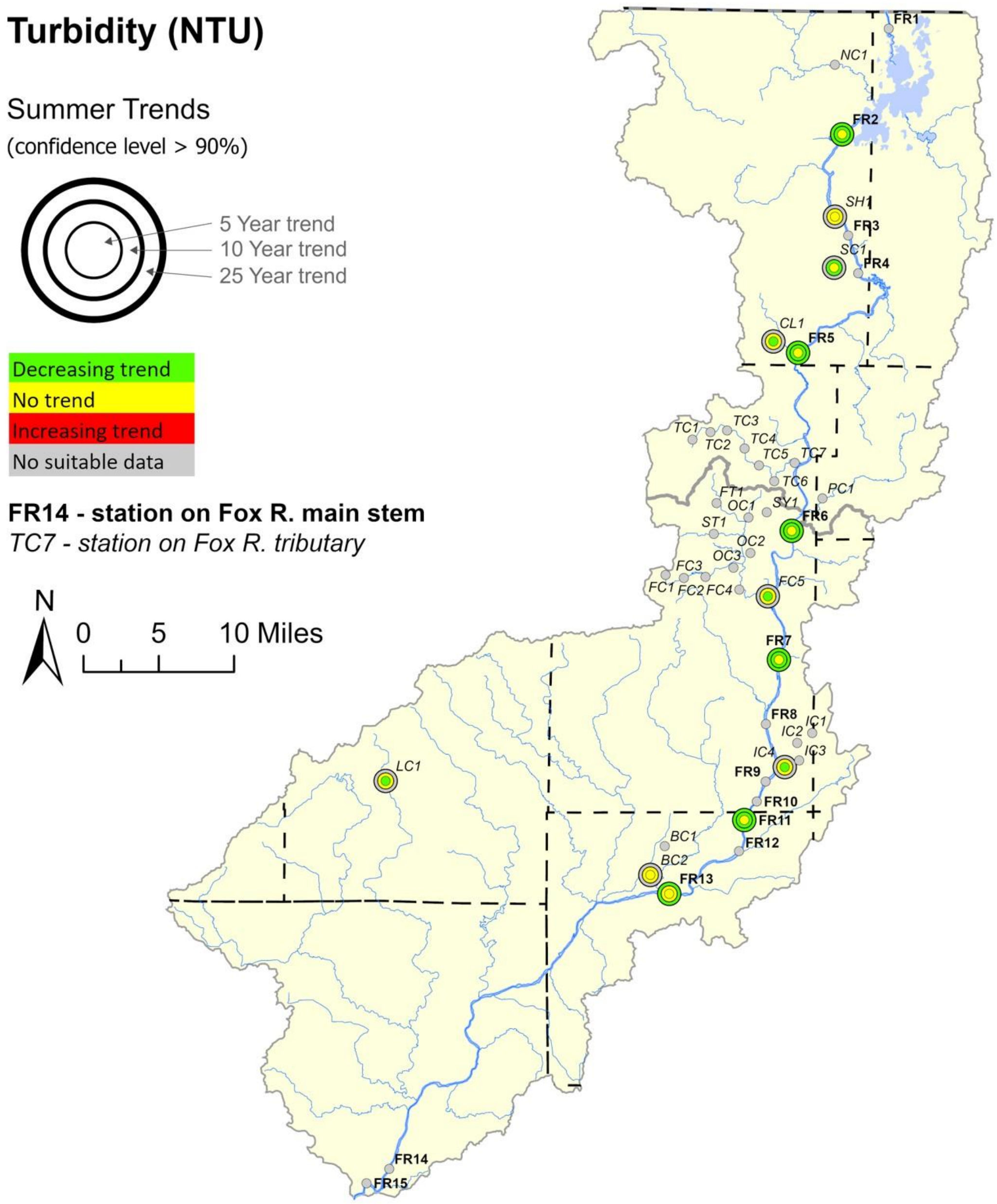
A downward longitudinal trend was observed for the summer and fall turbidity along the Fox River mainstem during the 10- and 25-year periods, and during the 10-year period, respectively.



Annual trend slopes for turbidity (NTU per year)

Trend year	FR7	IC4	FR11	FR13	LC1
	Monitoring sites				
5	-1.50	-1.10	-	-0.95	-0.57
10	-0.75	-	-0.50	-0.40	-
25	-	-	-	-	-

Figure 36. Annual trends of turbidity



Summer trend slopes for turbidity (NTU per year)

Trend year	FR2	SC1	CL1	FR5	FR6	FC5	FR7	IC4	FR11	FR13	LC1
	Monitoring sites										
5	-	-	-1.60	-	-	-4.60	-	-1.03	-	-	-2.07
10	-1.21	-0.28	-	-1.50	-1.11	-	-1.00	-	-0.57	-	-
25	-0.54	-	-	-1.00	-0.67	-	-0.60	-	-0.59	-0.41	-

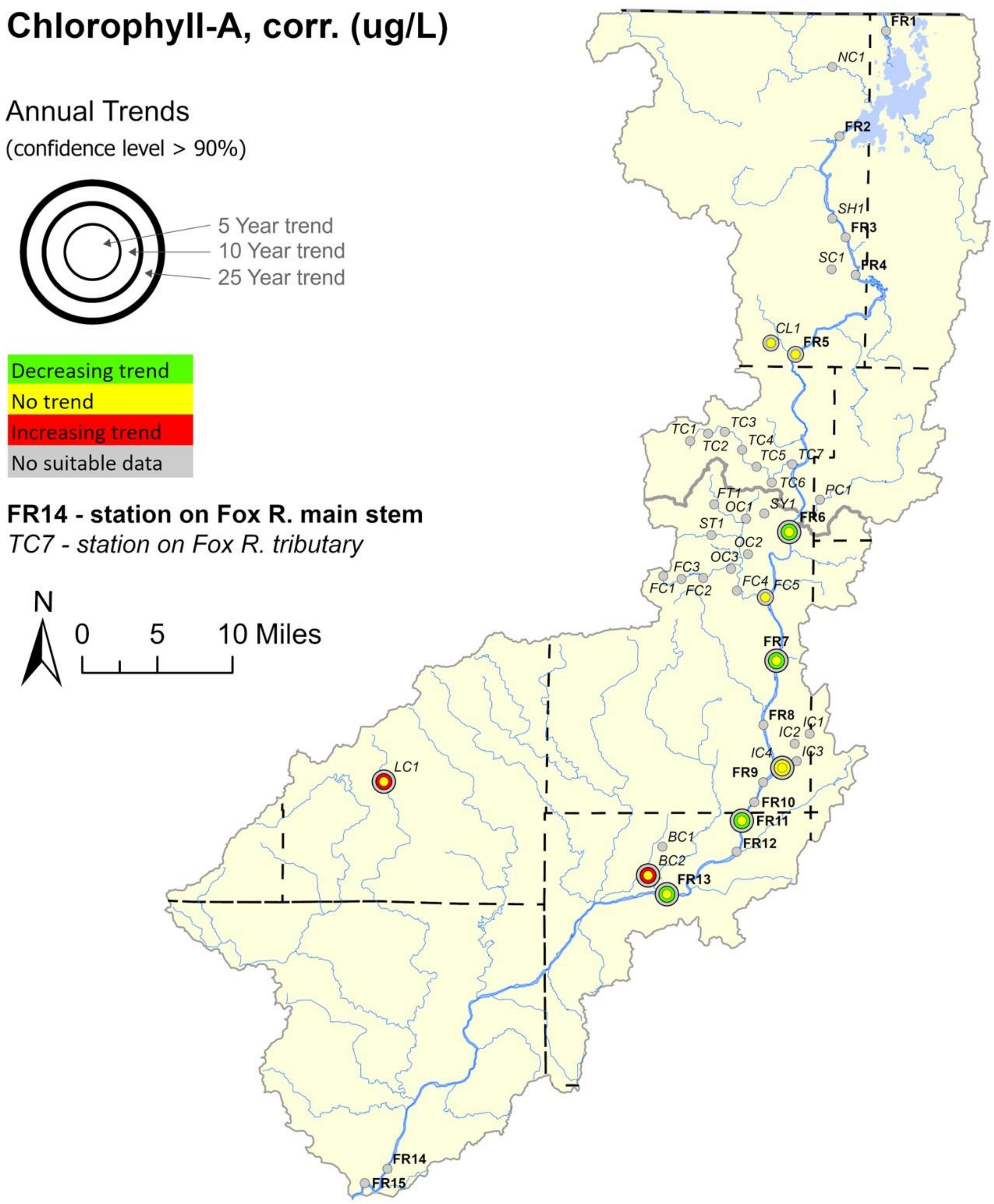
Figure 37. Summer trends of turbidity

Chlorophyll-A Trends

The annual trends of chlorophyll-A are shown in Figure 38. A 5-year trend was evaluated at 10 monitoring sites, but no trend was detected at any of the sites. For the 10-year period, no trend was observed only for Indian Creek upstream Rt. 25 (IC4). A downward 10-year trend was observed at four monitoring sites on the Fox River mainstem (i.e., FR6, FR7, FR11, and FR12), whereas an upward trend was detected at two sites on the tributaries (i.e., BC2 and LC1). The downward trend slopes range from 1.9 µg/L for FR6 to 4 µg/L per year for FR7, which amounts to 3% to 6% of their respective median concentration. The median chlorophyll-A concentration for FR6 and FR7 are 56.1 and 69.4 µg/L, respectively.

Figure 39 illustrates summer trends of chlorophyll-A. A 25-year summer trend was estimated at six monitoring sites where it showed no trend for all but one site. At 13 monitoring sites, 5- and 10-year summer trends were evaluated, indicating no trend in 11 and 9 of the monitoring sites, respectively. For the 10-year period, summer chlorophyll-A exhibited a downward trend at FR7 and FR11, whereas it showed an increasing trend at Blackberry Creek at Rt. 47 near Yorkville (BC2) and Little Indian Creek at downstream University Rd. Br. (LC1). Winter, spring, and fall trends were estimated only for a 5- and 10-year period and no 5-trend was observed, except for summer chlorophyll-A at FR7 that showed a decreasing trend (i.e., 1.2 µg/L per year). For the 10-year period between 2012 and 2021, no trend was detected at seven monitoring sites for winter, nine sites for spring, and ten sites for fall. For the 10-year period, chlorophyll-A showed an upward spring trend for two sites on the tributaries and a downward trend for five sites in spring.

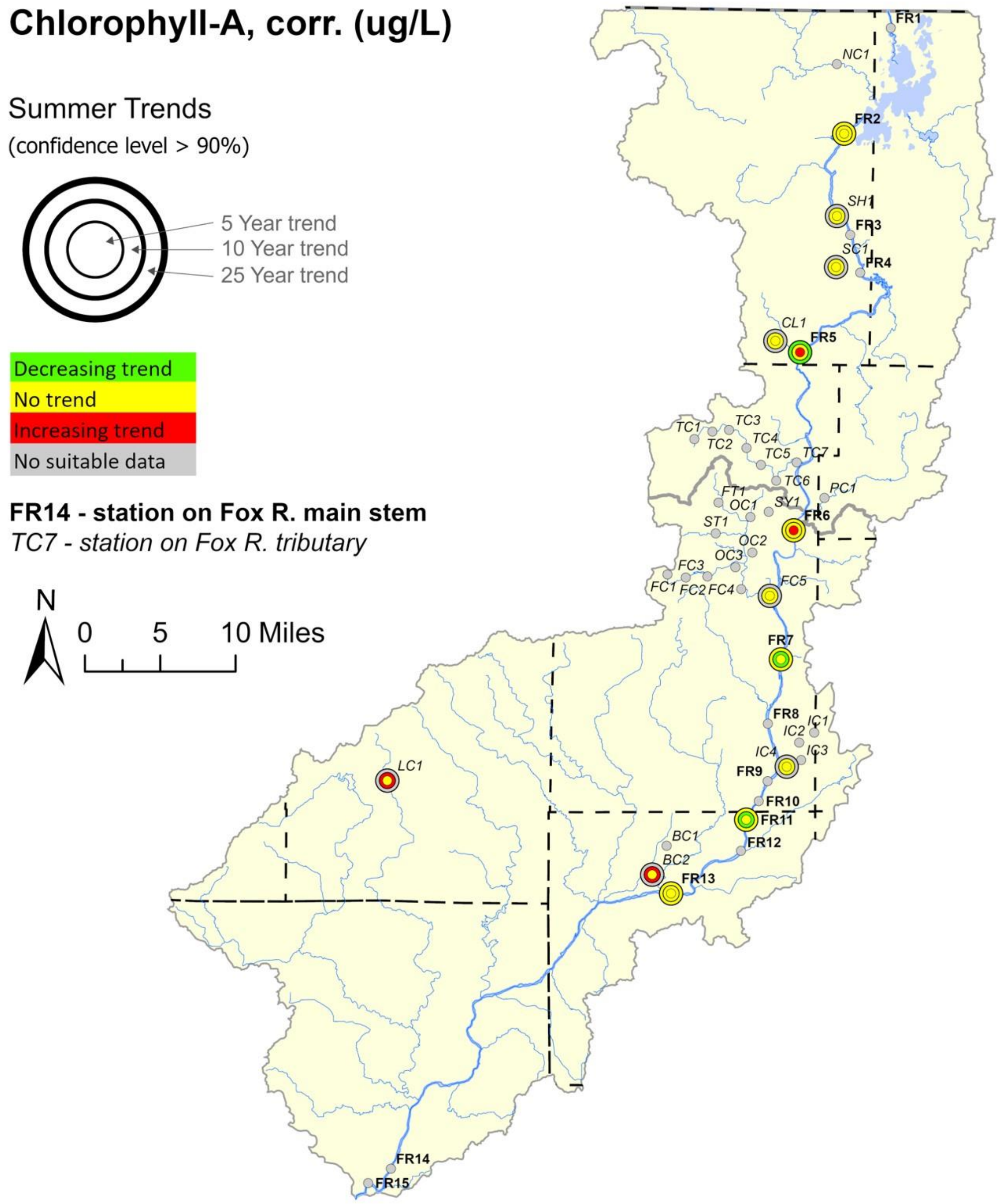
The annual and fall chlorophyll-A showed a decreasing longitudinal trend along the Fox River mainstem for the 10-year period between 2012 and 2021. No longitudinal trend was detected for any of the remaining seasons or periods of analysis.



Annual trend slopes for chlorophyll-A, corrected (µg/L per year)

Trend year	FR6	FR7	FR11	FR13	BC2	LC1
	Monitoring sites					
5	-	-	-	-	-	-
10	-1.85	-4.00	-3.78	-3.36	0.28	0.30
25	-	-	-	-	-	-

Figure 38. Annual trends of chlorophyll-A



Summer trend slopes for chlorophyll-A, corrected (µg/L per year)

Trend year	Monitoring sites					
	FR5	FR6	FR7	FR11	BC2	LC1
5	13.15	23.65	-	-	-	-
10	-	-	-10.61	-8.00	0.60	0.34
25	-2.48	-	-	-	-	-

Figure 39. Summer trends of chlorophyll-A (corrected)

5.2 Trend Analysis using WRTDS Method

The WRTDS method was applied to estimate trends in both water quality constituent's concentration and fluxes or loads and, unlike the SKT method, it considers year-to-year variability in hydrologic condition while estimating trends. Flow-normalized concentration and fluxes that remove flow-driven variability are calculated to estimate the presence or absence of trends in a constituent's concentration and fluxes. The WRTDS method also allows the computation of historical concentration and flux estimates for various timesteps. Any trend in concentration may not translate into a similar trend in flux because high flows could strongly affect flux trends but have little effect on concentration trends. Similar trends in concentration and flux can only be possible if changes in concentration for all ranges of flows and seasons are somewhat identical. Trend estimation using WRTDS could vary across seasons and flow regimes, and thus are not restricted to being linear or monotonic.

Using the WRTDS method, concentration and flux trends were estimated for chloride and chlorophyll-A at two monitoring sites on the tributaries and at a single monitoring site on the Fox River mainstem, which all have continuous flow and concentration data during the period of analysis. These monitoring sites are Poplar Creek at Elgin (PC1), Blackberry Creek at Rt. 47 near Yorkville (BC1) and Fox River at Montgomery (FR11). All other monitoring sites do not have continuous flow data or enough concentration data samples to develop WRTDS models. In total, four WRTDS models were developed using concentration-discharge relationships that account for the variability in concentration as a function of time, discharge, and season. The resulting models were then used to estimate flow-normalized concentrations and fluxes of chloride and chlorophyll-A at the three monitoring sites and their respective annual and seasonal trends.

The performance of the WRTDS models developed were examined using graphical comparisons and computations of the model biases. In Figure 40, the outputs of the chloride WRTDS model for Fox River at Montgomery (FR11) are presented in eight-panel plots. The residual plots in the top four panels show the difference between observed and estimated concentration values as a function of estimated concentrations in natural log units, discharge, date, and month, respectively. The first three plots generally appear to be symmetrical along the zero residual line and show no apparent curvature that would otherwise indicate overestimation or underestimation. The residual boxplot by month is also symmetrical along the zero line for all months except December, accounting for seasonal variation of chloride concentration at this monitoring site. The boxplots of sampled concentration, sample day estimates, and all-day estimates in the fifth panel of the figure have similar medians, interquartile ranges, and distribution, indicating the model's good performance. A wider boxplot for all-day estimates only indicates its greater sample size as compared to the other two boxplots. Except for a few outliers, the scatter plot in the sixth panel is clustered and nearly symmetrical around the 1:1 line, indicating a good match between observed and estimated chloride concentrations. In the seventh panel, the discharge boxplots for sampled days and all days are presented. Its similar distribution indicates a representative sampling of chloride concentration at this site covering ranges of discharges, which is critical for accurate estimation of fluxes and their trends. The last and eighth panel is a scatter plot of observed versus estimated chloride fluxes, showing a good match. The absolute flux bias statistic is 0.0141, which is an average error of 1.41% in estimated chloride fluxes for Fox River at Montgomery (FR11). Similarly, chloride WRTDS models were developed for Poplar Creek at Elgin (PC1) and Blackberry Creek at Rt. 47 near Yorkville (BC1). Their absolute flux bias statistics obtained were 0.007 for PC1 and 0.0164 for BC1, indicating an average error of less than 1.64% in chloride flux estimates at both sites. In contrast, the absolute flux bias statistic obtained for chlorophyll-A WRTDS model of FR11 was 0.14, showing a larger bias as compared to chloride (i.e., an average flux error of 14%). Better performance of the chloride WRTDS model may be attributed to its larger data samples as compared to chlorophyll-A. For each of the three monitoring sites, trends in flow-normalized concentration and fluxes of chloride and chlorophyll-A are presented hereafter.

Trends in Flow-normalized Concentration

Using WRTDS models, the annual and seasonal trends in flow-normalized concentration were estimated for chloride at Poplar Creek at Elgin (PC1), Fox River at Montgomery (FR11), and Blackberry Creek at Rt. 47 near Yorkville (BC1), and for chlorophyll-A at Fox River at Montgomery (FR11). Changes in the flow-normalized concentrations and their respective percent changes are presented in Table 12 for the three periods (i.e., 2017–2021, 2012–2021, and 2003–2021). The annual trends were estimated based on a water year that starts in October and ends in the following September.

The annual and seasonal chloride concentration at Polar Creek at Elgin exhibited a decreasing trend for all cases except for fall of the 2003–2021 period, where it showed an upward trend. For the 5-year period between 2017 and 2021, the decrease in chloride concentration at PC1 was 24 mg/L (i.e., 10%). In contrast, the changes in chloride concentration for the 2012–2021 and 2003–2021 periods were 22% and 20%, respectively. The highest decreases in chloride concentration at PC1 was obtained in the spring for all three periods, including 17% for 2017–2021, 34% for 2012–2021, and 32% for the 2003–2021 periods. For Fox River at Montogomery (FR11), the annual and seasonal chloride concentration showed an upward long-term trend between 2003 and 2021 with increases ranging from 4.9% in the fall to 19% in summer. However, a downward trend was detected for the 5- and 10-year periods, except for an increase in summer chloride concentration (i.e., 5.3 mg/L) between 2012 and 2021. At FR11, chloride concentrations decreased the most in winter of the 2012–2021 period, by 14 mg/L. The annual and seasonal chloride concentrations at BC1 show an upward trend for all periods, although it showed improvement in the last 5- and 10-year periods. The increase in chloride concentration for the 5-year period between 2017 and 2021 was 0.8%–2.1% and 1.9%–5.4% for the 2012–2021 period. However, the concentration increases between 2003 and 2021 range from 36% for fall to 54% for summer seasons.

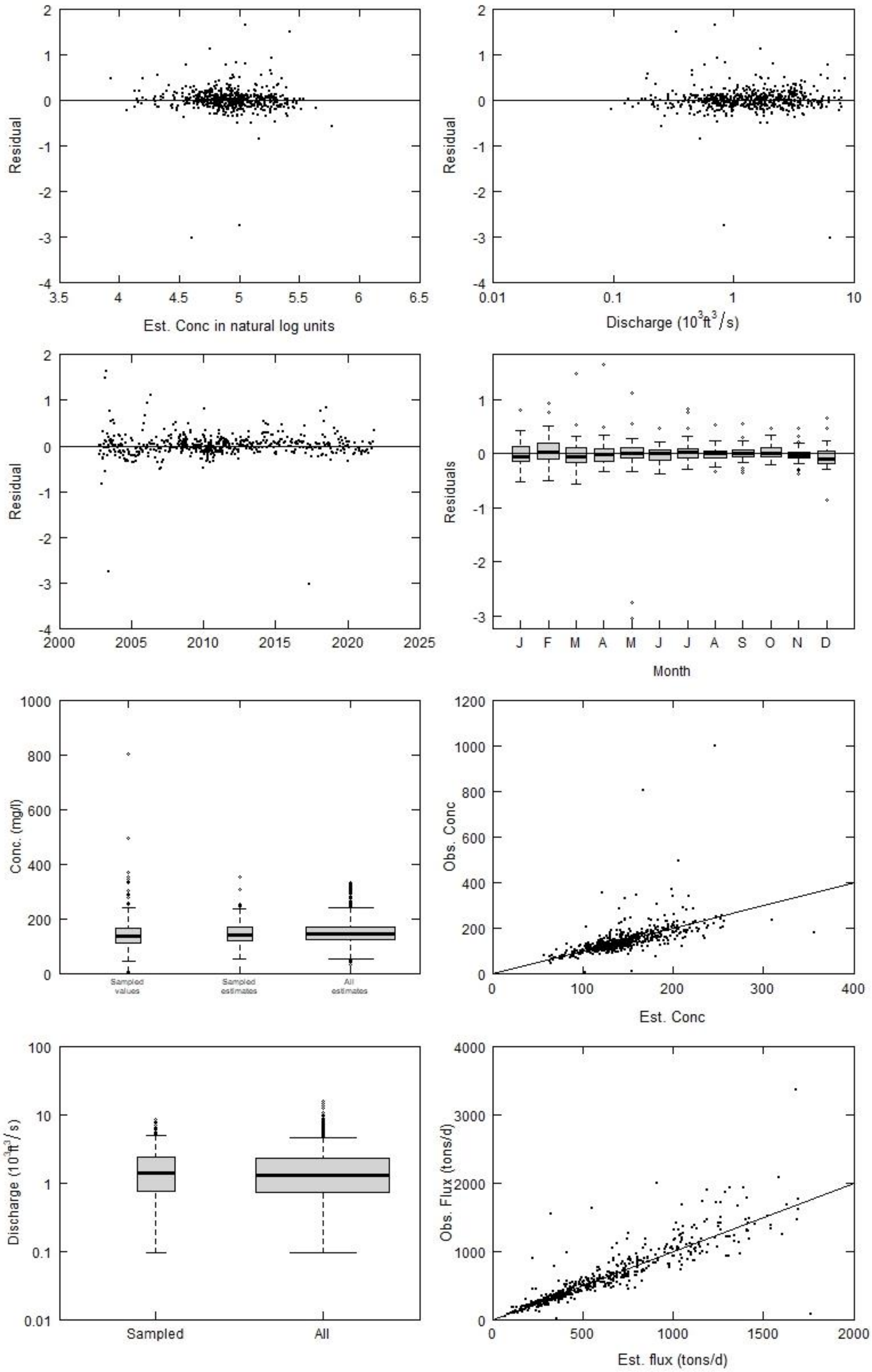


Figure 40. Chloride WRTDS model outputs for Fox River at Montgomery

Table 12. Changes in flow-normalized concentrations of chloride and chlorophyll-A

Water quality Parameter / Monitoring site	Changes in flow-normalized concentration				
	Annual	Winter	Spring	Summer	Fall
Chloride, mg/L (%)					
Poplar Creek at Elgin (PC1)					
2017 - 2021	-24 (-10%)	-41 (-13%)	-45 (-17%)	-8.6 (-4.4%)	-3.9 (-2.1%)
2012 - 2021	-61 (-22%)	-110 (-29%)	-116 (-34%)	-15 (-7.6%)	-3.4 (-1.9%)
2003 - 2021	-54 (-20%)	-123 (-31%)	-103 (-32%)	-16 (-7.7%)	22 (13%)
Fox River at Montgomery (FR11)					
2017 - 2021	-4.5 (-2.9%)	-8.6 (-4.9%)	-7.5 (-5.1%)	-1.1 (-0.77%)	-1.3 (-0.82%)
2012 - 2021	-4 (-2.6%)	-14 (-7.8%)	-7.1 (-4.8%)	5.3 (3.8%)	-1.1 (-0.75%)
2003 - 2021	16 (12%)	7.8 (4.9%)	12 (9.5%)	23 (19%)	17 (13%)
Blackberry Creek at Rt. 47 near Yorkville (BC1)					
2017 - 2021	1.5 (1.5%)	0.87 (0.82%)	1.7 (1.6%)	1.9 (2.1%)	1.5 (1.7%)
2012 - 2021	5 (5.2%)	2 (1.9%)	5.8 (5.4%)	9.2 (11%)	2.1 (2.4%)
2003 - 2021	32 (48%)	35 (48%)	38 (50%)	32 (54%)	24 (36%)
Chlorophyll-A, corrected, μg/L (%)					
Fox River at Montgomery (FR11)					
2017 - 2021	-0.011 (-15%)	-0.002 (-14%)	-0.001 (-2.5%)	-0.019 (-15%)	-0.018 (-26%)
2012 - 2021	-0.013 (-19%)	-0.004 (-20%)	0.005 (11%)	-0.024 (-17%)	-0.036 (-41%)
2003 - 2021	-0.047 (-44%)	-0.03 (-66%)	-0.037 (-41%)	-0.056 (-33%)	-0.059 (-53%)

Chlorophyll-A concentration trends were estimated only for Fox River at Montgomery (FR11). A downward trend was observed at FR11 for all periods of analysis except for spring of the 2012–2021 period. The long-term trend indicates that a decrease in chlorophyll-A concentration ranges from 33% in summer to 66% in winter for the 2003–2021 period. The fall concentration changes in the 5- and 10-year periods were 26% and 41%, respectively, which were the highest for their respective periods. The annual decrease in chlorophyll-A concentration at FR11 was 15% for 2017–2021, 19% for 2021–2021, and 44% for the 2003–2021 period.

For Fox River at Montgomery, the annual mean and flow-normalized chloride and chlorophyll-A concentrations are presented in Figure 41. An upward annual trend of chloride concentration was observed until 2013, beyond which it exhibited a downward trend. In contrast, a downward annual trend of chlorophyll-A concentration was generally detected, except for the period between 2010 and 2015. The seasonal mean and flow-normalized chloride concentrations are plotted in Figure 42. Fall and winter chloride trends conform to the annual trends despite varying changes in concentration magnitudes. The spring and summer concentration trends, however, exhibited an extended upward trend until 2015, but it decreased afterward. Annual and seasonal plots of mean and flow-normalized concentrations for all three sites (i.e., PC1, FR11, and BC1) are provided in Appendix C.

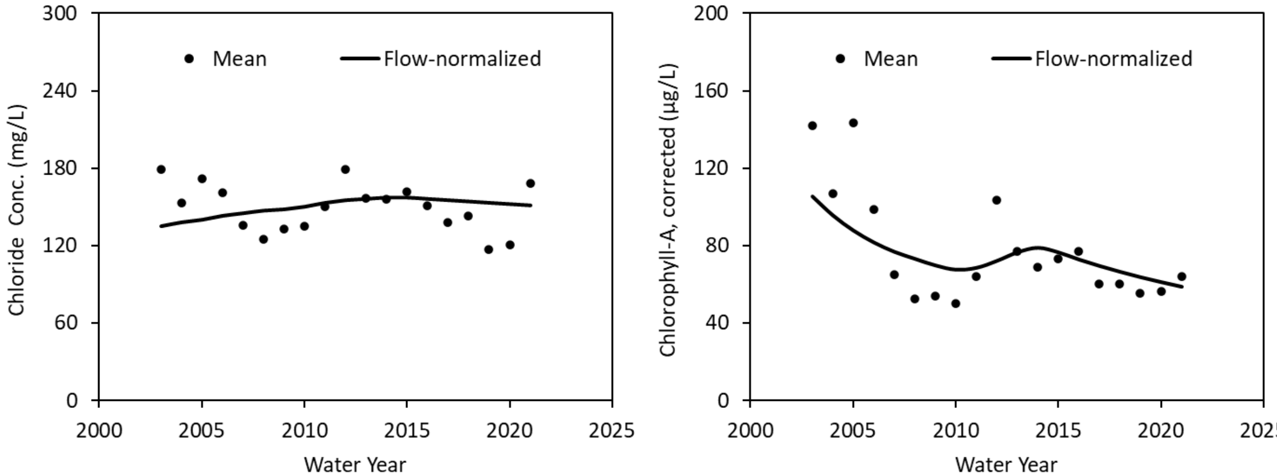


Figure 41. Annual mean and flow-normalized concentrations of chloride and chlorophyll-A for Fox River at Montgomery

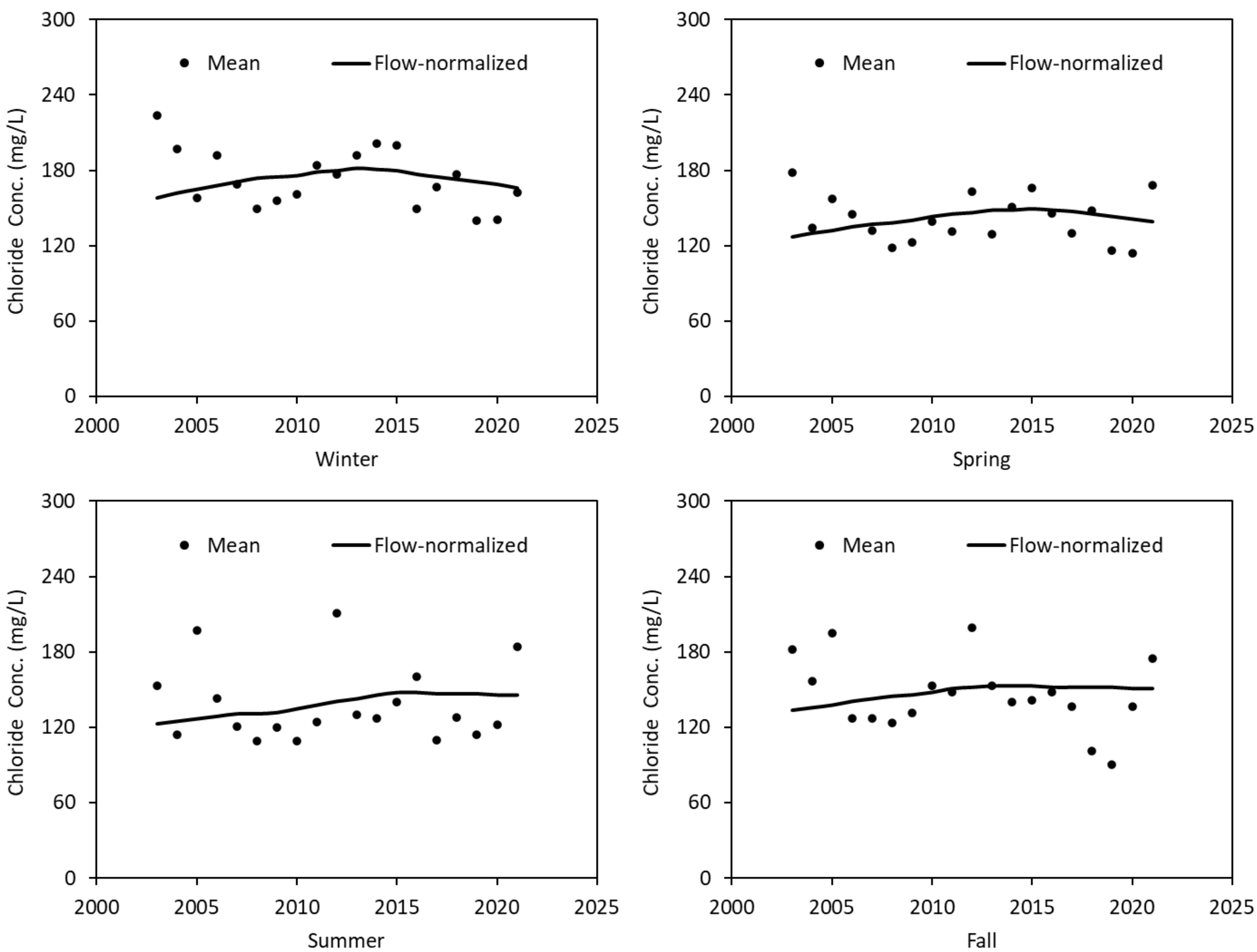


Figure 42. Seasonal mean and flow-normalized concentrations of chloride for Fox River at Montgomery

Trends in Flow-normalized Flux

The annual and seasonal trends in flow-normalized chloride flux were evaluated at PC1, FR11, and BC1 monitoring sites, whereas the chlorophyll-A flux trends were estimated only at FR11. For the 2017–2021, 2012–2021 and 2003–2021 periods, changes in the flow-normalized fluxes and their corresponding percent changes are presented in Table 13. The annual and seasonal trends in flow-normalized chloride flux for all three monitoring sites generally conform to their respective concentration trends with few exceptions. For all three periods of analysis, a downward trend was obtained for annual and seasonal chloride flux at PC1. The decreasing changes were 13%–29% for annual and 9%–32% for seasonal chloride fluxes at PC1, and the percentage changes were the highest in winter for all periods. For the same site, the decreases in annual chloride fluxes were 1.94, 5.18, and 4.4 million lbs (Mlbs) for the 2017–2021, 2012–2021, and 2003–2021 periods, respectively. At the BC1 site, the chloride flux showed an increasing trend for all except for winter of the 2017–2021 and 2021–2021 periods, where reductions of 0.4% and 3.5% were obtained, respectively. The chloride flux at BC1 increased by 62% (3.24Mlbs) in summer of the 2003-2021 period, but only up to 11% (0.8 Mlbs) in any season of the 2017-2021 and 2012-2021 periods, showing notable progress. At the FR11 site, the annual and seasonal chloride fluxes exhibited an upward trend for the 2003–2021 period with flux changes ranging from 6.5% in winter to 13% in summer. In contrast, a decreasing flux trend was observed at FR11 for the 2017–2021 and 2012–2021 periods. The maximum decrease in chloride flux was 43.87 Mlbs in winter of the 2012–2021 period, when the maximum reduction in chloride concentration was also obtained.

Table 13. Changes in flow-normalized fluxes of chloride and chlorophyll-A

Water quality Parameter / Monitoring site	Changes in flow-normalized flux				
	Annual	Winter	Spring	Summer	Fall
Chloride, x10^{6} lbs/yr (%)					
Poplar Creek at Elgin (PC1)					
2017 - 2021	-1.94 (-13%)	-2.54 (-14%)	-3.92 (-15%)	-0.78 (-11%)	-0.52 (-9%)
2012 - 2021	-5.18 (-29%)	-7.52 (-32%)	-10.1 (-31%)	-1.78 (-21%)	-1.21 (-19%)
2003 - 2021	-4.4 (-26%)	-6.67 (-30%)	-7.62 (-25%)	-2.79 (-30%)	-0.72 (-12%)
Fox River at Montgomery (FR11)					
2017 - 2021	-19.59 (-4.4%)	-25.08 (-5.3%)	-38.09 (-5.7%)	-9.42 (-2.7%)	-6.71 (-2.2%)
2012 - 2021	-27.63 (-6.1%)	-43.87 (-8.9%)	-49.89 (-7.4%)	-3.29 (-0.96%)	-15.37 (-5%)
2003 - 2021	34.46 (8.8%)	27.26 (6.5%)	44.73 (7.7%)	38.36 (13%)	21.35 (7.9%)
Blackberry Creek at Rt. 47 near Yorkville (BC1)					
2017 - 2021	0.12 (1.1%)	-0.05 (-0.44%)	0.22 (1.1%)	0.21 (2.5%)	0.1 (1.8%)
2012 - 2021	0.26 (2.3%)	-0.44 (-3.5%)	0.6 (3.2%)	0.8 (11%)	0.06 (1.1%)
2003 - 2021	3.75 (49%)	3.49 (41%)	6.42 (51%)	3.24 (62%)	1.7 (42%)
Chlorophyll-A, corrected, x10^{3} lbs/yr (%)					
Fox River at Montgomery (FR11)					
2017 - 2021	-15.87 (-8.1%)	-5.51 (-10%)	-5.73 (-2.1%)	-26.46 (-8.6%)	-24.25 (-17%)
2012 - 2021	-0.66 (-0.37%)	-2.18 (-4.2%)	28.66 (12%)	-9.04 (-3.1%)	-28.66 (-21%)
2003 - 2021	-101.41 (-36%)	-61.73 (-56%)	-147.71 (-36%)	-103.62 (-27%)	-74.96 (-40%)

The chlorophyll-A flux trends obtained for FR11 conform to the concentration trends in that downward trends were detected except for the upward spring trend of the 2012–2021 period. The spring flux of chlorophyll-A at FR11 showed an increase of 12% in the 10-year period. The long-term flux trends (2003–2021) showed high percentage changes, ranging from 27% in summer to 56% in winter. For the 5-year period between 2017 and 2021, an 8.1% decrease in annual flux was obtained, and the seasonal decrease ranges from 2.1% in spring to 17% in the fall. In contrast, the 2012–2021 period had much smaller annual and seasonal flux decreases than the 5-year period, except for fall, which had a 21% decrease.

Figure 43 illustrates the annual total and flow-normalized chloride and chlorophyll-A fluxes for FR11. The annual trends in flow-normalized fluxes followed a similar pattern as their corresponding flow-normalized concentrations. The trend in the annual chloride flux showed a downward trend after 2013. A downward annual trend of chlorophyll-A flux was largely observed, except for the period between 2010 and 2015, similar to its concentration trend. In Figure 44, the seasonal total and flow-normalized chloride fluxes are illustrated. The fall and winter chloride flux trends conform to the annual trends, although the changes in flux vary. However, for the spring and summer seasons, the upward trend continued until 2015. Annual and seasonal plots of the mean and flow-normalized fluxes are included in Appendix C for all three monitoring sites (i.e., PC1, FR11, and BC1).

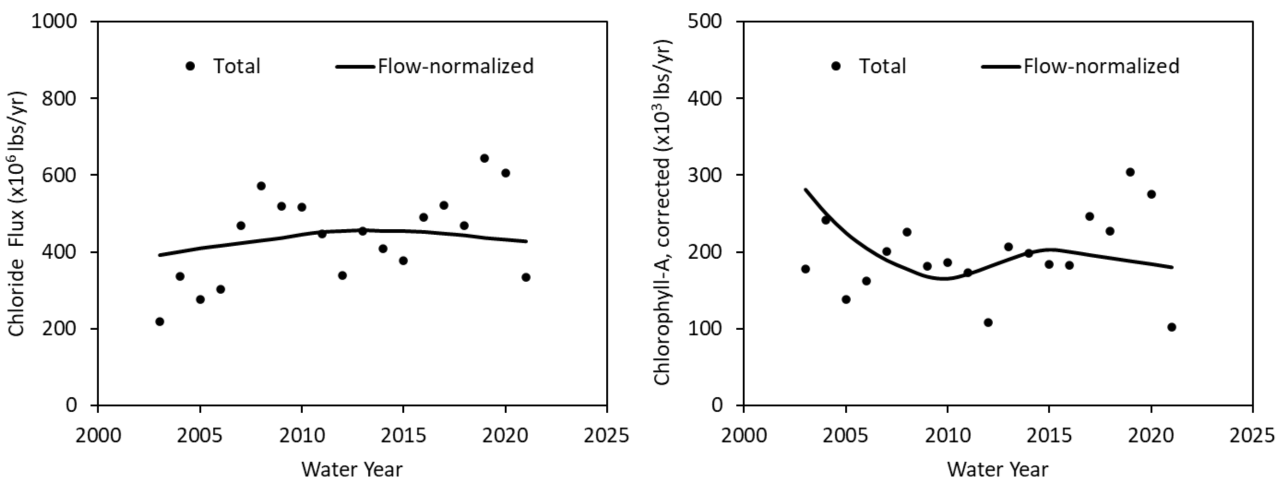


Figure 43. Annual mean and flow-normalized fluxes of chloride and chlorophyll-A for Fox River at Montgomery

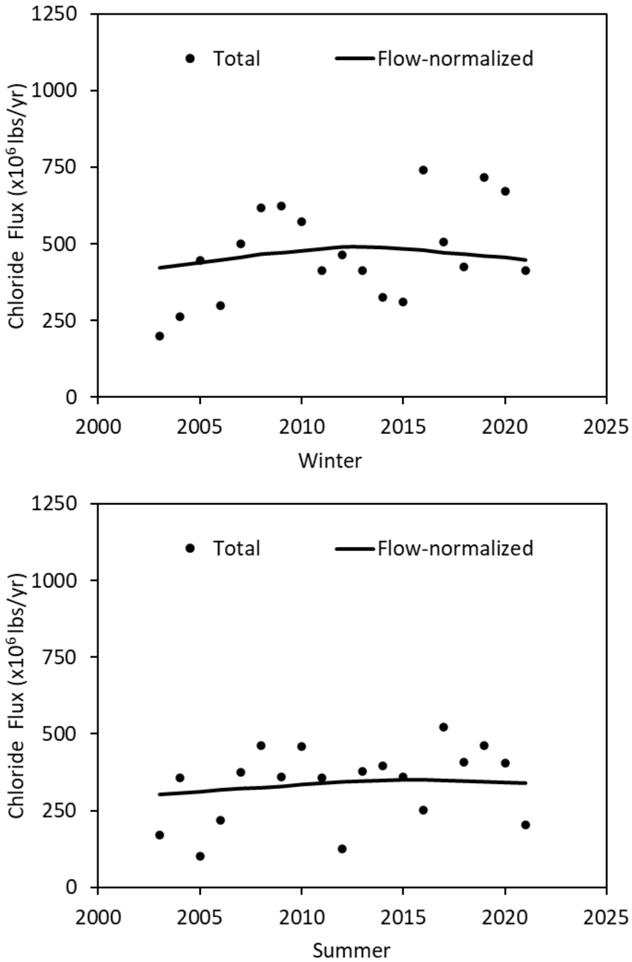


Figure 44. Seasonal mean and flow-normalized chloride flux for Fox River at Montgomery

5.3 Trends in Streamflow Statistics

Selected streamflow statistics and their respective trends were evaluated for Poplar Creek at Elgin (PC1), Fox River at Montgomery (FR11), and Blackberry Creek at Rt. 47 near Yorkville (BC1) where flow-normalized concentration and flux trends were estimated. The flow statistics (i.e., 7-day minimum, mean, and 1-day maximum) are illustrated in Figures 45, 46, and 47 for PC1, FR11, and BC1, respectively. The annual 7-day minimum was computed for a climate year (i.e., April to March), whereas the annual mean and 1-day maximum flow statistics were calculated based on water year. Using the climate year avoids double counting of individual drought events in consecutive water years because a water year is bound by low flow months. The streamflow statistics are plotted as runoff depths (i.e., mm/d) over the drainage areas of their monitoring sites, which are 35.2, 1732, and 70.2 square miles for PC1, FR11, and BC1 sites, respectively. The circles and lines in the figures represent the actual and smoothed streamflow statistics, respectively. The annual 7-day minimum flows obtained for FR11 were 116–1010 cfs. The spring 7-day minimum, in contrast, ranges from 254 cfs in 2003 to 2144 cfs in 2019, which appears to be the highest of all seasons. The mean and 1-day maximum flow statistics were also the highest for the spring season. Similar trend was observed for the PC1 and BC1 sites. In general, the lowest value for each flow statistic was obtained for the fall season, except for mean daily and 1-day maximum flows for FR11 and PC1, respectively. The smoothed flow statistics shown in the figures were used to examine trends in 7-day minimum, mean, and 1-day maximum flows at the three sites. The annual 1-day maximum flow is different from the annual peak discharge, which is the instantaneous maximum discharge value for the year. Flow variability in smaller streams could be significant in each day, resulting in a larger difference between the two discharges. Although the mean flow provides the central tendency of the multi-year variability, the 7-day minimum and maximum flow trends may allow explaining only part of a trend in constituent concentration and/or fluxes. For explicit attribution of hydrologic factors to the change in water quality trends, the impact of other potential factors affecting water quality trends such as conservation efforts and land use changes need to be considered.

Changes in annual and seasonal flow statistics in cfs and percentage are presented in Table 12 for FR11, PC1, and BC1. The annual and seasonal 7-day minimum, mean and 1-day maximum flows showed an upward trend at all three sites for the 5- and 10-year periods (i.e., 2017–2021, and 2012–2021). At FR11, the percentage change for the 5-year period was 31% for annual and 16%–24% for seasonal 7-day minimum flows with the highest change of 221 cfs occurring in winter. In contrast, for the 10-year period ending in 2021, the changes in annual and seasonal 7-day minimum flow statistics were 86% and 42%–64%, respectively, with the smallest percent change in spring. The change in annual mean flow was 238 cfs (13%) between 2017 and 2021 and 509 (32%) cfs for the 2012–2021 period. The seasonal mean flows for the 5- and 10-year periods increased by 162–250 cfs and 353–528 cfs, respectively, with the largest increase in winter. The 1-day maximum flow showed an upward trend of 3.5% for the 5-year period, whereas it showed a 9% increase for the 10-year period. For both periods of analysis, the percent change appears to increase from high to low flow statistics (e.g., a 7-day minimum exhibits a larger percent change than a 1-day maximum). The trends in annual and seasonal flow statistics generally show similar patterns with steep to gradual slope changes from 7-day minimum to 1-day maximum flow statistics, as illustrated in Figures 13–15.

.

Table 14. Changes in annual and seasonal flow statistics

Changes in flow statistics in cfs (%) for 2017 - 2021 and 2012 - 2021 periods

2017 - 2021	Annual	Winter	Spring	Summer	Fall
Poplar Creek at Elgin (PC1)					
7-day minimum	1.1 (35%)	2.4 (32%)	0.98 (9%)	0.88 (23%)	0.82 (21%)
Mean	3.5 (8.9%)	3.6 (11%)	5.4 (8.4%)	3.4 (12%)	2.8 (13%)
1-day maximum	22 (3.7%)	19 (7.6%)	42 (9.7%)	33 (12%)	26 (14%)
Fox River at Montgomery (FR11)					
7-day minimum	157 (31%)	221 (24%)	186 (16%)	111 (19%)	123 (24%)
Mean	238 (13%)	250 (15%)	215 (7.8%)	162 (11%)	241 (20%)
1-day maximum	262 (3.5%)	333 (8.8%)	528 (8.4%)	621 (13%)	315 (10%)
Blackberry Creek at Rt. 47 near Yorkville (BC1)					
7-day minimum	5.4 (45%)	5.4 (23%)	5.2 (15%)	5.2 (32%)	4.8 (36%)
Mean	11 (17%)	9.1 (15%)	15 (14%)	9.1 (17%)	11 (30%)
1-day maximum	49 (7%)	37 (13%)	69 (13%)	24 (9.6%)	69 (36%)

2012 - 2021	Annual	Winter	Spring	Summer	Fall
Poplar Creek at Elgin (PC1)					
7-day Min	2.1 (96%)	4.5 (84%)	2 (20%)	1.8 (60%)	1.7 (55%)
Mean	7.5 (21%)	7.6 (26%)	11 (20%)	7.2 (28%)	5.7 (30%)
1-Day Max	50 (8.9%)	41 (18%)	86 (22%)	69 (31%)	52 (33%)
Fox River at Montgomery (FR11)					
7-day Min	304 (86%)	444 (63%)	396 (42%)	229 (49%)	249 (64%)
Mean	509 (32%)	528 (38%)	481 (19%)	353 (27%)	495 (51%)
1-Day Max	636 (9%)	737 (22%)	1148 (20%)	1345 (32%)	689 (25%)
Blackberry Creek at Rt. 47 near Yorkville (BC1)					
7-day Min	9.9 (133%)	11 (60%)	11 (38%)	10 (87%)	9.2 (101%)
Mean	23 (43%)	20 (40%)	31 (35%)	19 (42%)	22 (81%)
1-Day Max	113 (18%)	85 (34%)	146 (33%)	51 (22%)	131 (102%)

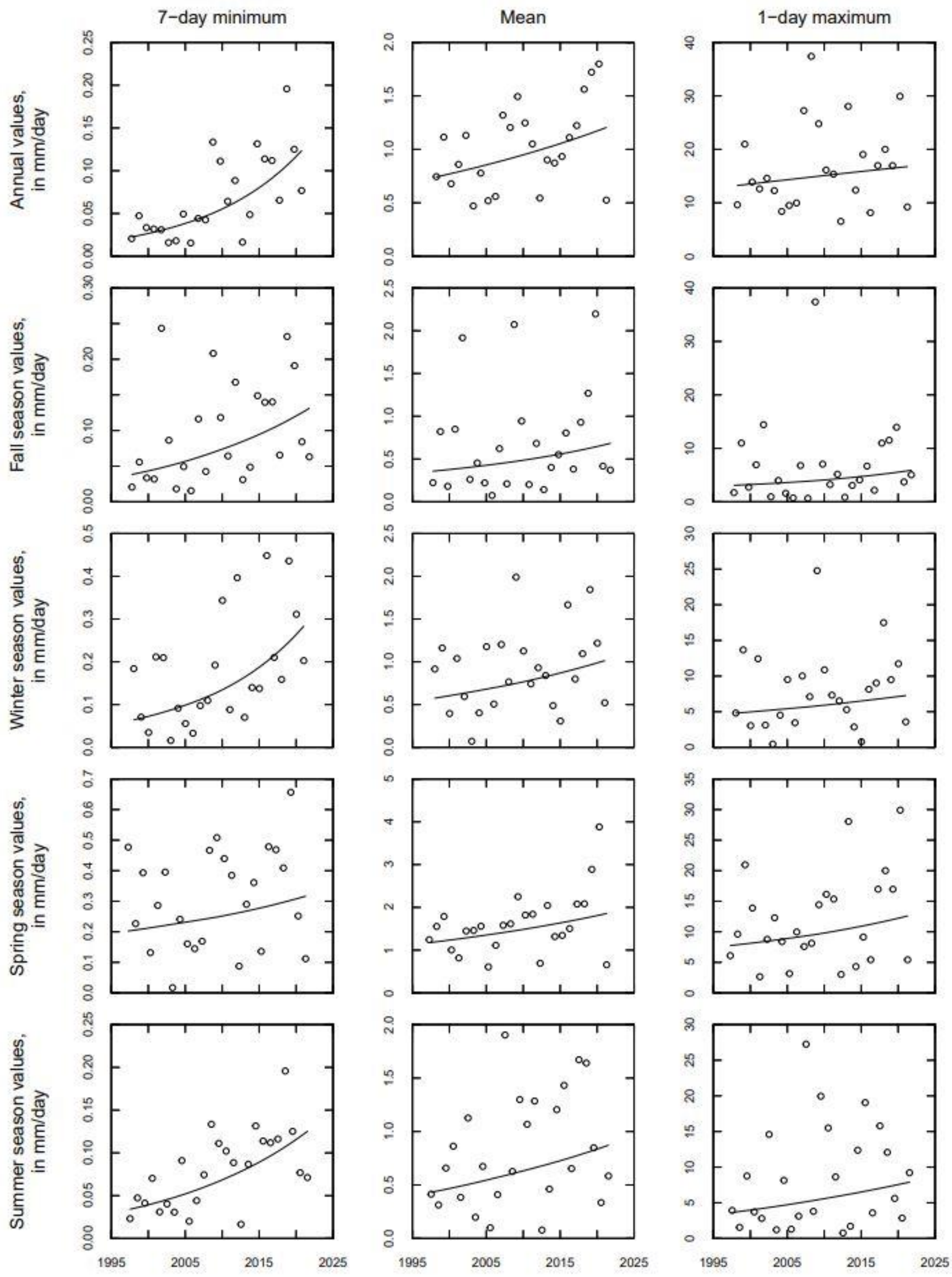


Figure 45. Annual and seasonal flow statistics for Poplar Creek at Elgin

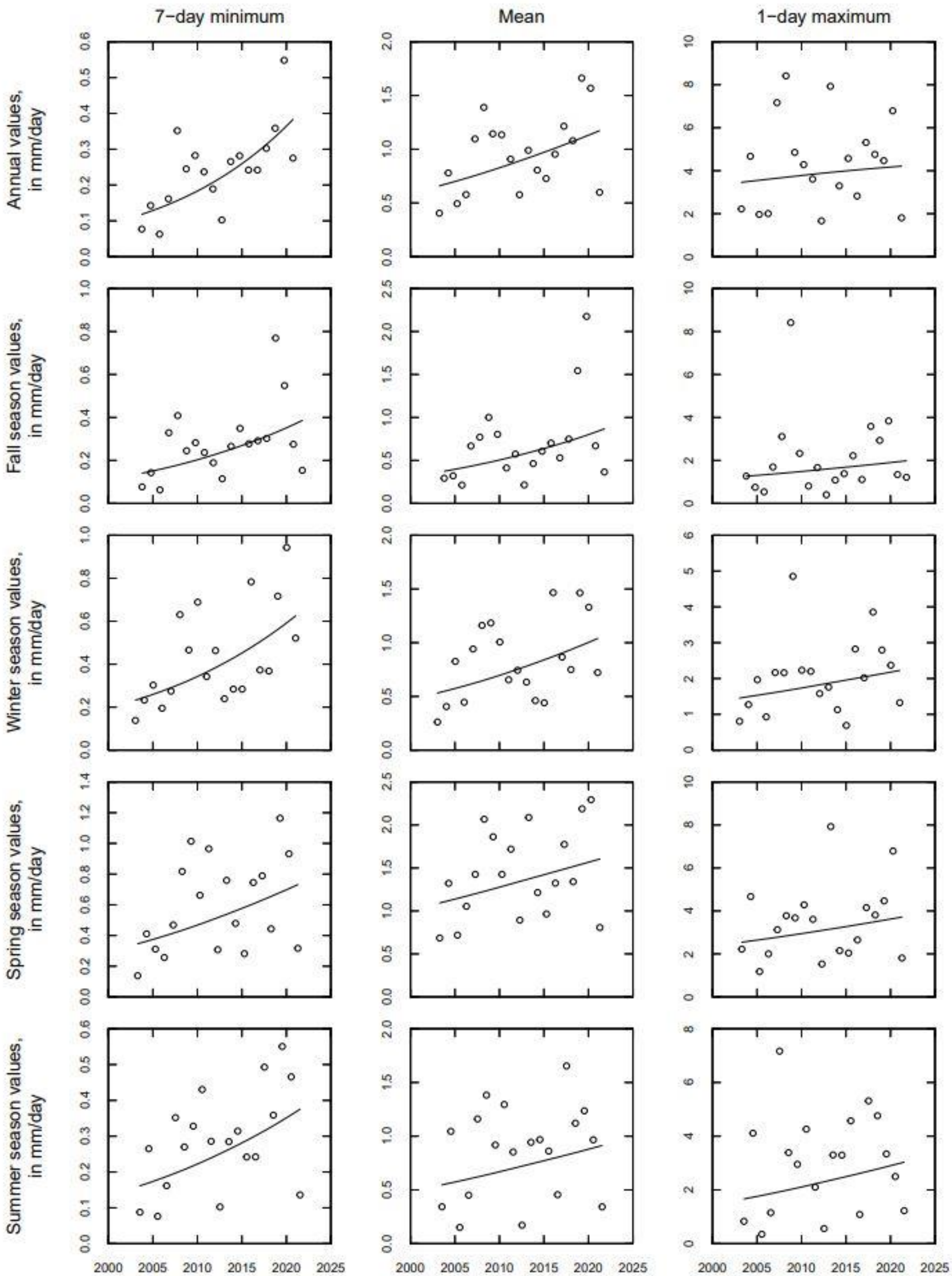


Figure 46. Annual and seasonal flow statistics for Fox River at Montgomery

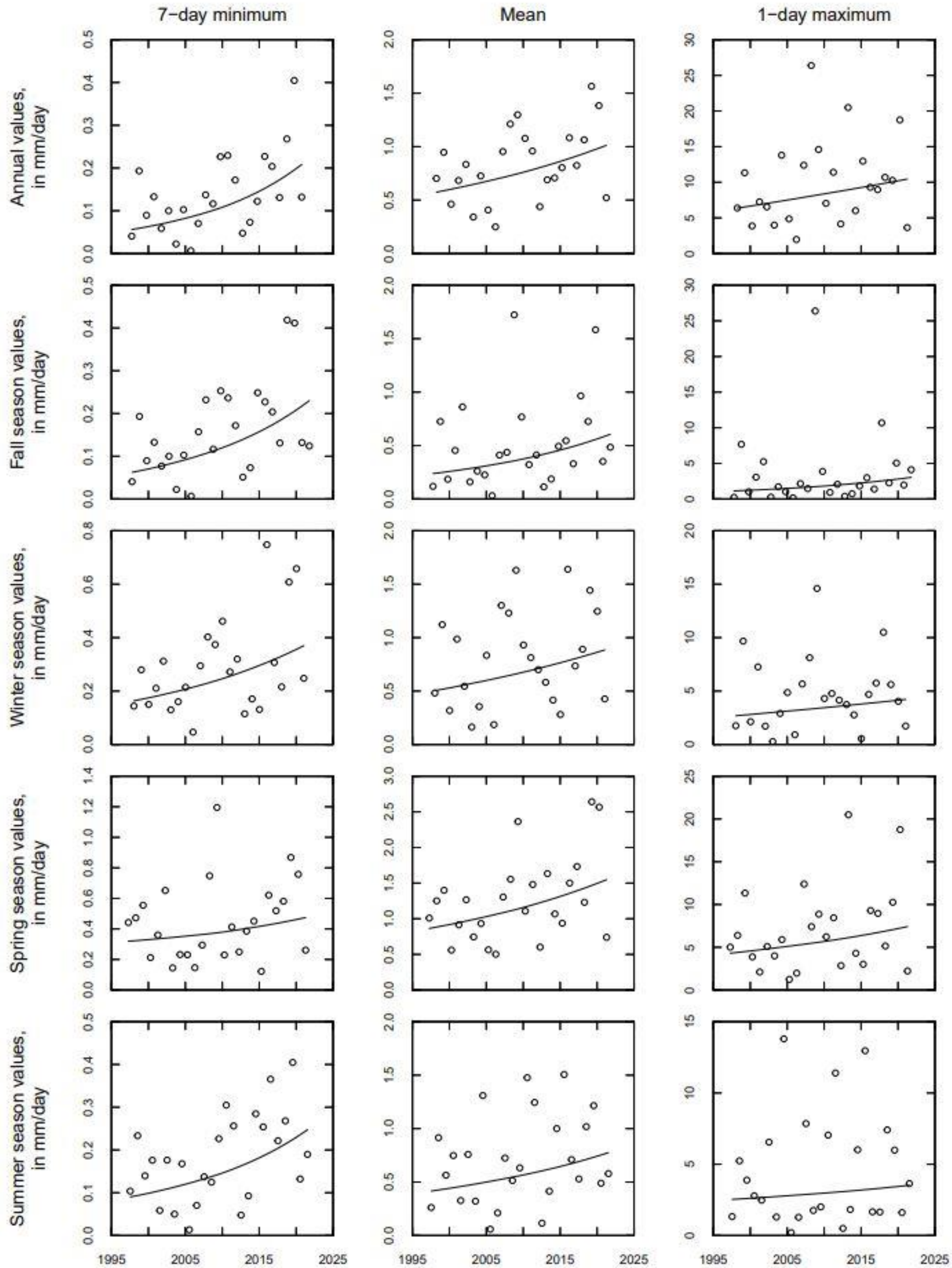


Figure 47**.** Annual and seasonal flow statistics for Blackberry Creek at Rt. 47 near Yorkville

6. Summary and Conclusions

The objective of this research was to update the Fox River environmental database (FoxDB) and conduct trend analysis for six water quality indicators (i.e., chloride, water temperature, pH, specific conductance, turbidity, and chlorophyll-A) at 45 sampling locations in the Fox River watershed – Stratton Dam to Illinois River. Exploratory data analysis (EDA) was applied, and data factsheets were produced for each water quality variable. The data factsheets contain a map of the sampling locations with data, graphs of data availability for each location, strip charts, boxplots of the water quality variable by location and waterbody, and summary statistics. Moreover, detailed data such as time series of samples, monthly and annual boxplots, and empirical cumulative distribution function (CDF) plots of the water quality variables were presented for each sampling location. Python scripts were developed to generate water quality data factsheets and detailed EDA outputs. A web application that can display selected trend analysis results was developed. The application lets users see data factsheets for the six water quality constituents, EDA outputs by monitoring site, and trend maps and tables, which are also included in the Appendix. In addition, Tableau dashboards were created for improved visualization of data factsheets, EDA outputs, and trend maps and tables.

The study employed the SKT method following an in-depth Exploratory Data Analysis (EDA) and data suitability assessment across three distinct periods (2017–2021, 2012–2021, and 1997–2021) to evaluate annual and seasonal trends for the six water quality parameters. Customized R programming codes facilitated the identification of suitable data subsets for each period and estimation of trends using the EnvStats R-package and SKT method. The analysis encompassed 45 monitoring sites in the Fox River watershed, resulting in 633 5-year, 495 10-year, and 92 25-year scenarios for annual and seasonal evaluations, totaling 1220 trend assessments. Visual representations of annual and seasonal trends were mapped across monitoring sites, highlighting areas lacking adequate data for specific trends. Overall, the collective trends for water quality constituents indicated either a downward trajectory or stability approximately 90% of the time across all analysis periods. Specifically, the 5-year period from 2017 to 2021 showed 8.9% downward, 6.9% upward, and 84.2% stable trends. The subsequent 2012–2021 period exhibited more downward trends (31.3%), with 62.2% showing no distinct trend. Conversely, the 25-year analysis from 1997 to 2021 displayed a higher proportion of both upward (51.4%) and downward (10.6%) trends. A notable observation was the considerably lesser availability of suitable data for the 25-year analysis compared to the 5- and 10-year periods. This limitation was evident, with approximately five to six times fewer data sets suitable for the extended 25-year evaluation. Thus, it might affect the accuracy and reliability of conclusions drawn about longer-term trends in comparison to the shorter 5- and 10-year assessments, warranting cautious interpretation of findings within the context of data availability.

Chloride concentration showed either downward or no trend for the 2012–2021 period for almost all 40 monitoring sites in the watershed, but it exhibited a slight increase for the 1997–2021 period. Similarly, for the 5-year period between 2017 and 2021, either downward or no trend was observed at nearly all monitoring sites, except in summer and fall seasons where upward trends were obtained for at least seven monitoring sites. For the 2012-2021 period, a decreasing longitudinal trend was detected for the annual and seasonal chloride concentration along the Fox River except for spring season. Similarly, the 10-year annual, fall and summer chloride concentration for Tyler Creek, which has 7 monitoring sites, showed a downward longitudinal trend along the creek. In contrast, an upward longitudinal trend was detected for the 5-year annual and fall chloride concentrations.

Water temperatures of the Fox River and tributaries showed a downward or no trend for the 5-year and 10-year periods, except for the fall season when an upward trend was exhibited in some of the tributaries for the 10-year period. No longitudinal trend was detected for annual or seasonal water temperatures in the Fox River or its tributaries except for Ferson Creek where the fall water temperatures for the 10-year period showed an upward trend.

For the 5-, 10-, and 25-year periods, no annual or seasonal pH trend was detected 81%, 69%, and 34.6% of the time, respectively. For monitoring sites on the Fox River mainstem, the pH generally indicates either a downward or no long-term trend except for the summer season when some upward trends were detected. No longitudinal trend was detected for either annual or seasonal pH along Fox River and its tributaries. However, the 25-year annual and seasonal pH exhibited a downward trend for Fox River at Montgomery and a couple of downstream monitoring sites except for summer.

Specific conductance in the 10-year period showed no trend for almost all monitoring sites. However, in the 5-year period, increasing annual and seasonal trends were observed in some of the monitoring sites. A downward longitudinal trend was observed for summer specific conductance downstream of Fox River at Sullivan Br. for the 10-year period.

The turbidity of the water showed a stable or decreasing pattern for most of the monitoring sites in the Fox River and its tributaries over the 5- and 10-year periods, except for a site on Indian Creek that had an upward 10-year trend of turbidity in spring. The turbidity also decreased along the Fox River mainstem from upstream to downstream for summer of the 1997–2021 period, indicating a longitudinal trend. The same downward trend was observed for summer and fall of the 2012–2021 period, and for fall of the 1997–2021 period, respectively.

Chlorophyll-A exhibited an increasing summer trend at two monitoring sites on the Fox River mainstem for the 2017–2021 period. However, for most other sites and periods, chlorophyll-A showed no trend annually and seasonally. The annual and fall chlorophyll-A exhibited a decreasing longitudinal trend along the Fox River mainstem for the 2012–2021 period. No longitudinal trend was detected for any of the remaining seasons or periods of analysis.

To estimate the annual and seasonal trends in flow-normalized concentration and fluxes of chloride and chlorophyll-A, we applied the WRTDS method to three sites with continuous flow data on the Fox mainstem and its tributaries for the periods of analysis. The results showed that chloride concentration and fluxes decreased significantly for Fox River at Montgomery and Poplar Creek at Elgin, especially in the winter season of 2012–2021. However, Blackberry Creek at Rt. 47 near Yorkville showed an increase in chloride concentration and flux, except for the winter flux, which decreased. Chlorophyll-A concentration and flux also decreased for Fox River at Montgomery for both 5- and 10-year periods, with a large decrease in the fall season.

Trends in selected streamflow statistics were evaluated for the three monitoring sites to provide insights into influences of hydrologic variability on changes in concentration and fluxes. These statistics include mean, 7-day minimum, and 1-day maximum flows. Changes in concentration and flux may be partly explained by the minimum and maximum flows; however, other factors affecting water quality trends, such as conservation efforts in the watershed, also need to be considered to properly attribute the impact of hydrologic factors on trends. The trends in annual and seasonal flow statistics show steep to gradual slope changes from 7-day minimum to 1-day maximum flow, indicating increasing variability in the low flow statistics during the periods of analysis.

This comprehensive trend analysis for 5-, 10- and 25- periods suggests predominant stability or declining trends in water quality parameters across the Fox River watershed – Stratton Dam to Illinois River. The analysis of water quality trends, facilitated by the updated Fox River environmental database and comprehensive data factsheets, offers valuable insights into the state of the selected water quality constituents in the watershed. By assessing trends over different periods, this analysis provides a nuanced understanding of how conservation efforts may influence water quality improvements through the years. This information serves as a crucial guide for initiatives aimed at enhancing the overall health of the Fox River ecosystem.

7. Recommendations for Future Work

The FoxDB has many water quality monitoring sites that lack continuous flow data, which hinders the use of WRTDS models to estimate trends in concentration and fluxes of chloride, chlorophyll-A, sediment, and nutrients. In this study, only four WRTDS models were developed to estimate trends in flow-normalized concentration and fluxes of chloride and chlorophyll-A at three monitoring sites. Hydrologic modeling of the Fox River watershed can produce more accurate estimates of continuous flows at some of the monitoring sites on the Fox River mainstem. These estimated flows, along with long-term concentration data from some of the monitoring sites, enable the use of WRTDS models to estimate trends in flow-normalized concentration and fluxes. The Fox River watershed model was previously developed by ISWS to assess the effects of possible climate change on water supply availability in the watershed (Bekele (Getahun) and Knapp, 2010). A more comprehensive watershed model for hydrologic and water quality simulation can be further made to not only produce continuous flow estimates for WRTDS models but also to model some of the NPS pollutants and evaluate impacts of selected conservation practices on improving Fox river's water quality.

References

Bekele, E.G. (Getahun, E.), and H.V. Knapp. 2010. Watershed modeling to assessing impacts of potential climate change on water supply availability. *Journal of Water Resources Management*. doi:10.1007/s11269-010-9607-y.

Getahun, E., L. Keefer, S. Chandrasekaran, and A. Zavelle. 2019. *Water Quality Trend Analysis for the Fox River Watershed: Stratton Dam to the Illinois River*. Illinois State Water Survey Contract Report 2019-04, Champaign, IL, 54pp. http://hdl.handle.net/2142/103009

Hirsch, R.M., and L.A. De Cicco. 2015. User Guide to Exploration and Graphics for RivEr Trends (EGRET) and Data Retrieval–R Packages for Hydrologic Data. Version 2.0, February 2015. In *U.S. Geological Survey techniques and methods*, Book 4, Chapter A10, 93 pp. http://dx.doi.org/10.3133/tm4A10

Hirsch, R.M., and J.R. Slack. 1984. A nonparametric trend test for seasonal data with serial dependence. *Water Resources Research* 20(6):727–732.

Hirsch, R.M., D.L. Moyer, and S.A. Archfield. 2010. Weighted Regressions on Time, Discharge, and Season (WRTDS), with an application to Chesapeake Bay River inputs. *Journal of the American Water Resources Association* 46(5):857–880. http://onlinelibrary.wiley.com/doi/10.1111/j.1752-1688.2010.00482.x/full

Meals, D.W., J. Spooner, S.A. Dressing, and J.B. Harcum. 2011, *Nov. Statistical analysis for monotonic trends*, Tech Notes 6. Developed for U.S. Environmental Protection Agency by Tetra Tech, Inc., Fairfax, VA, 23 pp. https://www.epa.gov/sites/default/files/2016-05/documents/tech_notes_6_dec2013_trend.pdf

McConkey, S.A., A. Bartosova, L. Lin, K. Andrew, M. Machesky, and C. Jennings. 2004 *Fox River Watershed Investigation: Stratton Dam to the Illinois River*. Water quality issues and data report to the Fox River Study Group, Inc. Illinois State Water Survey Contract Report 2004-06, Champaign, IL. http://hdl.handle.net/2142/94218

Millard, S.P. 2013. *EnvStats: An R Package for Environmental Statistics*. Springer Science Business Media, New York. http://dx.doi.org/10.1007/978-1-4614-8456-1

Appendices

This report includes four appendices that are compiled as a separate document. The appendices are:

Appendix A: Data Factsheets showing EDA Outputs by Water Quality Parameter and Monitoring Site

Appendix B: Annual and Seasonal Trend Maps and Slopes for Water Quality Constituents

Appendix C: Trends in Annual and Seasonal Flow-normalized Concentration and Fluxes

Appendix D: Organizational Chart of Fox River Environmental Database (FoxDB)

ISWS CONTRACT REPORT 2023-03

APPENDICES

Water Quality Trends for Selected Constituents in the Fox River Watershed: Stratton Dam to the Illinois River

Elias Getahun and Atticus Zavelle

December 2023

Prairie Research Institute
UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN

Water-Quality Trends for Selected Constituents in the Fox River Watershed: Stratton Dam to the Illinois River

by

Elias Getahun and Atticus Zavelle

Illinois State Water Survey
Prairie Research Institute
University of Illinois at Urbana-Champaign

Prepared for
Fox River Study Group

December 2023

Appendices

Appendix A: Data Factsheets showing EDA Outputs by Water Quality Constituent and Monitoring Site

Appendix B: Annual and Seasonal Trend Maps and Slopes for Water Quality Constituents

Appendix C: Trends in Annual and Seasonal Flow-normalized Concentration and Fluxes for Chloride and Chlorophyll-A

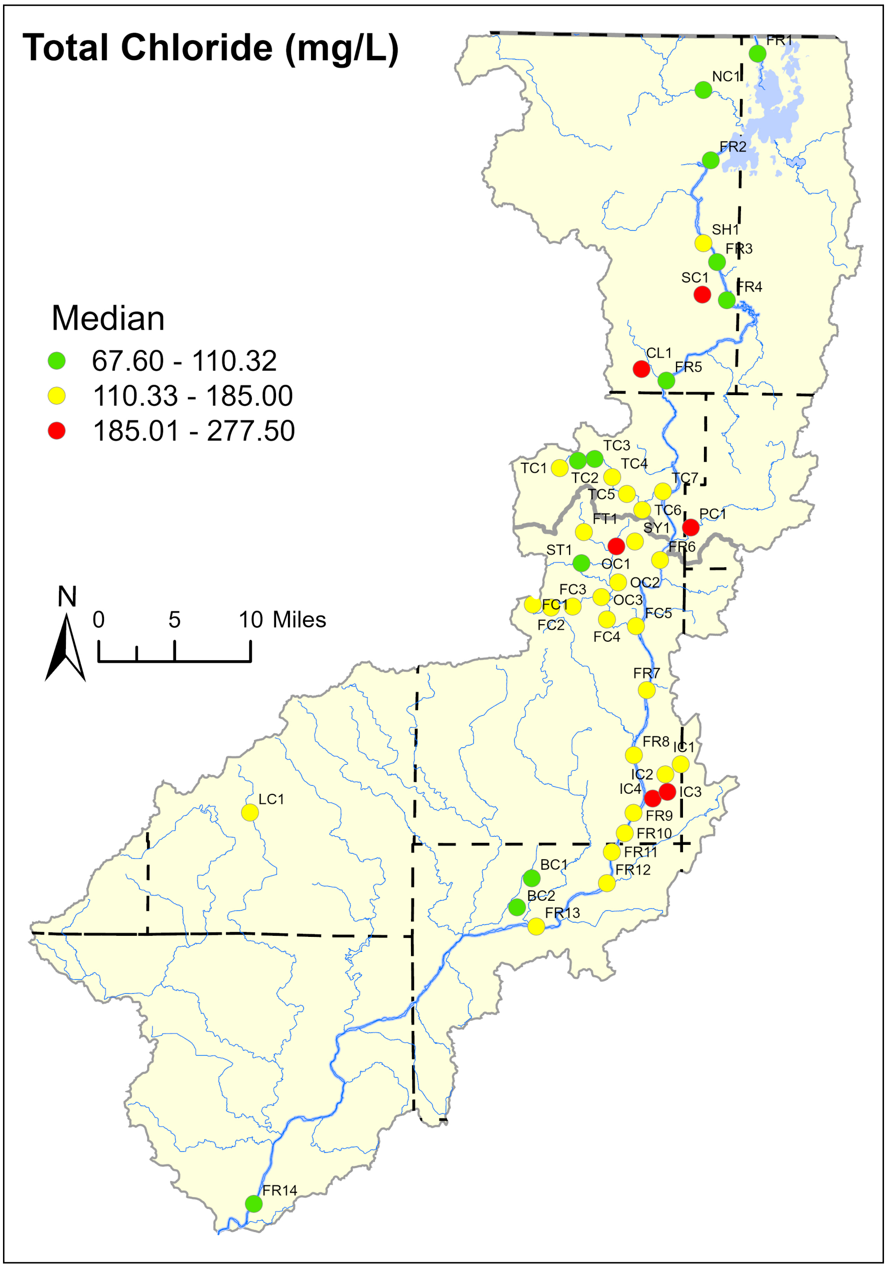
Appendix D: Organizational Chart of Fox River Environmental Database (FoxDB)

Appendix A: Data Factsheet showing EDA Outputs by Water Quality Constituent and Monitoring Site

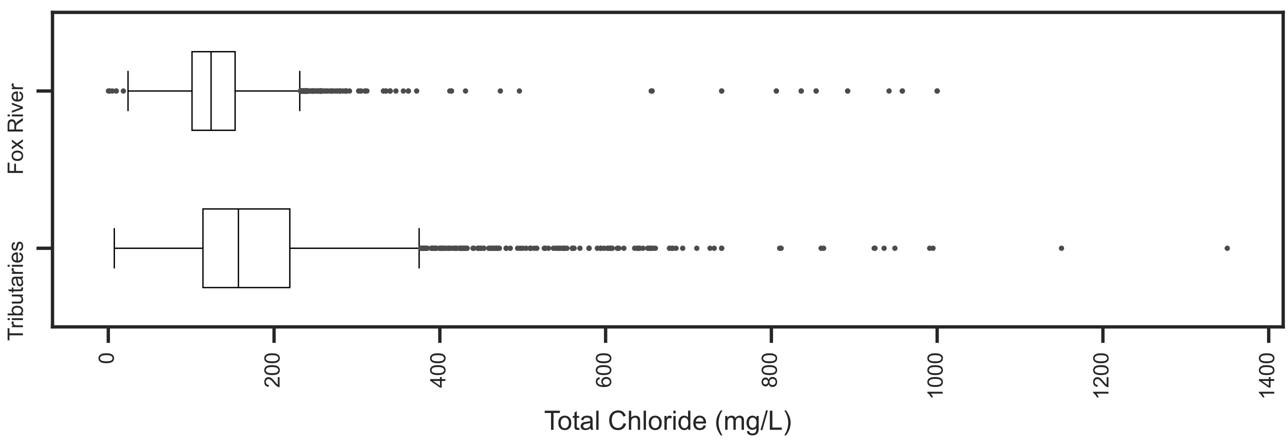
Table A1. Data Factsheets for water quality consituents

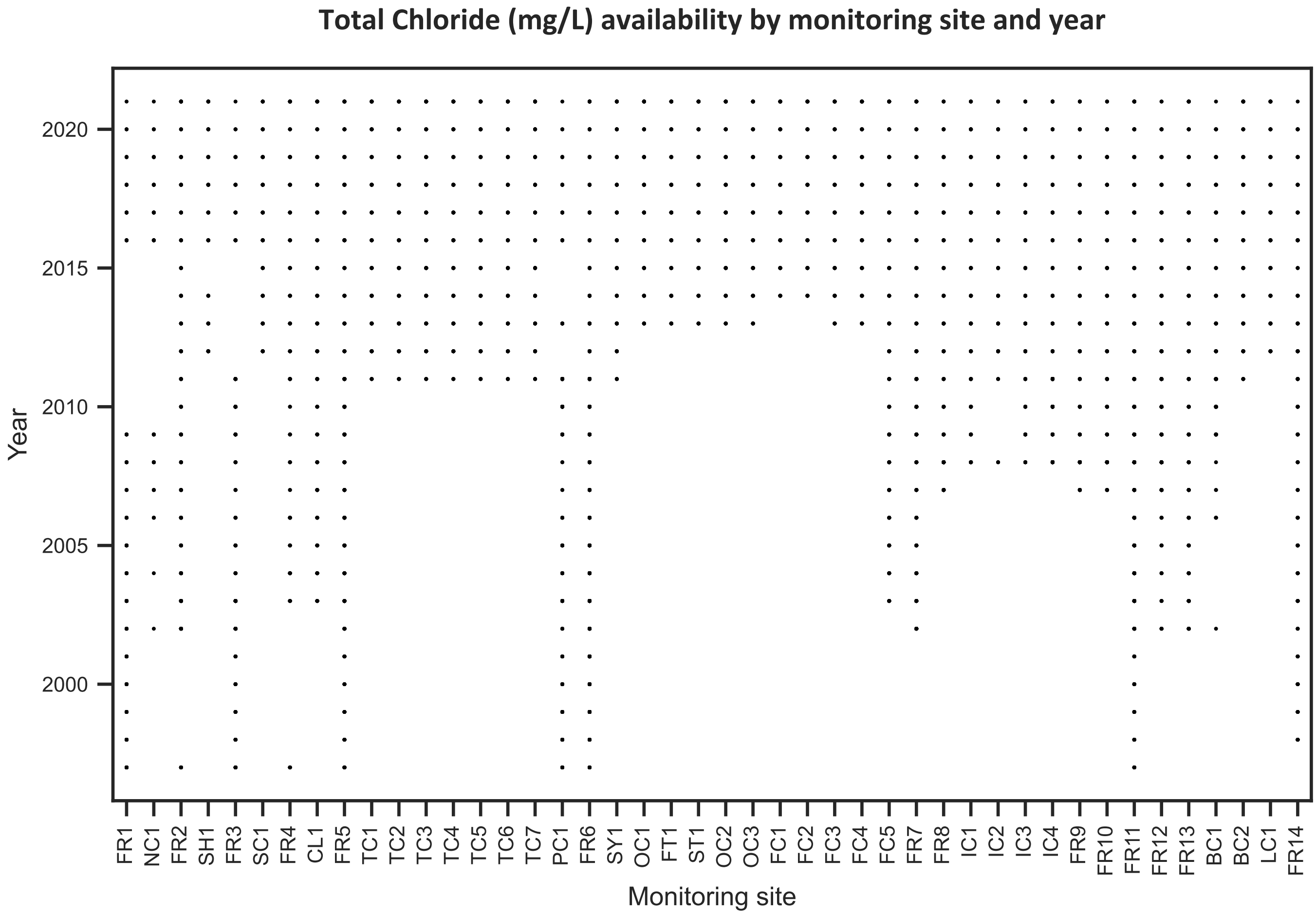
Code in FoxDB	Water Quality Constituent
940	Total chloride (mg/L)
406	pH (su)
10	Water temperature (^{0}C)
95	Specific conductance (µmhos/cm @ 25^{0}C)
82079	Turbidity(NTU)
32209	Chlorophyll-A, corrected (µg/L)

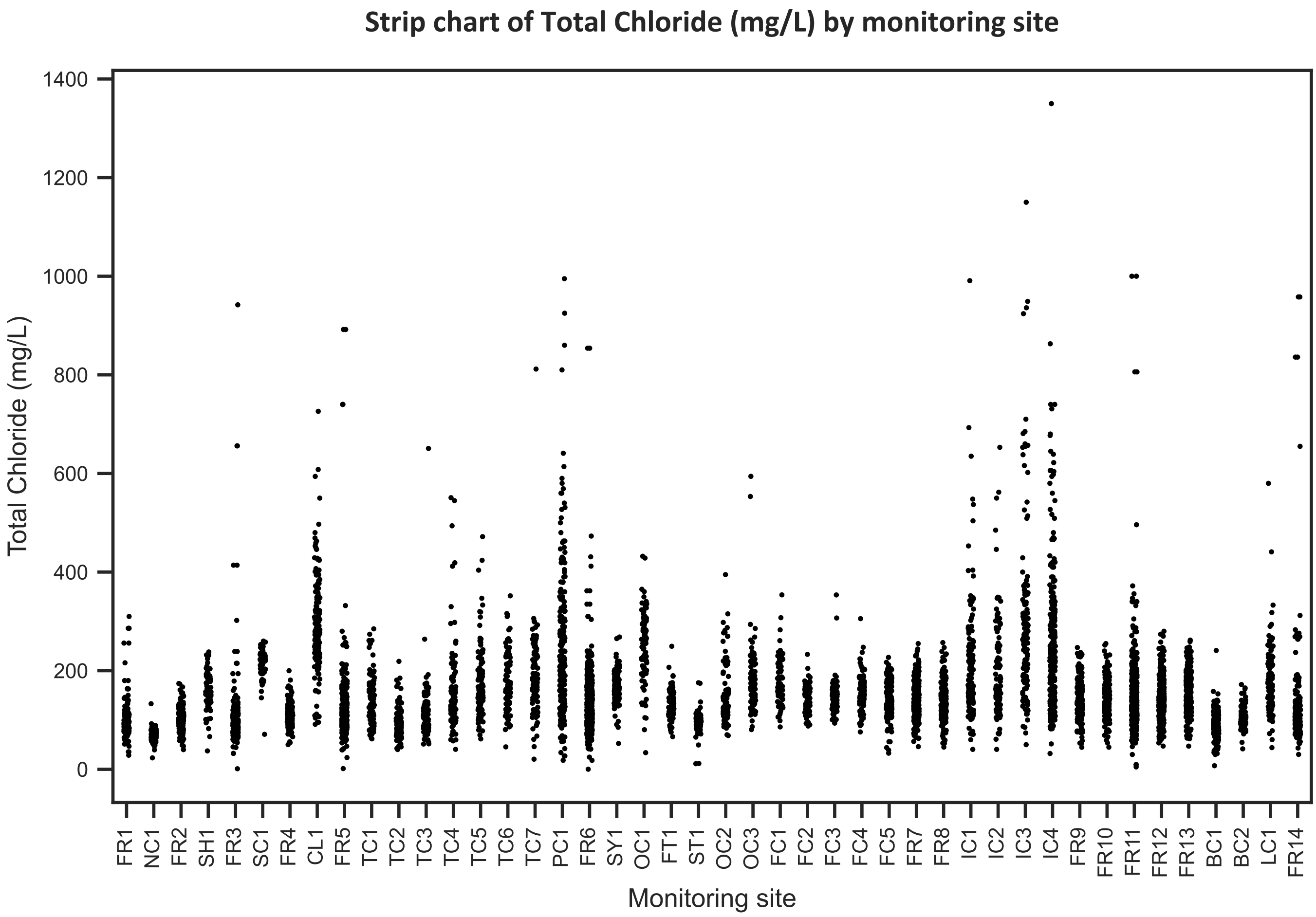
Data Factsheet for Total Chloride (mg/L)

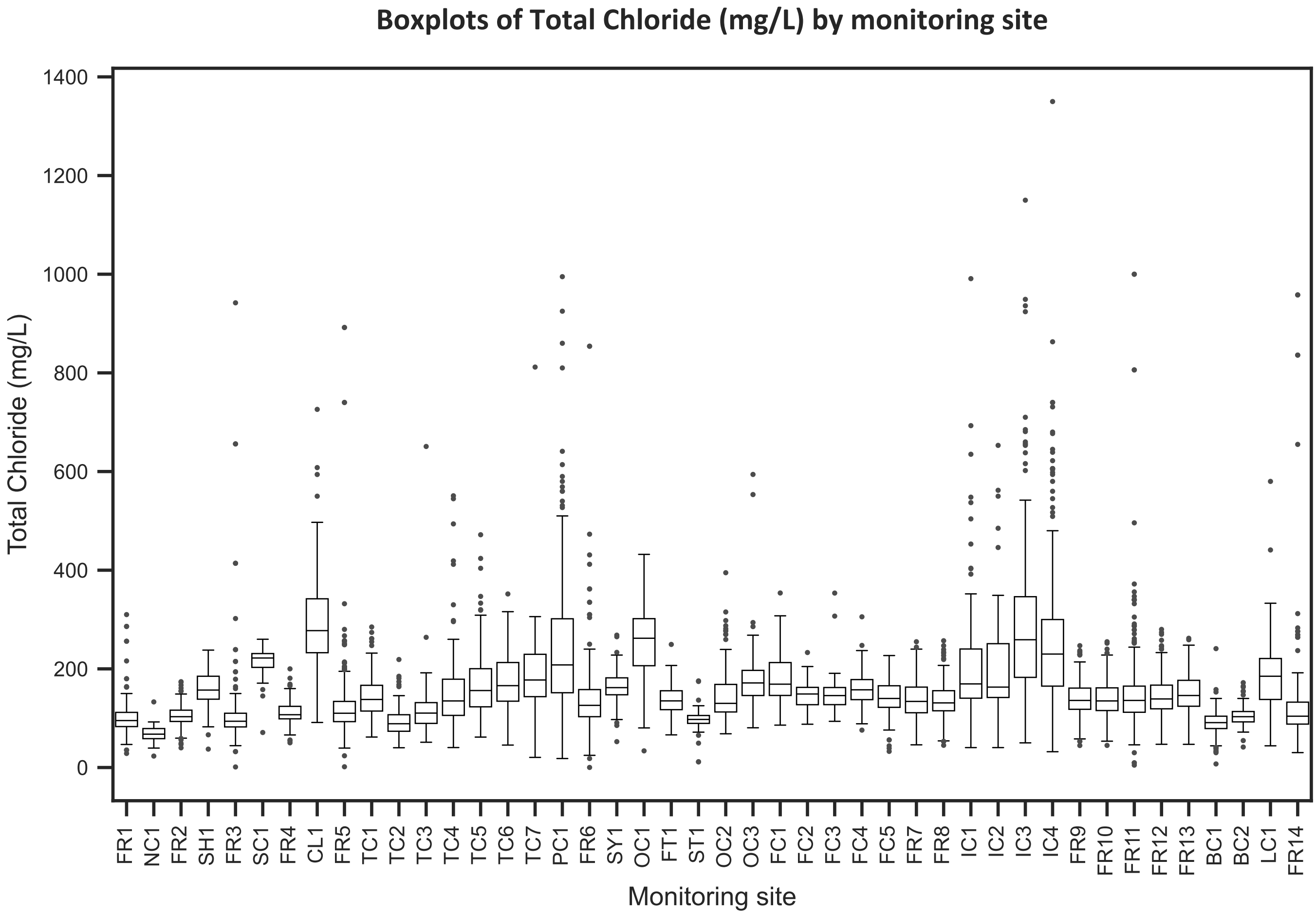


Total Chloride (mg/L) for Fox River and its tributaries

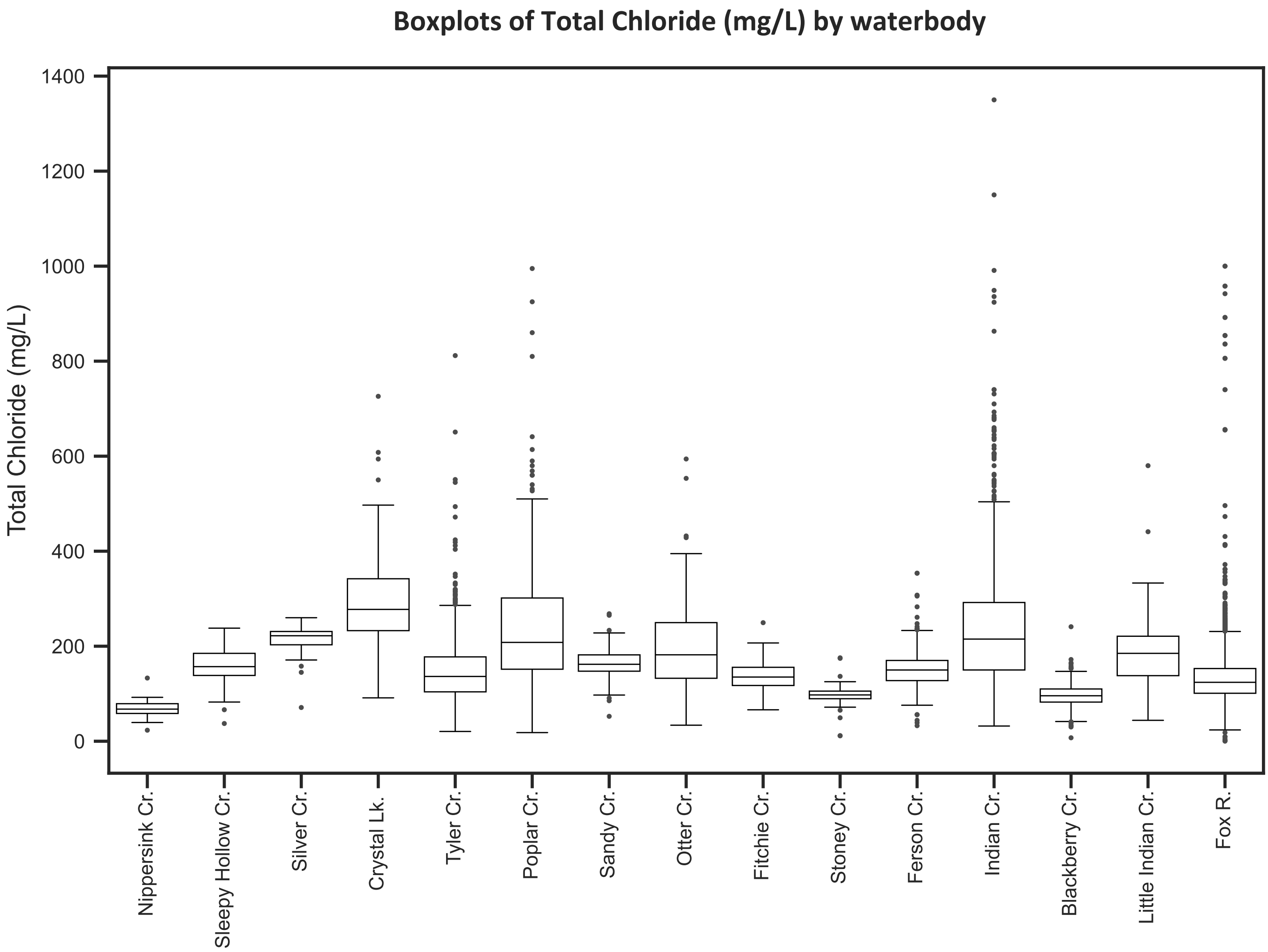



Total Chloride (mg/L) availability by monitoring site and year
Year
2000
2005
2010
2015
2020
FR1 NC1 FR2 SH1 FR3 SC1 FR4 CL1 FR5 TC1 TC2 TC3 TC4 TC5 TC6 TC7 PC1 FR6 SY1 OC1 FT1 ST1 OC2 OC3 FC1 FC2 FC3 FC4 FC5 FR7 FR8 IC1 IC2 IC3 IC4 FR9 FR10 FR11 FR12 FR13 BC1 BC2 LC1 FR14
Monitoring site


Strip chart of Total Chloride (mg/L) by monitoring site
Total Chloride (mg/L)
0
200
400
600
800
1000
1200
1400
FR1 NC1 FR2 SH1 FR3 SC1 FR4 CL1 FR5 TC1 TC2 TC3 TC4 TC5 TC6 TC7 PC1 FR6 SY1 OC1 FT1 ST1 OC2 OC3 FC1 FC2 FC3 FC4 FC5 FR7 FR8 IC1 IC2 IC3 IC4 FR9 FR10 FR11 FR12 FR13 BC1 BC2 LC1 FR14
Monitoring site



Boxplots of Total Chloride (mg/L) by monitoring site
Total Chloride (mg/L)
0
200
400
600
800
1000
1200
1400
FR1
NC1
FR2
SH1
FR3
SC1
FR4
CL1
FR5
TC1
TC2
TC3
TC4
TC5
TC6
TC7
PC1
FR6
SY1
OC1
FT1
ST1
OC2
OC3
FC1
FC2
FC3
FC4
FC5
FR7
FR8
IC1
IC2
IC3
IC4
FR9
FR10
FR11
FR12
FR13
BC1
BC2
LC1
FR14
Monitoring site

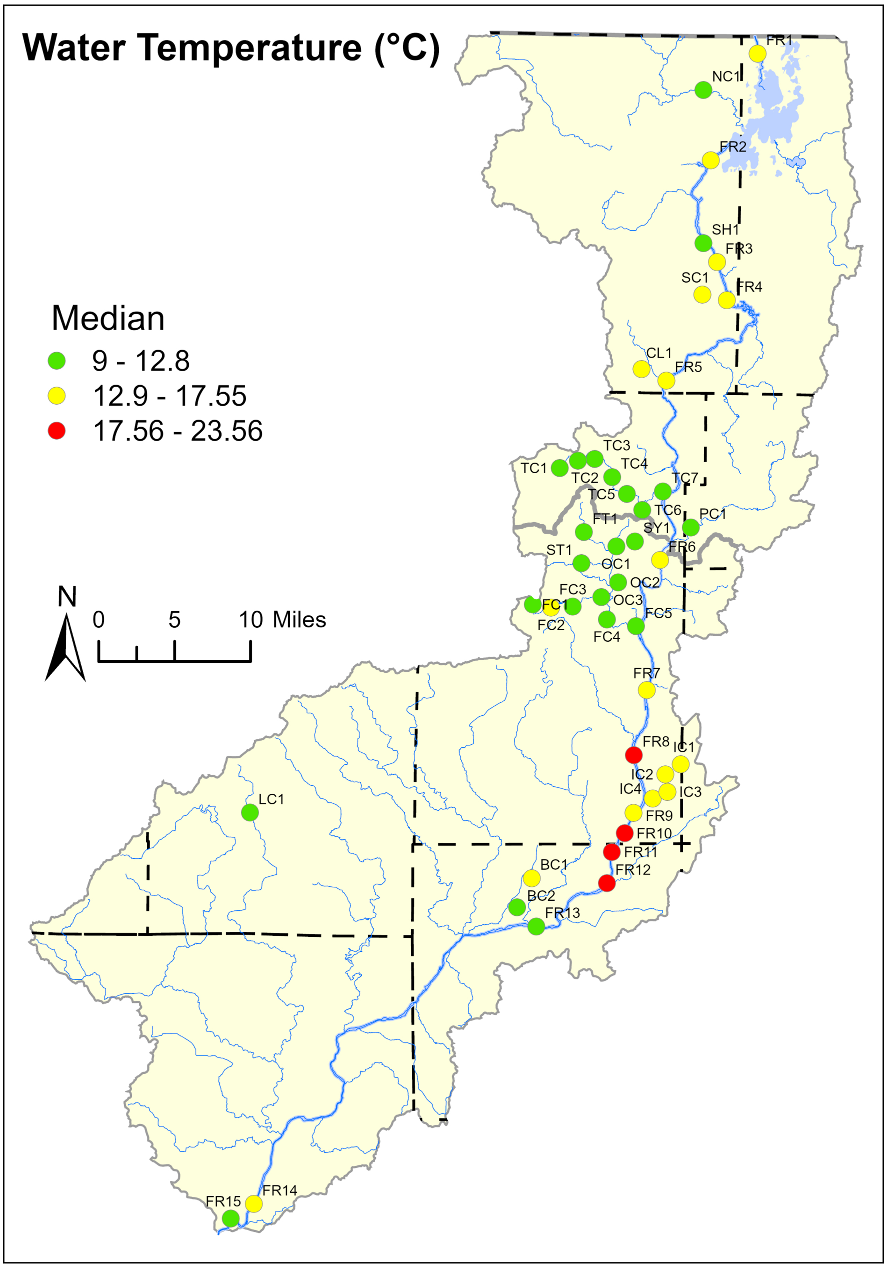


Boxplots of Total Chloride (mg/L) by waterbody
Total Chloride (mg/L)
0
200
400
600
800
1000
1200
1400
Nippersink Cr.
Sleepy Hollow Cr.
Silver Cr.
Crystal Lk.
Tyler Cr.
Poplar Cr.
Sandy Cr.
Otter Cr.
Fitchie Cr.
Stoney Cr.
Ferson Cr.
Indian Cr.
Blackberry Cr.
Little Indian Cr.
Fox R.

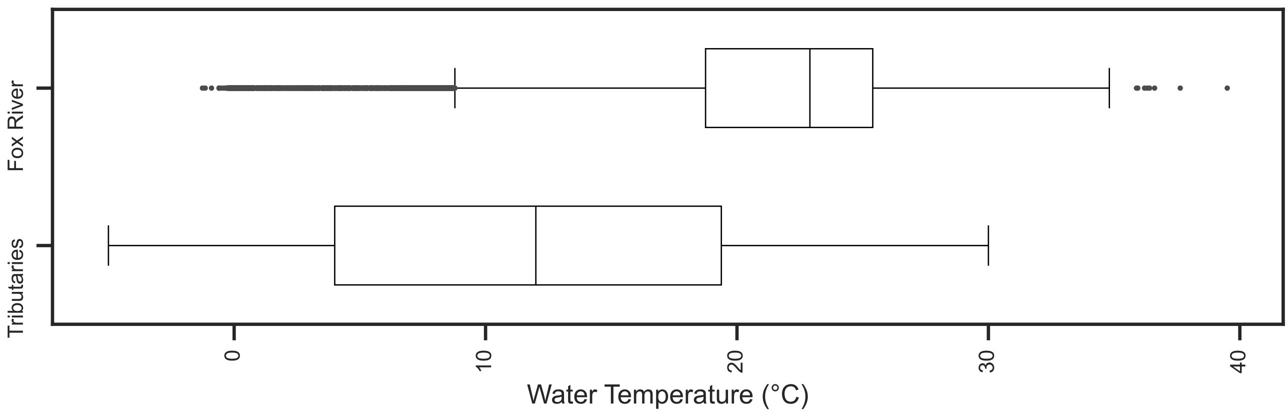
Summary statistics for Total Chloride (mg/L) by monitoring site

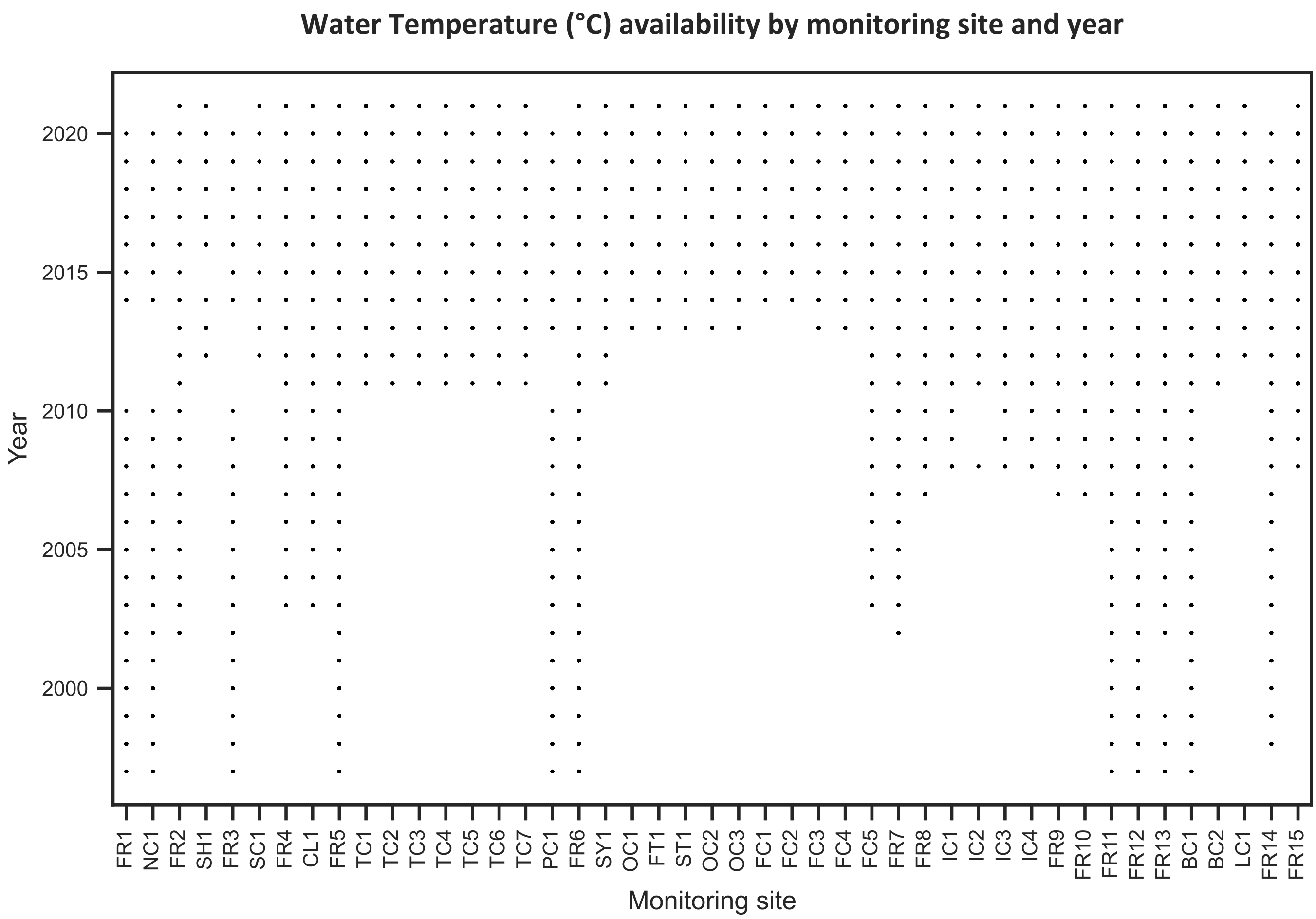
Station_PIDlabel	Start Date	End Date	N	Mean	Median	Max	Min	StdDev	Kurtosis	1st Quart	3rd Quart	Skewness
FR1	1997-01-06	2021-02-02	142	103.31	95.16	310.00	28.50	44.23	7.73	83.00	111.75	2.40
NC1	2002-07-09	2021-02-02	65	68.19	67.60	133.00	23.20	15.60	4.03	58.50	79.00	0.76
FR2	1997-06-11	2021-11-16	200	104.11	103.00	174.00	39.90	22.48	0.98	93.35	116.25	0.15
SH1	2012-01-17	2021-11-16	79	158.01	157.00	238.00	37.30	38.06	0.73	138.50	185.00	-0.35
FR3	1997-01-07	2021-02-02	251	108.63	93.80	942.00	1.13	83.90	53.35	82.30	110.00	6.65
SC1	2012-02-21	2021-08-17	89	215.52	222.00	260.00	71.00	26.61	9.14	203.00	231.00	-2.12
FR4	1997-06-11	2021-11-16	140	110.94	107.00	200.00	50.10	23.91	1.51	98.70	124.00	0.52
CL1	2003-06-24	2021-11-16	164	292.44	277.50	726.00	91.30	98.23	2.50	232.75	342.00	0.97
FR5	1997-01-07	2021-11-16	421	124.49	110.00	892.00	1.51	78.84	58.70	93.00	134.00	6.80
TC1	2011-08-29	2021-11-15	107	142.75	137.96	284.91	61.78	46.54	0.87	114.46	166.67	0.78
TC2	2011-08-29	2021-11-15	103	94.39	88.77	218.93	40.09	31.67	2.41	73.48	106.97	1.28
TC3	2011-08-29	2021-11-15	106	118.58	110.32	650.80	51.25	61.96	52.29	89.44	131.53	6.25
TC4	2011-08-29	2021-11-15	110	158.93	134.97	550.83	40.49	89.46	7.52	105.67	178.99	2.48
TC5	2011-08-29	2021-11-15	109	174.25	156.05	471.85	61.68	73.39	3.26	123.06	200.34	1.58
TC6	2011-08-29	2021-11-15	107	174.70	165.95	351.84	45.49	57.37	0.33	134.46	212.83	0.63
TC7	2011-08-29	2021-11-15	111	187.31	177.44	811.75	20.55	84.26	26.58	143.61	229.47	3.65
PC1	1997-01-07	2021-01-11	251	245.58	208.00	995.00	18.20	146.95	5.41	151.59	301.50	1.88
FR6	1997-01-07	2021-11-16	577	136.66	126.00	854.00	0.17	66.03	49.69	103.00	158.00	5.28
SY1	2011-08-29	2021-11-15	107	165.45	161.95	268.32	52.43	32.65	2.07	147.45	181.79	0.10
OC1	2013-05-28	2021-11-15	92	252.68	262.02	432.07	33.76	71.98	0.55	206.37	301.75	-0.41
FT1	2013-05-28	2021-11-15	91	135.14	135.09	249.52	66.18	29.44	1.76	117.31	155.60	0.52
ST1	2013-05-28	2021-11-15	89	96.32	97.47	175.57	11.37	22.30	6.38	89.47	105.48	-0.32
OC2	2013-05-28	2021-11-15	91	153.76	130.06	394.88	68.39	62.73	1.92	112.62	168.45	1.44
OC3	2013-05-28	2021-11-15	92	181.66	171.46	594.12	80.56	72.77	17.39	145.99	196.88	3.51
FC1	2014-05-19	2021-11-15	83	177.29	168.95	353.79	85.94	47.45	1.58	146.10	212.73	0.88
FC2	2014-05-19	2021-11-15	83	145.12	149.05	233.13	87.77	26.60	0.54	127.36	162.45	0.18
FC3	2013-05-28	2021-11-15	92	147.89	145.85	353.63	93.67	34.85	16.67	127.46	162.15	3.21
FC4	2013-05-28	2021-11-15	93	158.55	157.55	305.51	75.78	37.32	1.91	137.56	178.24	0.58
FC5	2003-06-24	2021-11-16	186	142.39	140.00	227.00	32.70	34.41	0.51	122.00	165.75	-0.29
FR7	2002-04-30	2021-11-16	292	138.76	134.00	255.00	46.00	37.14	0.07	111.00	163.00	0.45
FR8	2007-08-27	2021-08-17	218	135.46	131.00	257.00	45.00	36.42	1.02	115.00	155.75	0.54
IC1	2008-05-14	2021-08-17	160	206.70	169.50	991.00	40.40	119.55	13.48	140.50	240.25	2.96
IC2	2008-05-14	2021-03-16	113	201.98	163.00	653.00	40.40	103.09	4.38	142.00	251.00	1.77
IC3	2008-05-14	2021-08-17	140	299.48	259.00	1150.00	50.00	184.33	4.93	182.75	346.25	2.00
IC4	2008-04-29	2021-11-16	301	257.29	230.00	1350.00	32.00	149.93	10.57	165.00	300.00	2.42
FR9	2007-08-27	2021-08-17	219	139.77	136.00	247.00	44.60	36.77	0.41	118.00	161.00	0.34
FR10	2007-08-27	2021-08-17	203	140.59	135.00	255.00	44.80	36.86	0.53	115.50	161.50	0.49
FR11	1997-01-24	2021-11-16	670	147.67	136.00	1000.00	4.81	77.55	58.17	112.00	165.00	6.18
FR12	2002-02-01	2021-03-16	339	143.71	139.00	280.00	47.10	40.32	0.58	119.00	167.00	0.56
FR13	2002-04-30	2021-11-16	258	150.86	146.00	262.00	47.00	39.87	0.08	124.25	176.75	0.29
BC1	2002-07-17	2021-01-25	206	91.95	91.00	241.00	7.26	24.94	6.25	79.00	104.00	0.83
BC2	2011-07-19	2021-11-16	111	105.62	103.00	172.00	41.50	21.29	1.45	92.50	113.50	0.59
LC1	2012-01-17	2021-11-16	105	188.94	185.00	580.00	44.00	73.61	7.47	138.00	221.00	1.75
FR14	1998-02-24	2021-01-27	182	135.72	104.00	958.00	30.20	130.45	25.99	88.00	132.50	4.90

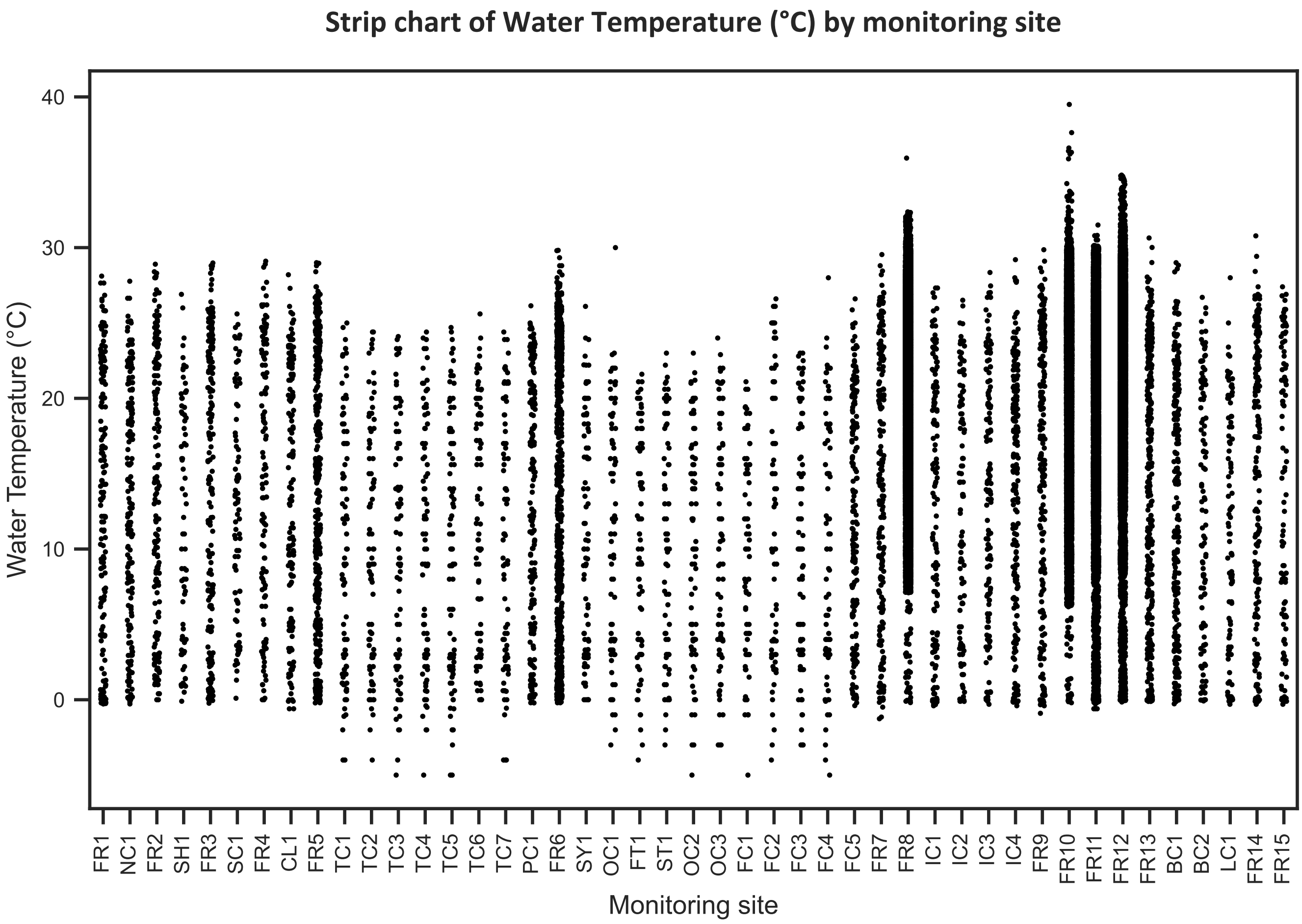
Data Factsheet for Water Temperature (°C)



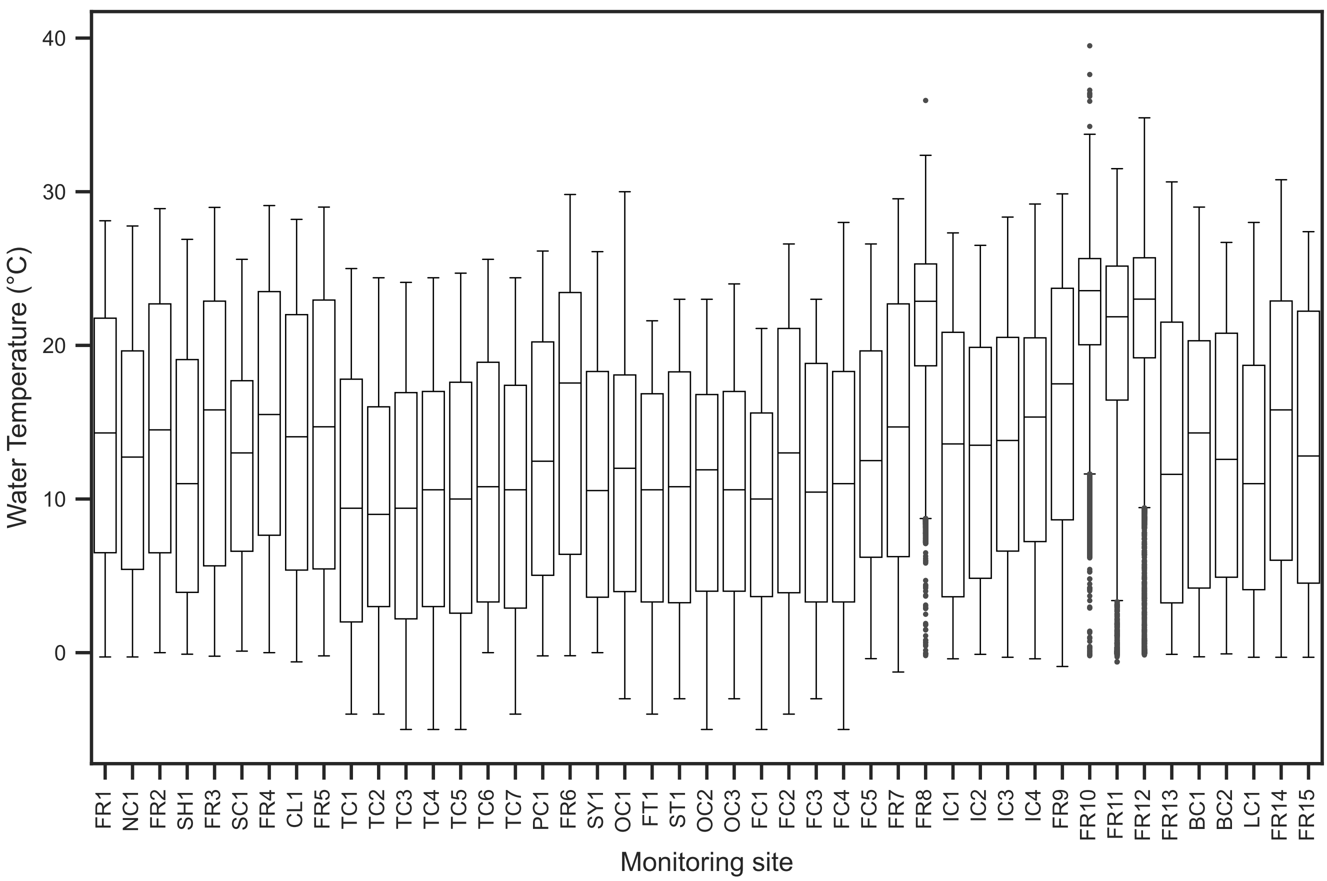
Water Temperature (°C) for Fox River and its tributaries



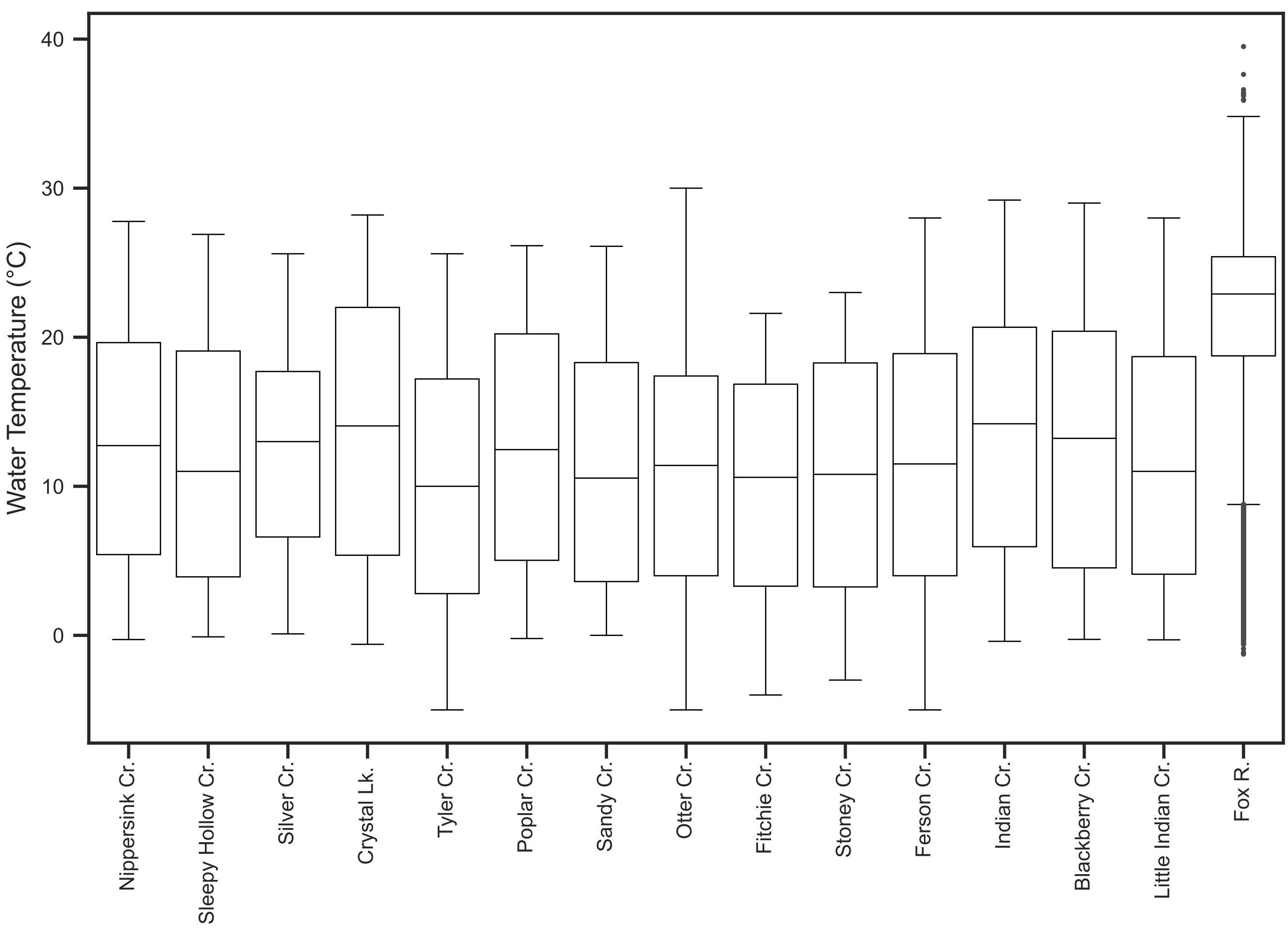

Water Temperature (°C) availability by monitoring site and year
Year
2000
2005
2010
2015
2020
FR1
NC1
FR2
SH1
FR3
SC1
FR4
CL1
FR5
TC1
TC2
TC3
TC4
TC5
TC6
TC7
PC1
FR6
SY1
OC1
FT1
ST1
OC2
OC3
FC1
FC2
FC3
FC4
FC5
FR7
FR8
IC1
IC2
IC3
IC4
FR9
FR10
FR11
FR12
FR13
BC1
BC2
LC1
FR14
FR15
Monitoring site


Strip chart of Water Temperature (°C) by monitoring site
Water Temperature (°C)
0
10
20
30
40
FR1
NC1
FR2
SH1
FR3
SC1
FR4
CL1
FR5
TC1
TC2
TC3
TC4
TC5
TC6
TC7
PC1
FR6
SY1
OC1
FT1
ST1
OC2
OC3
FC1
FC2
FC3
FC4
FC5
FR7
FR8
IC1
IC2
IC3
IC4
FR9
FR10
FR11
FR12
FR13
BC1
BC2
LC1
FR14
FR15
Monitoring site

Boxplots of Water Temperature (°C) by monitoring site



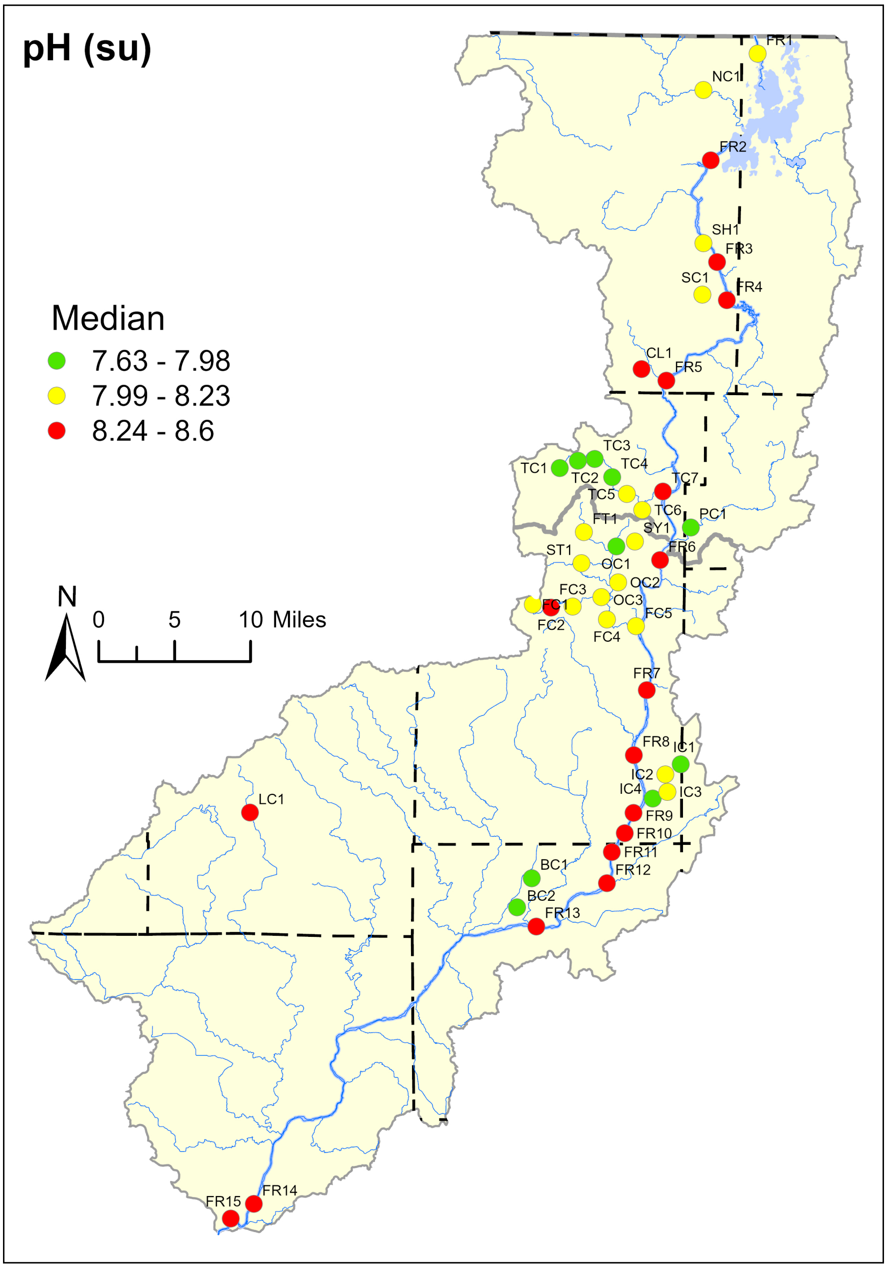
Boxplots of Water Temperature (°C) by waterbody



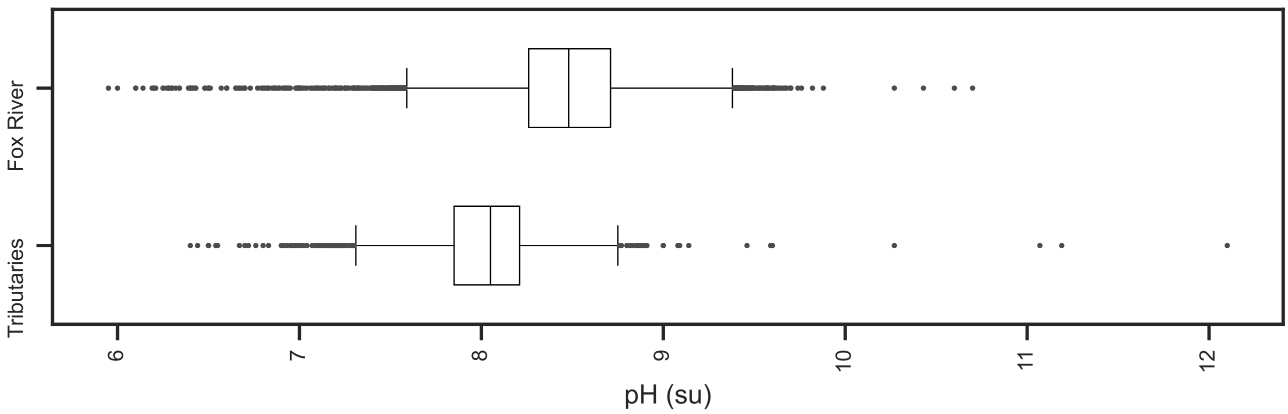
Summary statistics for Water Temperature (°C) by monitoring site

Station_PIDlabel	Start Date	End Date	N	Mean	Median	Max	Min	StdDev	Kurtosis	1st Quart	3rd Quart	Skewness
FR1	1997-01-06	2020-12-16	171	13.61	14.30	28.11	-0.28	8.65	-1.26	6.50	21.77	-0.17
NC1	1997-01-06	2020-12-16	179	12.74	12.73	27.77	-0.28	8.02	-1.29	5.42	19.64	-0.05
FR2	2002-04-30	2021-11-16	185	14.44	14.50	28.90	0.00	8.76	-1.39	6.50	22.70	-0.12
SH1	2012-01-17	2021-11-16	78	11.71	11.00	26.90	-0.10	7.96	-1.44	3.92	19.07	0.09
FR3	1997-01-07	2020-12-16	211	14.26	15.80	28.98	-0.23	9.23	-1.43	5.65	22.88	-0.18
SC1	2012-02-21	2021-08-17	85	12.69	13.00	25.60	0.10	7.13	-1.09	6.60	17.70	0.12
FR4	2003-08-05	2021-11-16	122	15.14	15.50	29.10	0.00	8.66	-1.30	7.64	23.50	-0.20
CL1	2003-06-24	2021-11-16	156	13.76	14.05	28.20	-0.60	8.36	-1.38	5.38	22.00	-0.16
FR5	1997-01-07	2021-11-16	403	13.94	14.70	29.00	-0.21	9.08	-1.40	5.45	22.95	-0.11
TC1	2011-08-29	2021-11-15	93	10.12	9.40	25.00	-4.00	8.28	-1.32	2.00	17.80	0.15
TC2	2011-08-29	2021-07-19	89	9.90	9.00	24.40	-4.00	7.67	-1.12	3.00	16.00	0.22
TC3	2011-08-29	2021-11-15	90	9.79	9.40	24.10	-5.00	8.03	-1.23	2.20	16.93	0.11
TC4	2011-08-29	2021-11-15	93	10.27	10.60	24.40	-5.00	7.91	-1.25	3.00	17.00	0.09
TC5	2011-08-29	2021-11-15	94	10.05	10.00	24.70	-5.00	8.26	-1.26	2.57	17.60	0.10
TC6	2011-08-29	2021-11-15	96	11.29	10.80	25.60	0.00	7.66	-1.42	3.30	18.90	0.02
TC7	2011-12-19	2021-11-15	83	10.52	10.60	24.40	-4.00	8.16	-1.30	2.90	17.40	0.03
PC1	1997-01-07	2020-12-01	186	12.72	12.46	26.14	-0.21	8.11	-1.36	5.04	20.23	-0.10
FR6	1997-01-07	2021-11-16	796	15.05	17.55	29.82	-0.20	9.26	-1.39	6.40	23.44	-0.36
SY1	2011-08-29	2021-11-15	95	11.17	10.55	26.10	0.00	7.57	-1.38	3.61	18.30	0.11
OC1	2013-05-28	2021-11-15	84	11.43	12.00	30.00	-3.00	7.79	-1.11	3.98	18.07	-0.02
FT1	2013-05-28	2021-11-15	83	10.24	10.60	21.60	-4.00	7.22	-1.25	3.30	16.85	-0.11
ST1	2013-05-28	2021-11-15	82	10.81	10.80	23.00	-3.00	7.55	-1.36	3.25	18.27	-0.09
OC2	2013-05-28	2021-11-15	83	10.67	11.90	23.00	-5.00	7.41	-1.17	4.00	16.80	-0.19
OC3	2013-05-28	2021-11-15	85	10.59	10.60	24.00	-3.00	7.68	-1.29	4.00	17.00	-0.01
FC1	2014-07-14	2021-11-15	75	9.77	10.00	21.10	-5.00	6.79	-1.16	3.65	15.60	-0.09
FC2	2014-07-14	2021-11-15	76	12.47	13.00	26.60	-4.00	9.08	-1.39	3.90	21.10	-0.00
FC3	2013-05-28	2021-11-15	86	10.76	10.45	23.00	-3.00	8.06	-1.36	3.30	18.82	-0.04
FC4	2013-05-28	2021-11-15	85	10.97	11.00	28.00	-5.00	8.34	-1.24	3.30	18.30	-0.02
FC5	2003-06-24	2021-11-16	181	12.42	12.50	26.60	-0.39	7.62	-1.26	6.21	19.64	-0.09
FR7	2002-04-30	2021-11-16	221	14.22	14.69	29.54	-1.26	8.92	-1.31	6.25	22.70	-0.15
FR8	2007-05-31	2021-08-17	75838	21.64	22.87	35.94	-0.19	4.88	-0.01	18.67	25.30	-0.79
IC1	2008-05-14	2021-08-17	154	12.71	13.59	27.32	-0.40	9.04	-1.46	3.64	20.85	-0.07
IC2	2008-05-14	2021-03-16	111	12.71	13.50	26.51	-0.11	8.07	-1.35	4.84	19.87	-0.08
IC3	2008-05-14	2021-08-17	137	13.52	13.81	28.35	-0.30	8.12	-1.23	6.61	20.52	-0.04
IC4	2008-04-29	2021-11-16	200	13.84	15.34	29.20	-0.40	8.07	-1.12	7.23	20.49	-0.28
FR9	2007-08-27	2021-08-17	216	15.88	17.50	29.86	-0.90	8.82	-1.08	8.64	23.71	-0.44
FR10	2007-06-01	2021-08-17	31687	22.28	23.56	39.50	-0.20	4.84	0.92	20.04	25.65	-1.11
FR11	1997-01-08	2021-12-14	16733	20.43	21.86	31.50	-0.60	6.15	0.97	16.44	25.16	-1.01
FR12	1997-01-08	2021-03-16	24426	21.93	23.01	34.81	-0.15	5.21	2.24	19.19	25.70	-1.19
FR13	1997-01-08	2021-11-16	372	12.34	11.61	30.64	-0.11	9.46	-1.45	3.24	21.51	0.09
BC1	1997-01-24	2021-12-14	275	12.85	14.30	29.00	-0.27	8.46	-1.36	4.21	20.30	-0.04
BC2	2011-07-19	2021-11-16	111	12.63	12.58	26.70	-0.08	8.25	-1.38	4.91	20.79	-0.03
LC1	2012-01-17	2021-11-16	105	11.34	11.00	28.00	-0.30	7.84	-1.29	4.10	18.70	0.03
FR14	1998-02-24	2020-12-22	191	14.42	15.80	30.78	-0.30	9.32	-1.39	6.01	22.89	-0.21
FR15	2008-11-20	2021-12-14	104	13.22	12.80	27.40	-0.30	9.46	-1.53	4.53	22.23	-0.02

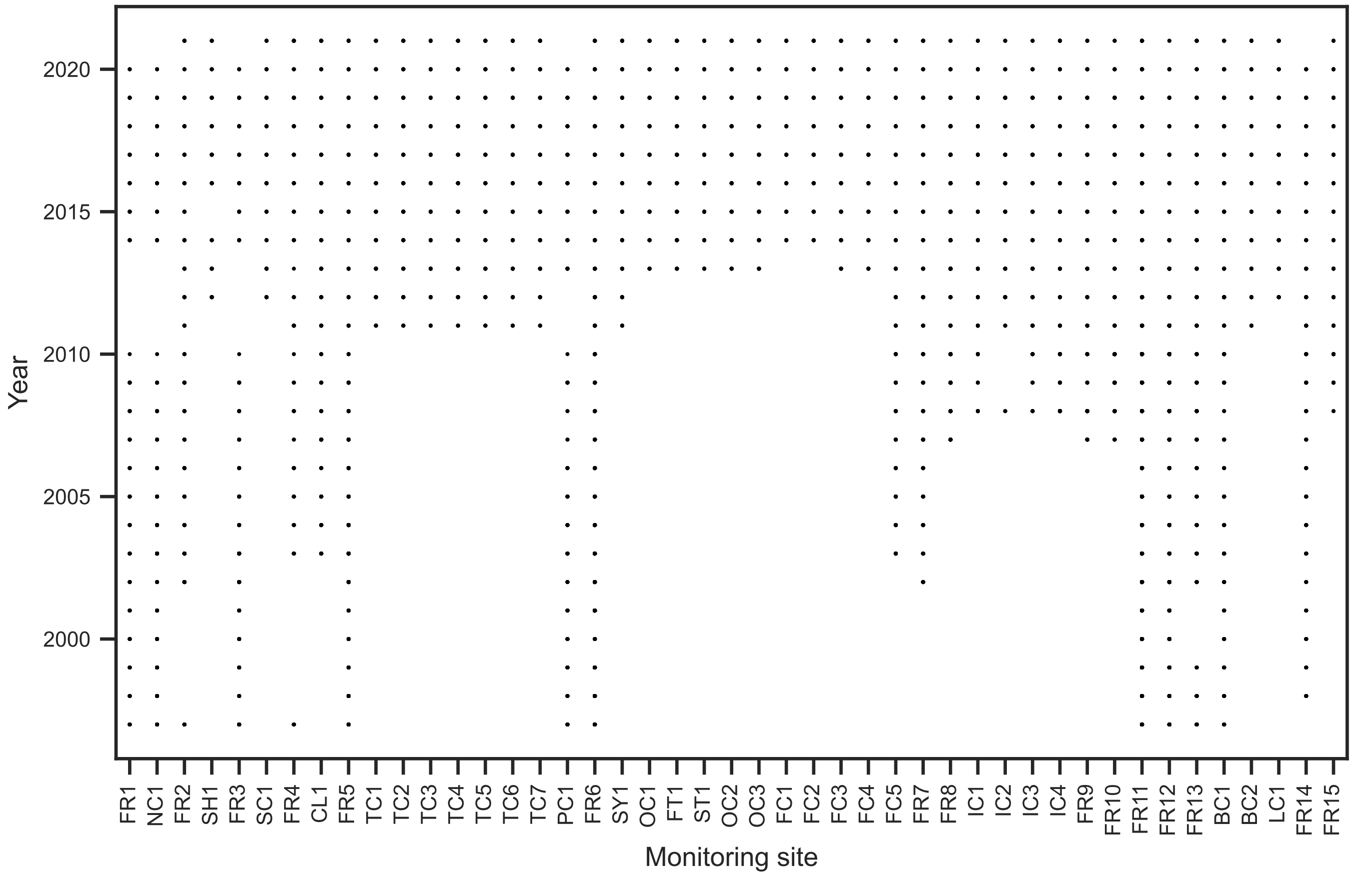
Data Factsheet for pH (su)



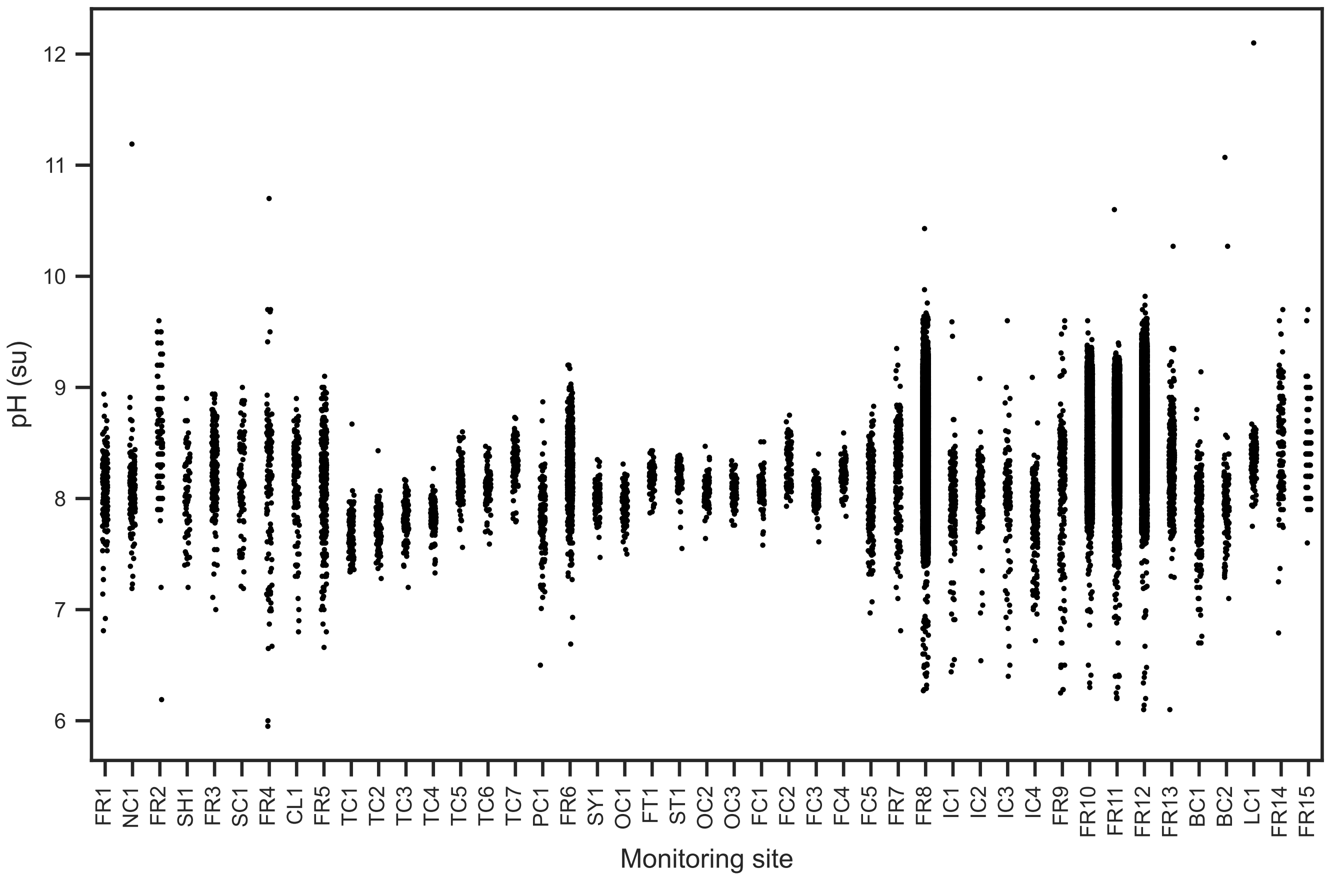
pH (su) for Fox River and its tributaries



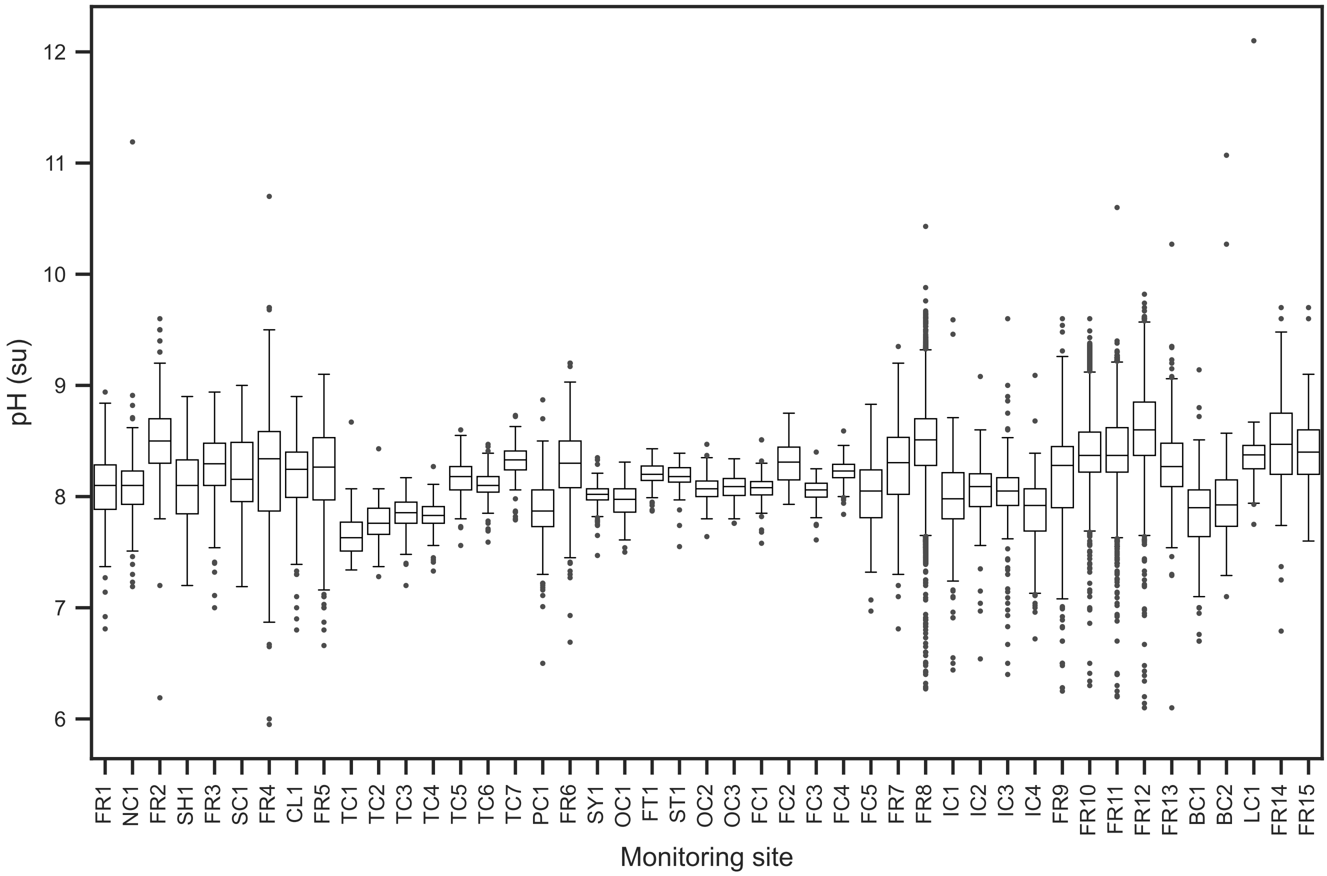
pH (su) availability by monitoring site and year



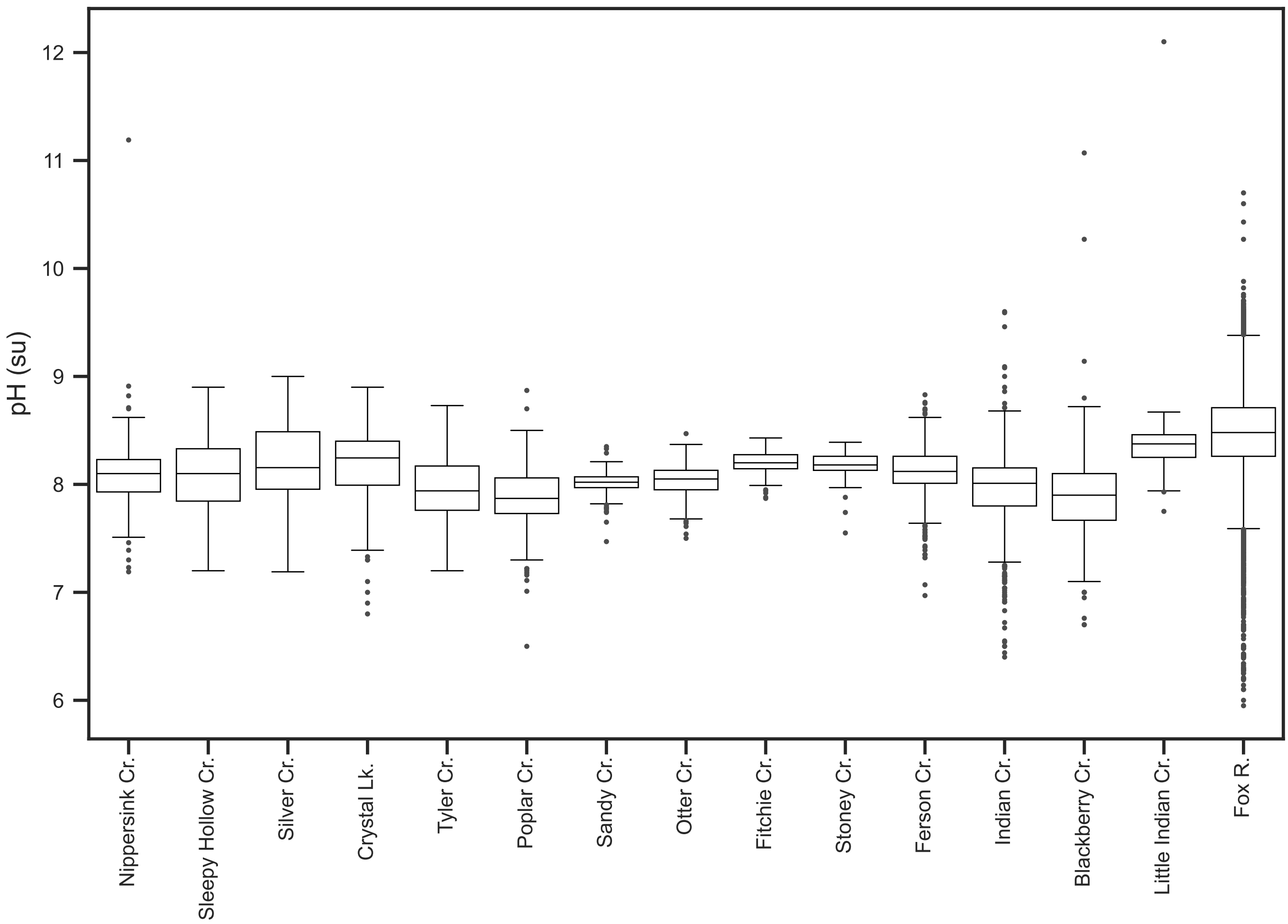
Strip chart of pH (su) by monitoring site



Boxplots of pH (su) by monitoring site



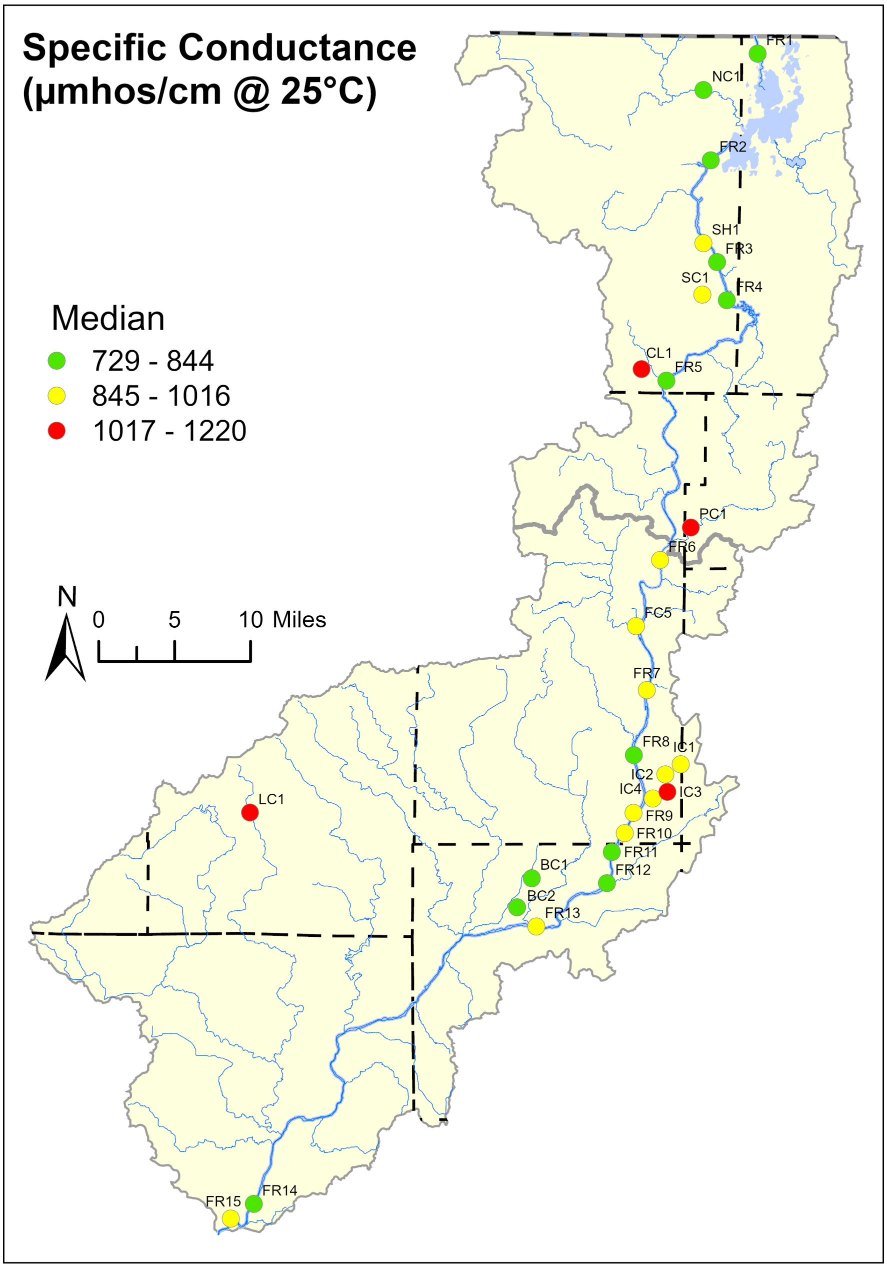
Boxplots of pH (su) by waterbody



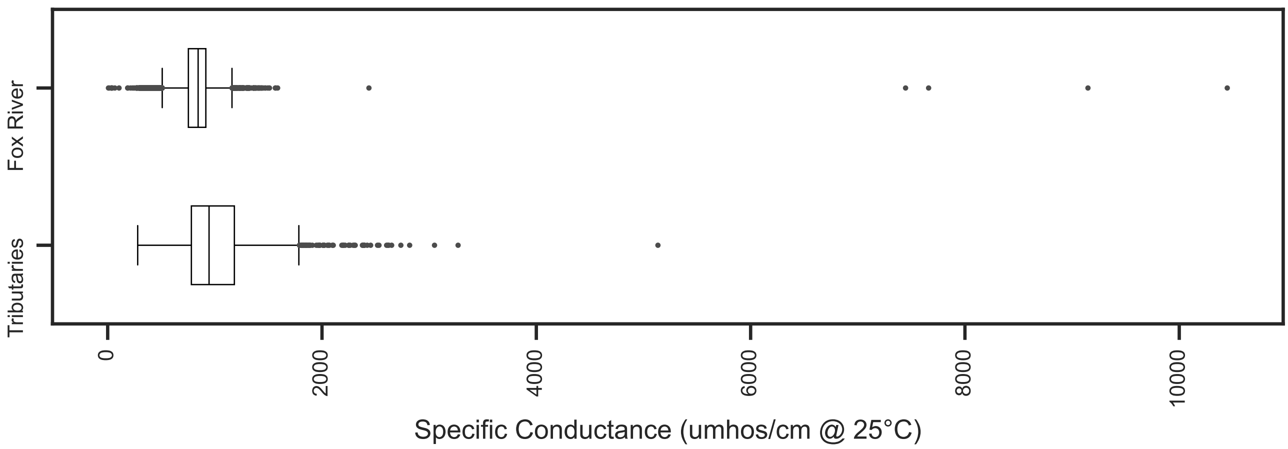
Summary statistics for pH (su) by monitoring site

Station_PIDlabel	Start Date	End Date	N	Mean	Median	Max	Min	StdDev	Kurtosis	1st Quart	3rd Quart	Skewness
FR1	1997-01-06	2020-12-16	159	8.07	8.10	8.94	6.81	0.32	1.95	7.88	8.29	-0.67
NC1	1997-01-06	2020-12-16	163	8.09	8.10	11.19	7.19	0.36	33.30	7.93	8.23	3.75
FR2	1997-06-11	2021-07-20	182	8.52	8.50	9.60	6.19	0.39	6.89	8.30	8.70	-0.85
SH1	2012-01-17	2021-11-16	74	8.09	8.10	8.90	7.20	0.36	-0.28	7.84	8.33	-0.18
FR3	1997-01-07	2020-12-16	196	8.27	8.29	8.94	7.00	0.32	1.93	8.10	8.48	-0.79
SC1	2012-02-21	2021-06-15	78	8.19	8.15	9.00	7.19	0.43	-0.39	7.96	8.49	-0.26
FR4	1997-06-11	2021-11-16	123	8.18	8.34	10.70	5.95	0.71	1.82	7.87	8.59	-0.33
CL1	2003-06-24	2021-11-16	156	8.15	8.24	8.90	6.80	0.39	1.30	7.99	8.40	-1.12
FR5	1997-01-07	2021-11-16	380	8.20	8.27	9.10	6.66	0.44	0.48	7.97	8.53	-0.76
TC1	2011-08-29	2021-11-15	107	7.66	7.63	8.67	7.34	0.20	4.66	7.51	7.77	1.28
TC2	2011-08-29	2021-11-15	103	7.76	7.76	8.43	7.28	0.18	0.93	7.66	7.89	0.07
TC3	2011-08-29	2021-11-15	106	7.84	7.86	8.17	7.20	0.17	1.35	7.76	7.95	-0.86
TC4	2011-08-29	2021-11-15	110	7.83	7.83	8.27	7.33	0.15	1.62	7.76	7.91	-0.56
TC5	2011-08-29	2021-11-15	109	8.17	8.18	8.60	7.56	0.18	1.27	8.06	8.27	-0.39
TC6	2011-08-29	2021-11-15	107	8.10	8.10	8.47	7.59	0.15	1.66	8.04	8.18	-0.51
TC7	2011-08-29	2021-11-15	111	8.31	8.33	8.73	7.79	0.18	1.53	8.24	8.41	-0.70
PC1	1997-01-07	2020-12-01	171	7.86	7.87	8.87	6.50	0.30	3.19	7.73	8.06	-0.69
FR6	1997-01-07	2021-11-16	717	8.29	8.30	9.20	6.69	0.33	1.08	8.08	8.50	-0.32
SY1	2011-08-29	2021-11-15	107	8.01	8.02	8.35	7.47	0.13	3.22	7.97	8.07	-0.73
OC1	2013-05-28	2021-11-15	92	7.96	7.97	8.31	7.50	0.16	0.27	7.86	8.07	-0.50
FT1	2013-05-28	2021-11-15	91	8.20	8.20	8.43	7.87	0.11	0.99	8.14	8.28	-0.64
ST1	2013-05-28	2021-11-15	89	8.18	8.18	8.39	7.55	0.13	6.75	8.13	8.26	-1.78
OC2	2013-05-28	2021-11-15	91	8.07	8.07	8.47	7.64	0.12	1.99	8.00	8.14	-0.01
OC3	2013-05-28	2021-11-15	92	8.08	8.09	8.34	7.76	0.12	0.21	8.01	8.16	-0.36
FC1	2014-05-19	2021-11-15	83	8.08	8.08	8.51	7.58	0.14	2.98	8.02	8.13	-0.24
FC2	2014-05-19	2021-11-15	83	8.31	8.31	8.75	7.93	0.19	-0.82	8.15	8.45	0.17
FC3	2013-05-28	2021-11-15	92	8.05	8.06	8.40	7.61	0.12	2.15	8.00	8.12	-0.66
FC4	2013-05-28	2021-11-15	93	8.22	8.23	8.59	7.84	0.12	1.26	8.17	8.29	-0.44
FC5	2003-06-24	2021-11-16	181	8.02	8.05	8.83	6.97	0.34	0.03	7.81	8.24	-0.27
FR7	2002-04-30	2021-11-16	220	8.24	8.30	9.35	6.81	0.41	0.40	8.02	8.53	-0.49
FR8	2007-08-27	2021-08-17	65493	8.49	8.51	10.43	6.27	0.33	0.52	8.28	8.70	-0.33
IC1	2008-05-14	2021-08-17	147	7.96	7.98	9.59	6.44	0.43	3.69	7.80	8.21	-0.52
IC2	2008-05-14	2021-03-16	111	8.04	8.09	9.08	6.54	0.32	6.55	7.91	8.21	-1.54
IC3	2008-05-14	2021-08-17	129	8.00	8.05	9.60	6.40	0.45	3.23	7.92	8.17	-0.81
IC4	2008-04-29	2021-11-16	193	7.84	7.92	9.09	6.72	0.35	1.02	7.69	8.07	-0.61
FR9	2007-08-27	2021-08-17	209	8.11	8.28	9.60	6.25	0.60	1.39	7.90	8.45	-0.93
FR10	2007-08-27	2021-08-17	13861	8.41	8.37	9.60	6.30	0.30	0.92	8.22	8.58	0.39
FR11	1997-01-08	2021-12-14	16686	8.43	8.37	10.60	6.20	0.30	1.56	8.22	8.62	0.22
FR12	1997-01-08	2021-03-16	20757	8.61	8.60	9.82	6.10	0.37	0.33	8.37	8.85	-0.11
FR13	1997-01-08	2021-11-16	353	8.29	8.27	10.27	6.10	0.36	5.81	8.09	8.48	0.10
BC1	1997-01-24	2021-12-14	254	7.84	7.90	9.14	6.70	0.35	1.38	7.64	8.06	-0.35
BC2	2011-07-19	2021-11-16	110	7.96	7.92	11.07	7.10	0.47	20.94	7.73	8.15	3.52
LC1	2012-01-17	2021-11-16	104	8.38	8.38	12.10	7.75	0.41	69.48	8.25	8.46	7.50
FR14	1998-02-24	2020-12-22	179	8.48	8.47	9.70	6.79	0.42	1.27	8.20	8.75	-0.06
FR15	2008-11-20	2021-12-14	99	8.45	8.40	9.70	7.60	0.35	1.68	8.20	8.60	0.82

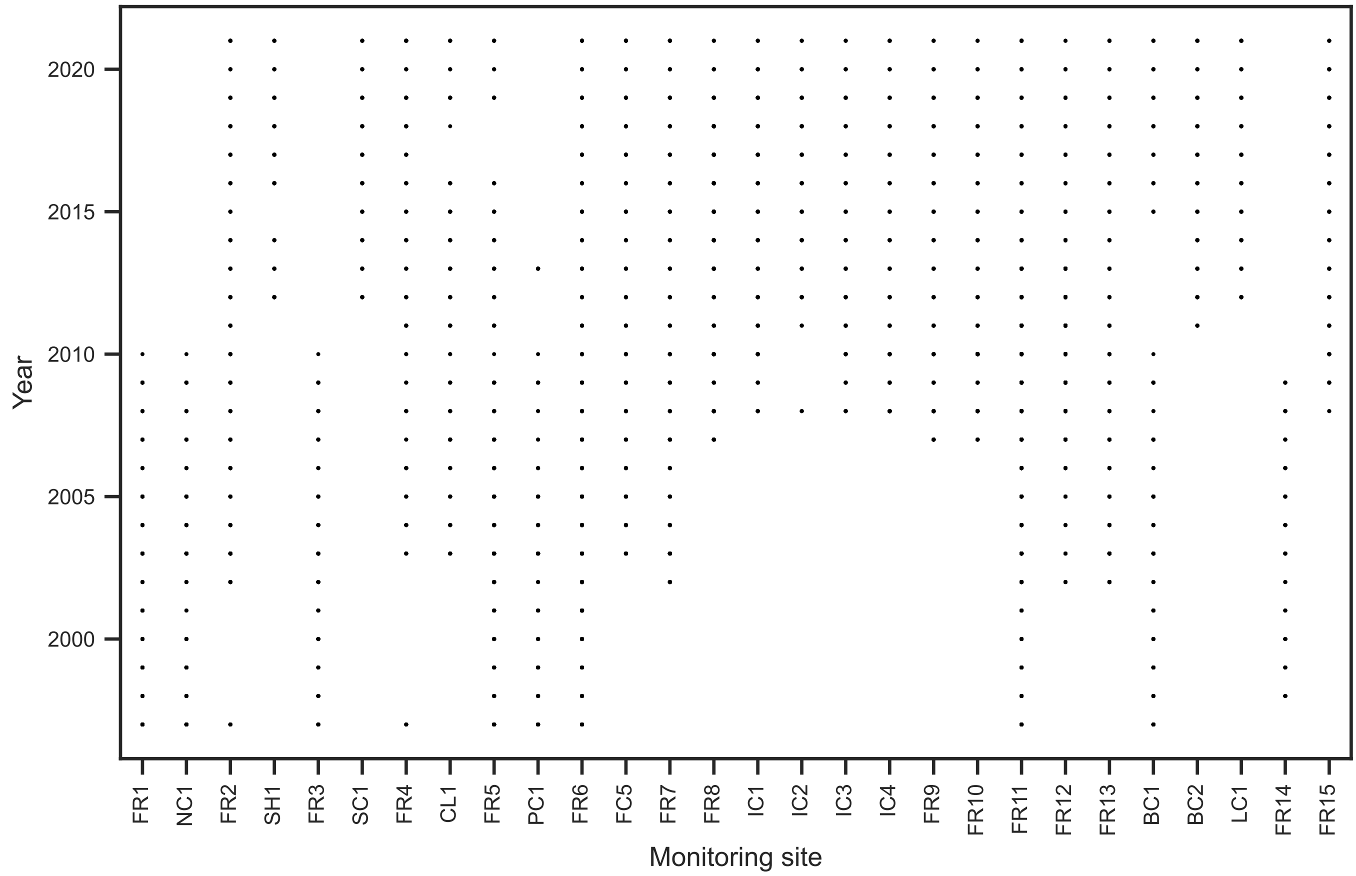
Data Factsheet for Specific Conductance (umhos/cm @ 25°C)



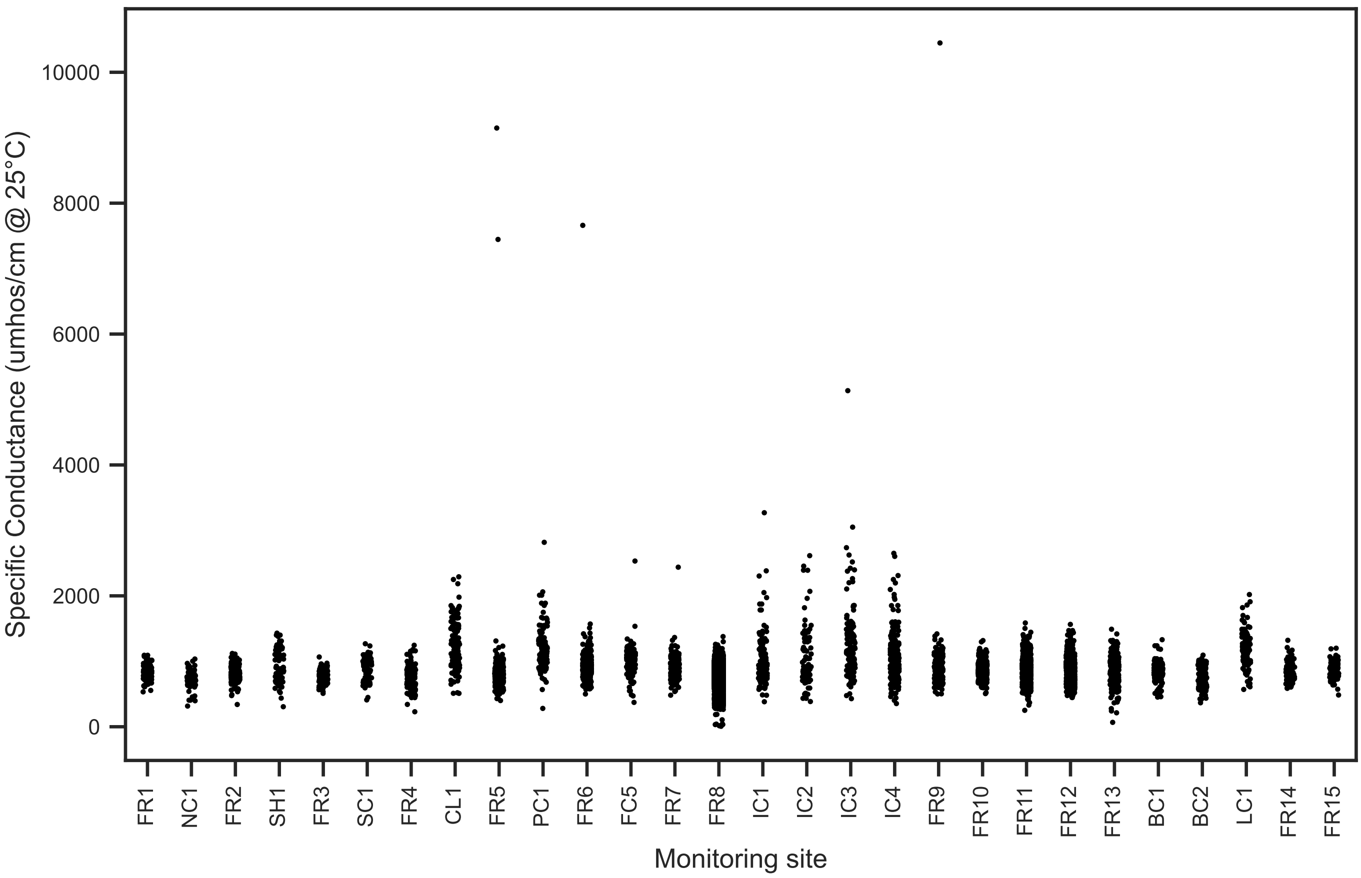
Specific Conductance (umhos/cm @ 25°C) for Fox River and its tributaries



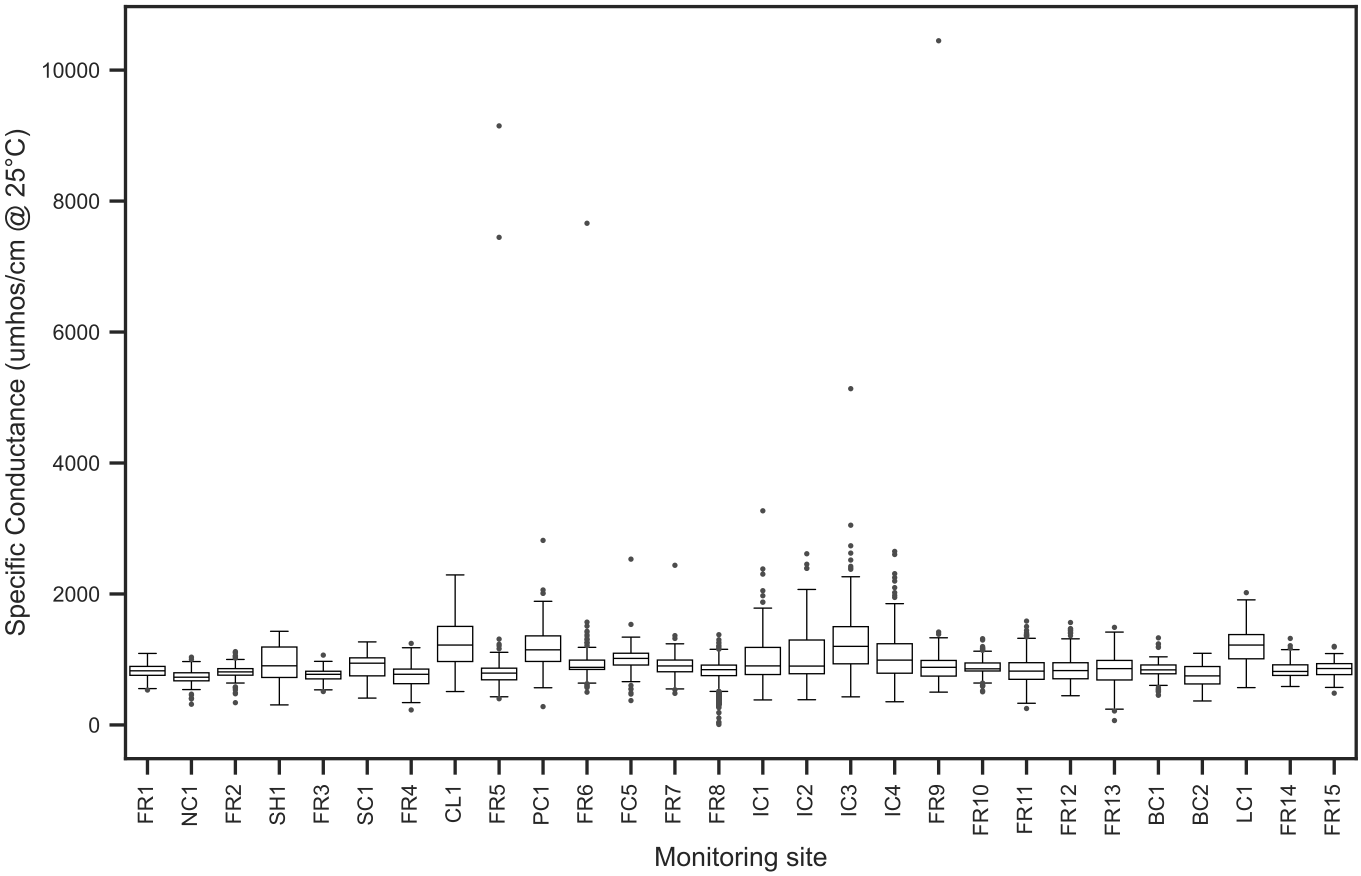
Specific Conductance (umhos/cm @ 25°C) availability by monitoring site and year



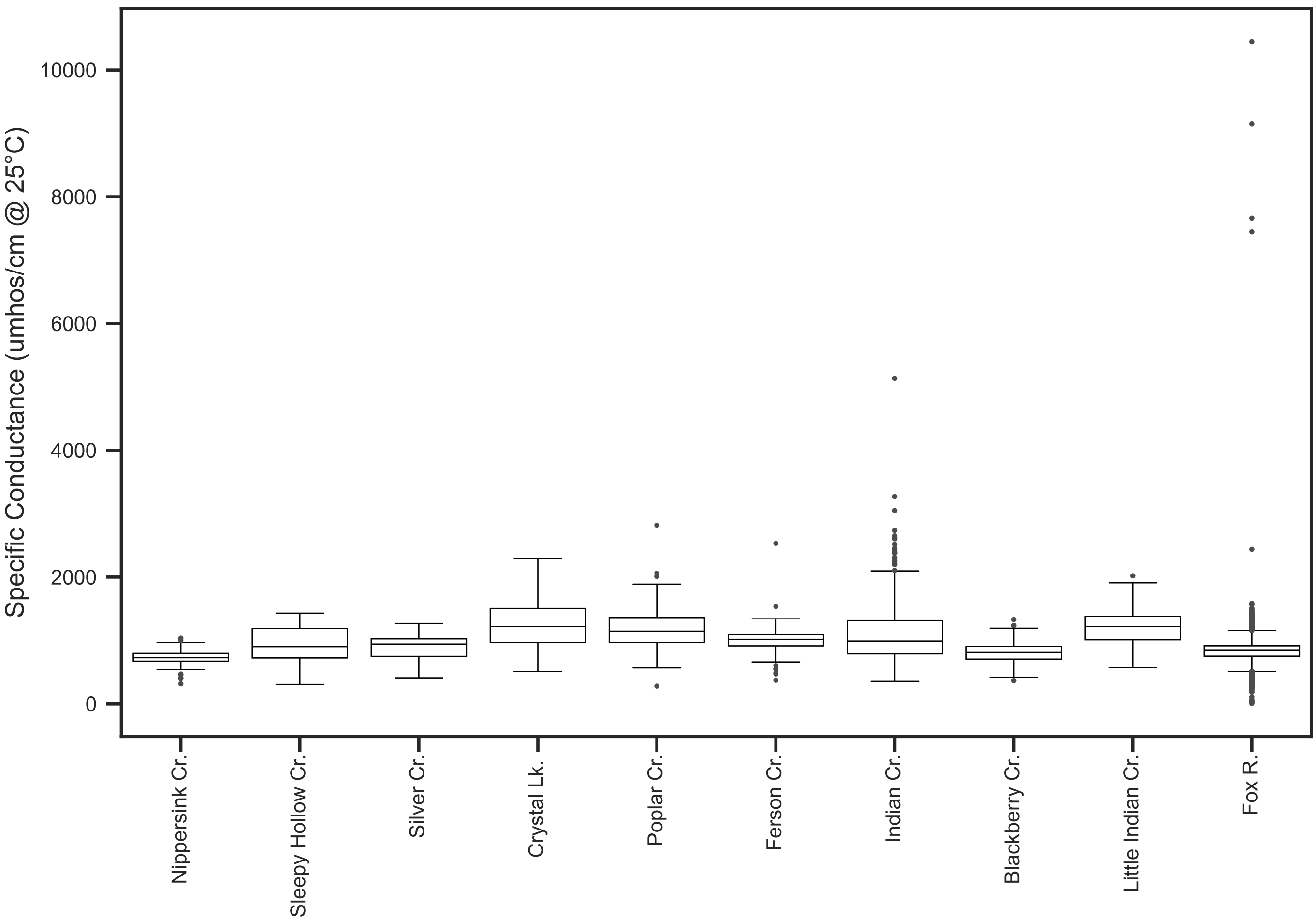
Strip chart of Specific Conductance (umhos/cm @ 25°C) by monitoring site



Boxplots of Specific Conductance (umhos/cm @ 25°C) by monitoring site



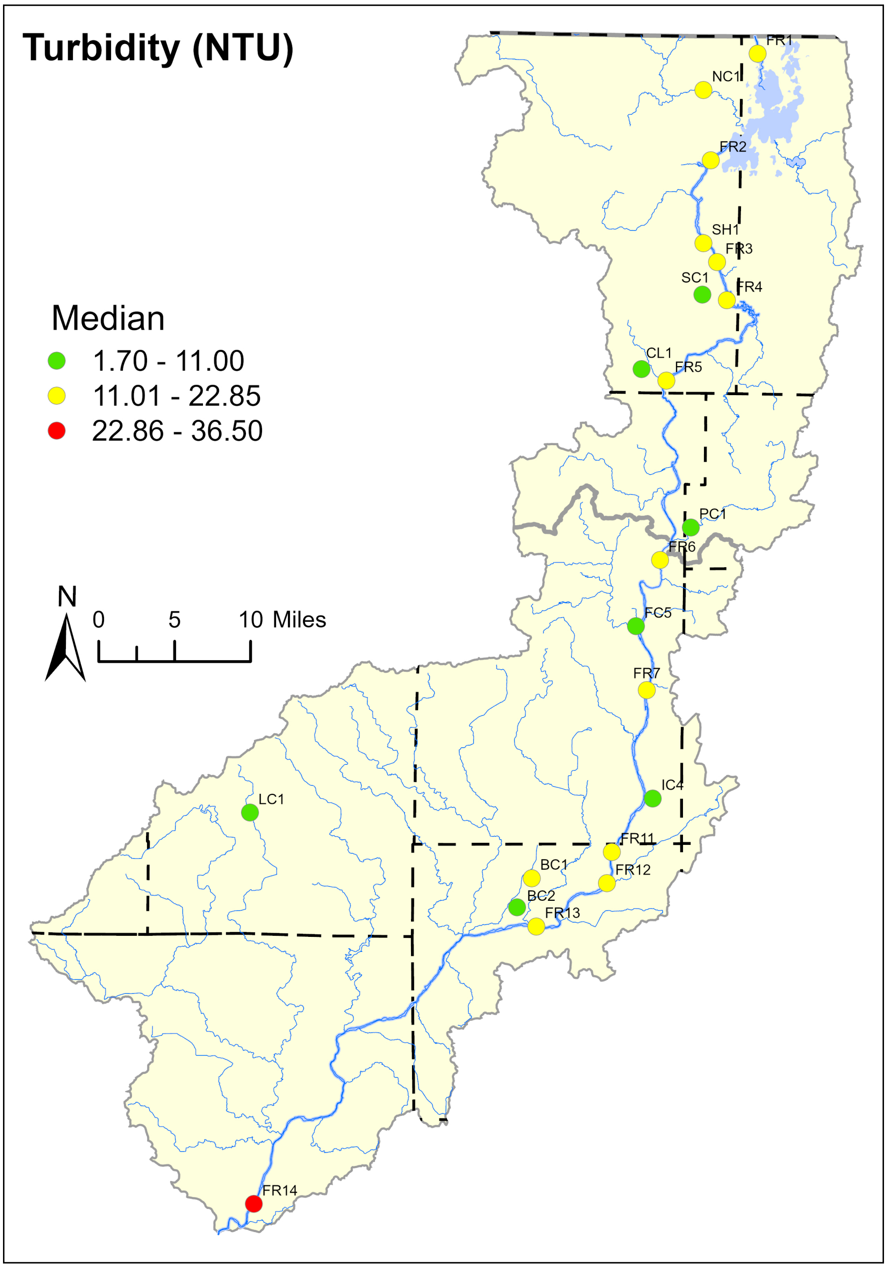
Boxplots of Specific Conductance (umhos/cm @ 25°C) by waterbody



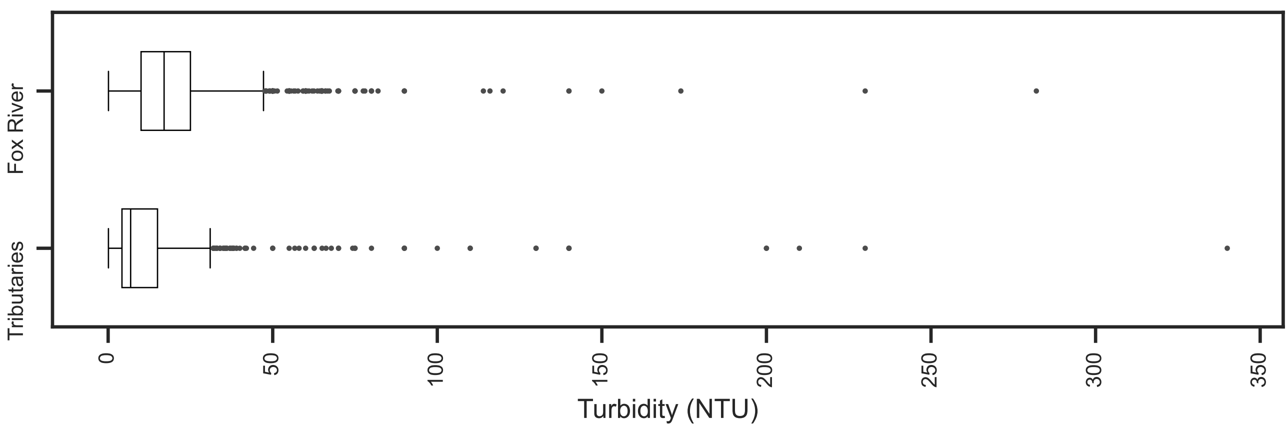
Summary statistics for Specific Conductance (umhos/cm @ 25°C) by monitoring site

Station_PIDlabel	Start Date	End Date	N	Mean	Median	Max	Min	StdDev	Kurtosis	1st Quart	3rd Quart	Skewness
FR1	1997-01-06	2010-02-03	110	827.03	826.50	1092.00	533.00	112.24	0.10	757.75	894.00	0.07
NC1	1997-01-06	2010-02-03	110	728.81	729.00	1035.00	316.00	118.74	1.99	673.50	796.50	-0.60
FR2	1997-06-11	2021-11-16	198	813.22	810.00	1120.00	340.00	113.05	1.98	760.00	860.00	-0.26
SH1	2012-01-17	2021-11-16	77	936.34	903.00	1430.00	306.00	266.74	-0.95	725.00	1190.00	0.05
FR3	1997-01-07	2010-02-03	150	764.69	773.00	1066.00	510.00	92.95	0.30	703.25	820.00	0.02
SC1	2012-02-21	2021-08-17	83	895.78	943.00	1268.00	410.00	177.34	-0.33	749.50	1024.50	-0.45
FR4	1997-06-11	2021-11-16	128	753.47	773.50	1245.00	229.00	180.20	0.31	630.00	853.00	0.08
CL1	2003-06-24	2021-11-16	122	1245.89	1220.00	2291.00	510.00	370.96	-0.08	968.50	1504.75	0.45
FR5	1997-01-07	2021-11-16	298	836.08	791.50	9148.00	400.00	633.86	139.20	689.25	867.00	11.48
PC1	1997-01-07	2013-08-07	114	1203.15	1147.00	2818.00	280.00	348.50	3.58	969.58	1360.00	1.19
FR6	1997-01-07	2021-11-16	513	931.39	879.80	7661.00	500.00	329.93	339.22	847.50	990.00	16.68
FC5	2003-06-24	2021-11-16	185	1003.84	1016.00	2532.00	372.00	195.35	20.45	915.00	1095.00	2.13
FR7	2002-04-30	2021-11-16	220	907.94	901.00	2438.00	482.00	176.37	25.03	812.00	991.00	2.96
FR8	2007-08-27	2021-08-17	52110	821.67	844.00	1378.00	7.00	134.08	1.59	753.00	914.00	-1.07
IC1	2008-05-14	2021-08-17	150	1016.28	901.50	3270.00	382.00	393.00	7.82	769.75	1184.00	2.18
IC2	2008-05-14	2021-03-16	109	1043.18	899.00	2614.00	385.00	428.01	2.91	782.00	1297.00	1.55
IC3	2008-05-14	2021-08-17	130	1303.65	1200.00	5135.00	429.00	585.64	13.88	933.50	1501.00	2.74
IC4	2008-05-12	2021-11-16	197	1062.59	990.00	2650.00	354.00	400.37	2.25	790.00	1240.00	1.26
FR9	2007-08-27	2021-08-17	211	928.45	880.00	10448.00	501.00	680.83	184.26	746.00	985.00	13.13
FR10	2007-08-27	2021-08-17	924	869.69	856.80	1317.00	506.00	105.95	0.73	823.88	946.48	0.02
FR11	1997-01-24	2021-12-14	867	837.31	822.00	1586.00	251.00	187.11	0.53	696.50	950.50	0.55
FR12	2002-02-01	2021-03-16	569	843.72	830.00	1564.00	446.00	186.02	0.81	705.00	950.00	0.72
FR13	2002-04-30	2021-11-16	260	839.33	860.00	1490.00	67.00	218.44	0.45	686.75	985.25	-0.15
BC1	1997-01-24	2021-12-14	157	838.45	841.00	1330.00	453.00	138.94	1.89	781.00	916.00	0.02
BC2	2011-07-19	2021-11-16	111	752.11	749.00	1094.00	366.00	160.97	-0.78	626.00	892.00	-0.10
LC1	2012-02-21	2021-11-16	101	1211.09	1220.00	2020.00	570.00	279.04	0.48	1010.00	1380.00	0.18
FR14	1998-02-24	2009-09-22	87	844.99	817.00	1321.00	587.00	144.37	0.72	756.00	918.00	0.72
FR15	2008-11-20	2021-12-14	104	857.44	861.50	1200.00	485.00	125.92	0.30	768.75	936.25	0.15

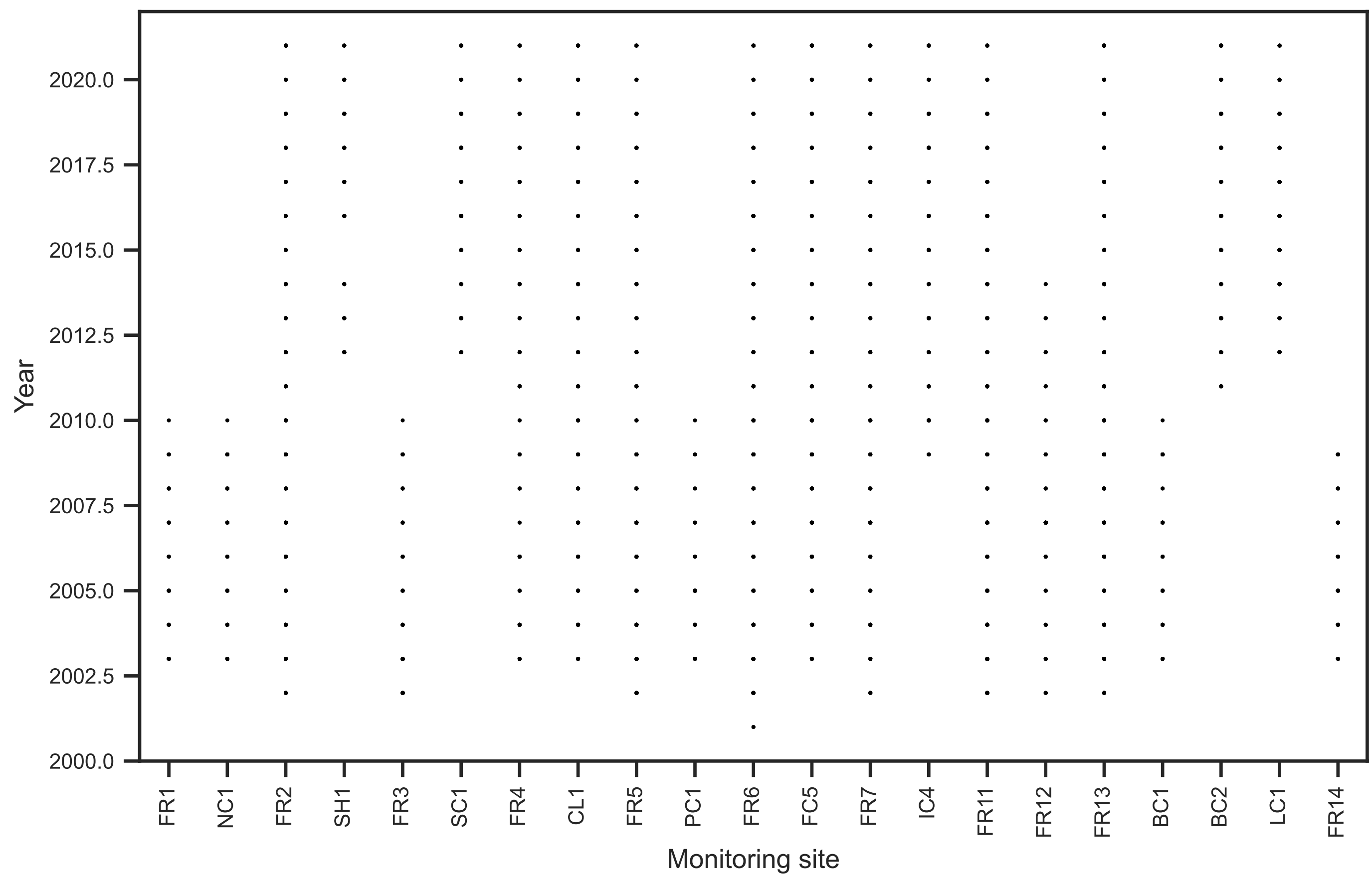
Data Factsheet for Turbidity (NTU)



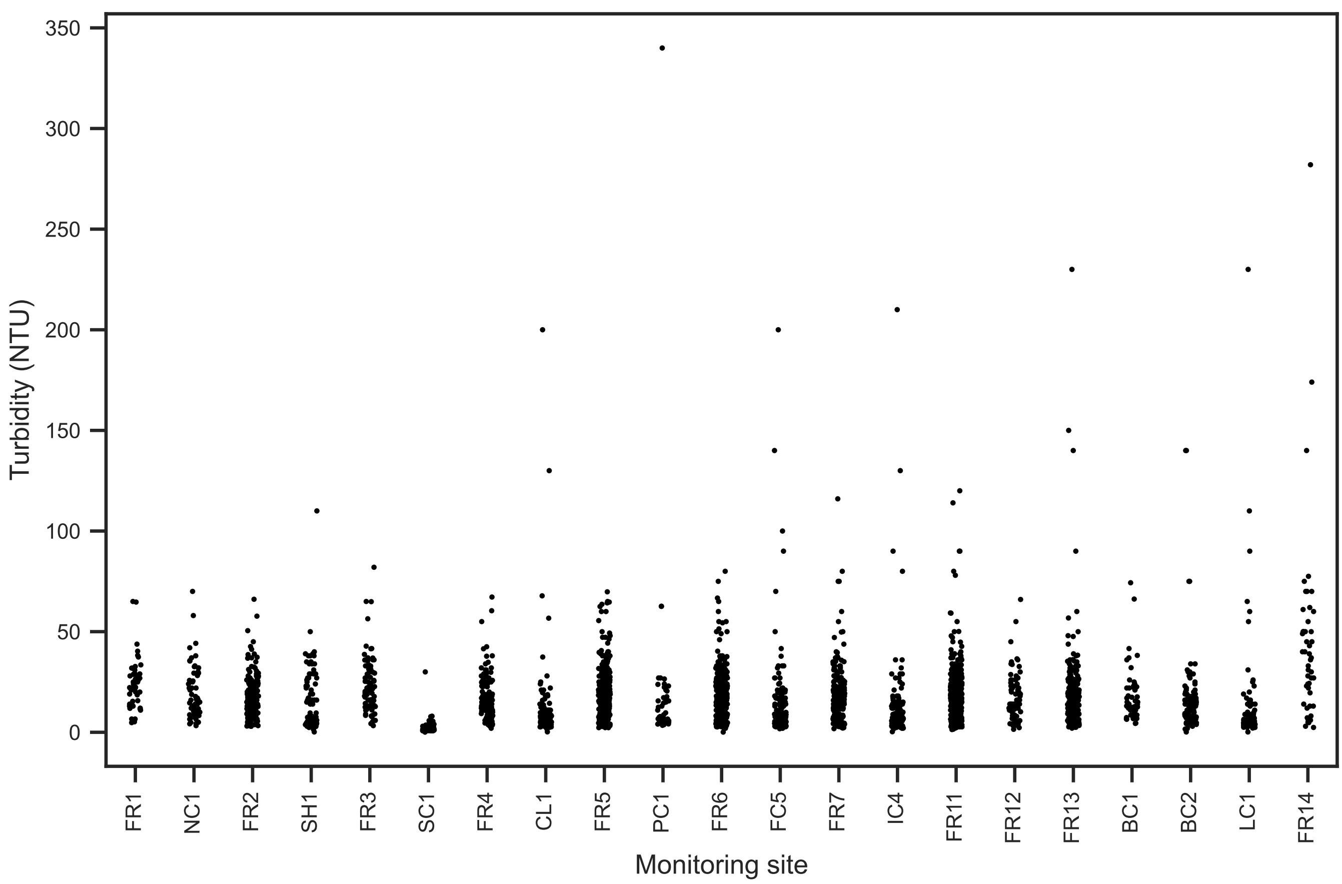
Turbidity (NTU) for Fox River and its tributaries

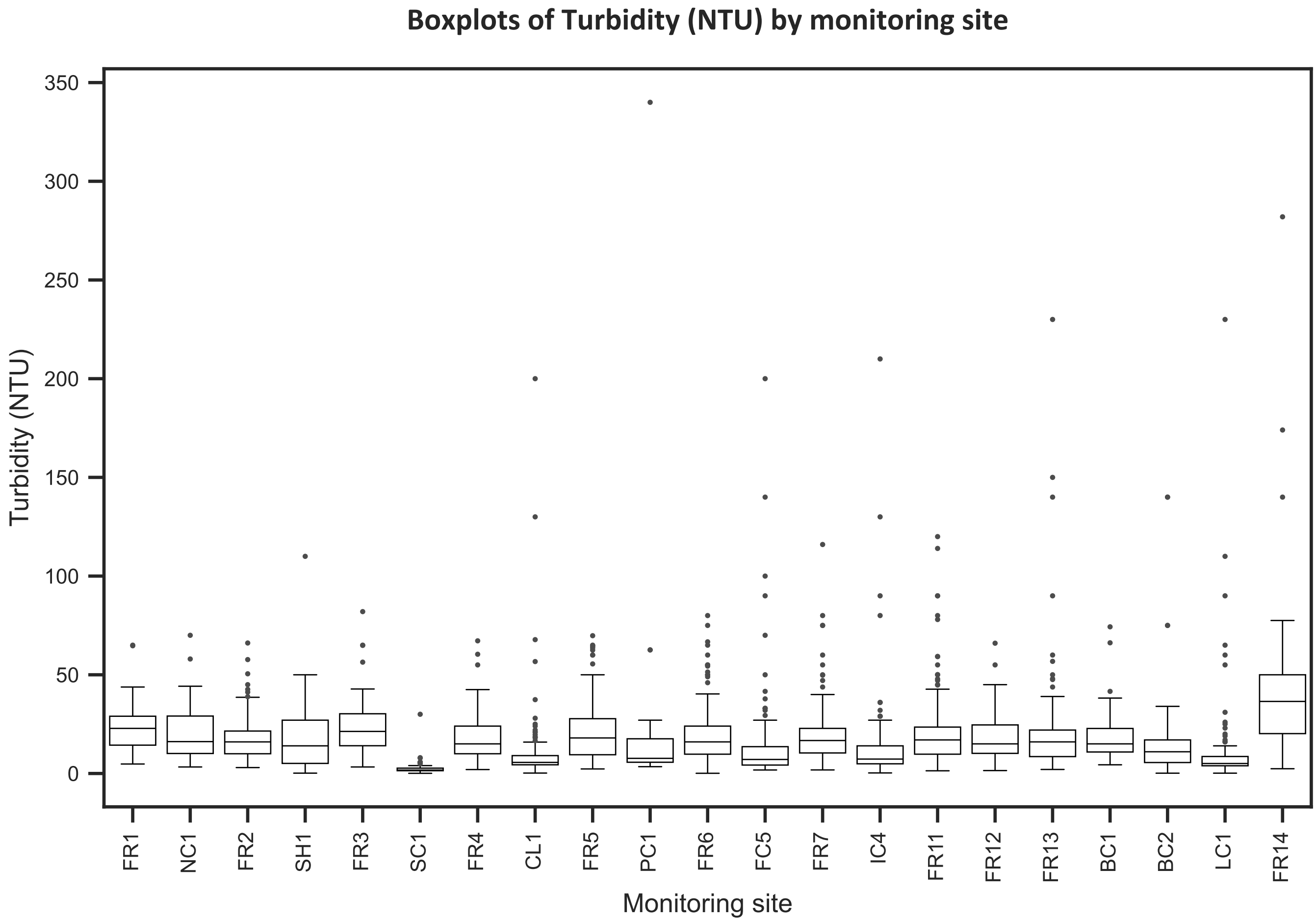


Turbidity (NTU) availability by monitoring site and year

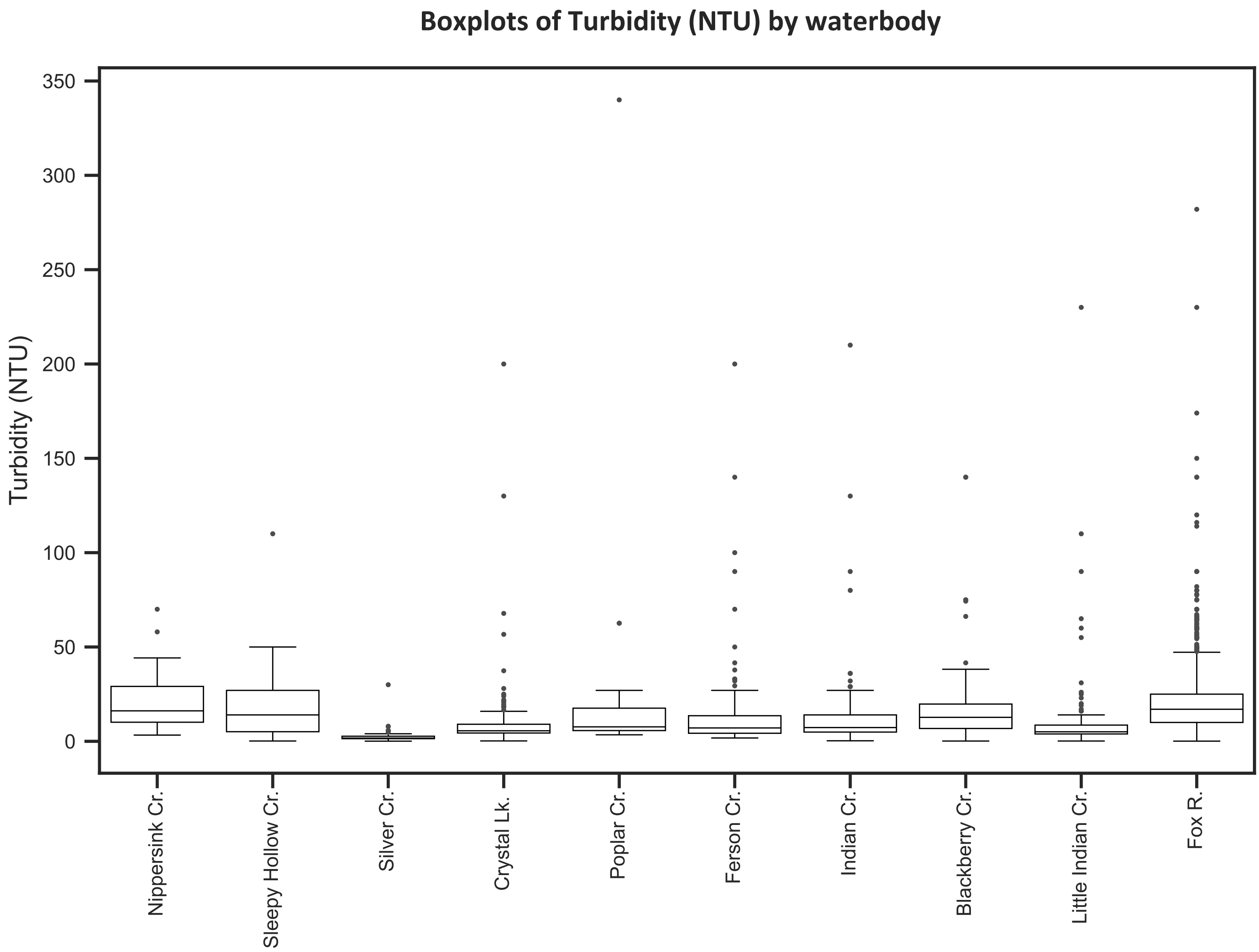


Strip chart of Turbidity (NTU) by monitoring site





Boxplots of Turbidity (NTU) by monitoring site
Turbidity (NTU)
350
300
250
200
150
100
50
0
FR1
NC1
FR2
SH1
FR3
SC1
FR4
CL1
FR5
PC1
FR6
FC5
FR7
IC4
FR11
FR12
FR13
BC1
BC2
LC1
FR14
Monitoring site

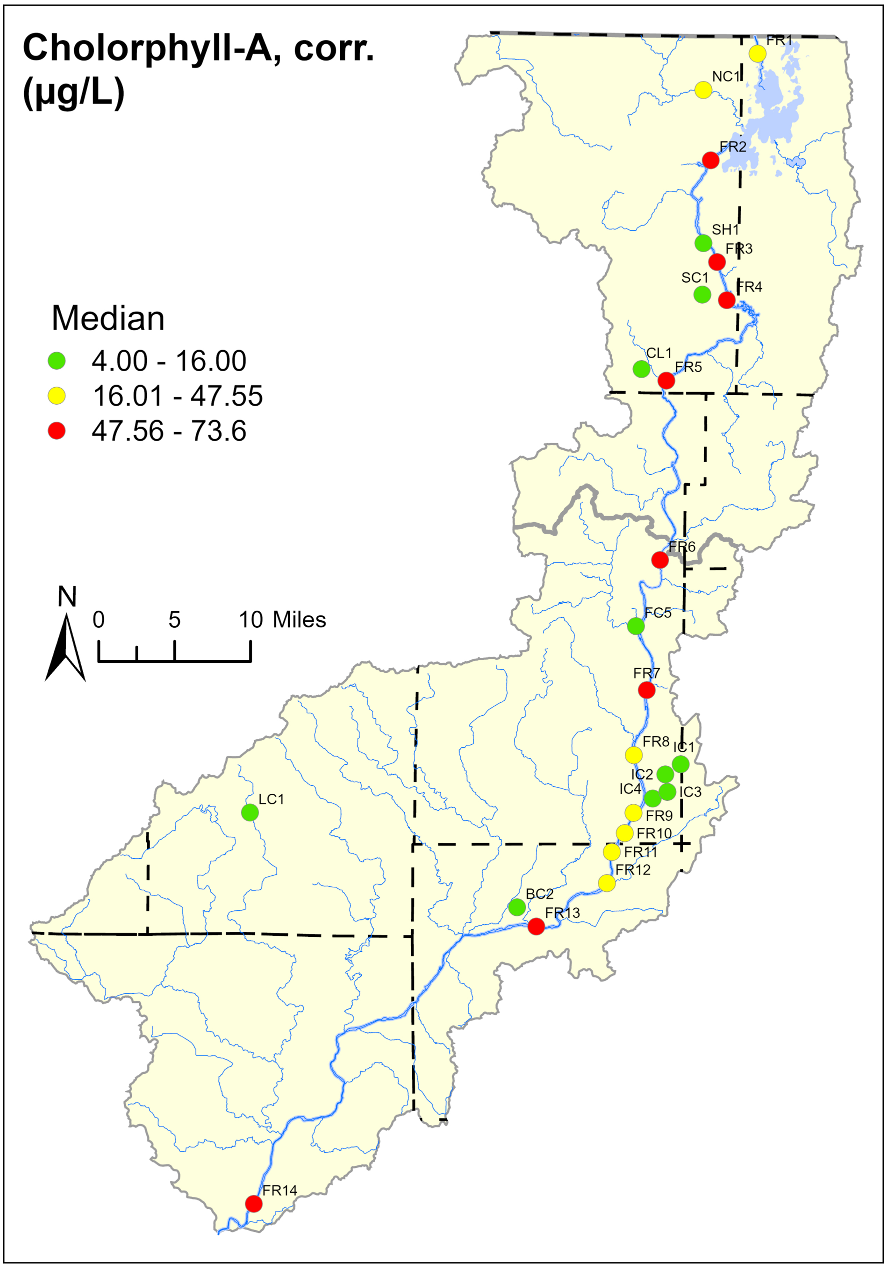


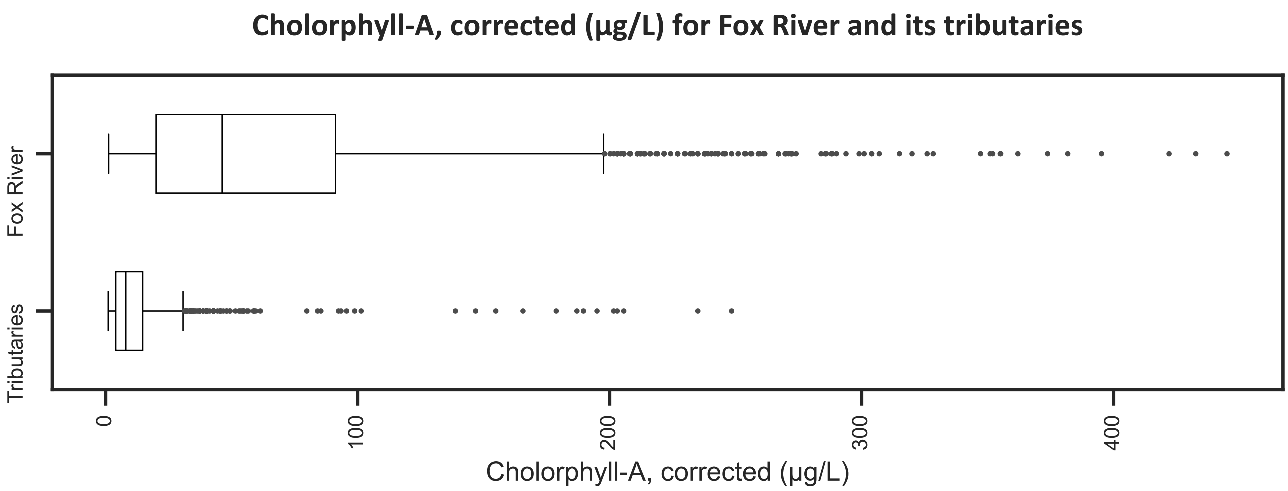
Boxplots of Turbidity (NTU) by waterbody
Turbidity (NTU)
350
300
250
200
150
100
50
0
Nippersink Cr.
Sleepy Hollow Cr.
Silver Cr.
Crystal Lk.
Poplar Cr.
Ferson Cr.
Indian Cr.
Blackberry Cr.
Little Indian Cr.
Fox R.

Summary statistics for Turbidity (NTU) by monitoring site

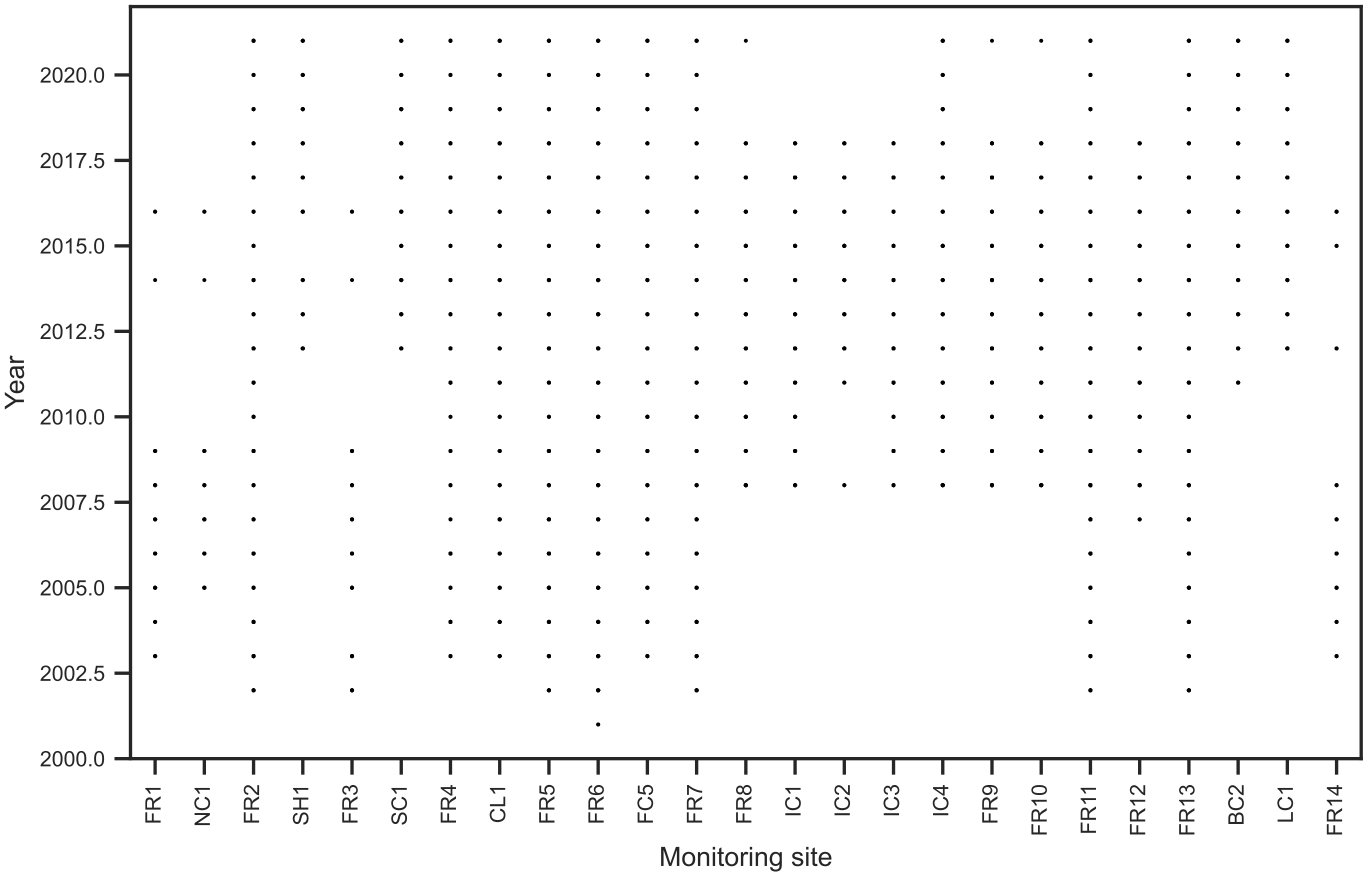
Station_PIDlabel	Start Date	End Date	N	Mean	Median	Max	Min	StdDev	Kurtosis	1st Quart	3rd Quart	Skewness
FR1	2003-04-17	2010-02-03	50	23.84	22.85	65.00	4.80	12.67	2.80	14.35	29.00	1.21
NC1	2003-02-06	2010-02-03	58	20.12	16.15	70.00	3.30	13.62	2.39	10.12	29.10	1.36
FR2	2002-04-30	2021-11-16	193	17.28	16.00	66.10	3.00	9.93	4.13	10.00	21.50	1.56
SH1	2012-01-17	2021-11-16	79	17.16	14.00	110.00	0.17	16.42	11.79	5.10	27.00	2.57
FR3	2002-04-30	2010-02-03	84	23.76	21.30	82.00	3.30	13.85	3.96	14.05	30.25	1.58
SC1	2012-02-21	2021-08-17	89	2.50	1.70	30.00	0.09	3.28	57.04	1.40	2.70	6.95
FR4	2003-08-05	2021-11-16	132	17.62	15.00	67.20	2.00	11.17	3.90	10.00	24.00	1.56
CL1	2003-06-24	2021-11-16	162	10.04	5.60	200.00	0.21	19.55	64.30	4.40	9.05	7.49
FR5	2002-04-30	2021-11-16	252	20.19	18.00	69.80	2.30	13.78	1.56	9.50	27.75	1.18
PC1	2003-01-03	2010-02-01	50	19.78	7.67	340.00	3.45	47.87	43.02	5.69	17.57	6.38
FR6	2001-08-16	2021-11-16	300	18.69	16.00	80.00	0.10	12.71	3.73	9.78	24.00	1.51
FC5	2003-06-24	2021-11-16	186	12.69	7.09	200.00	1.77	21.05	42.56	4.27	13.57	5.88
FR7	2002-04-30	2021-11-16	219	18.85	16.70	116.00	1.80	14.08	12.99	10.40	22.85	2.75
IC4	2009-08-18	2021-11-16	132	13.28	7.30	210.00	0.28	23.33	43.82	4.90	14.00	6.07
FR11	2002-02-01	2021-11-16	374	19.12	17.00	120.00	1.36	14.53	13.99	9.78	23.50	2.86
FR12	2002-02-01	2014-05-07	69	18.27	15.00	66.00	1.48	12.28	2.94	10.20	24.60	1.38
FR13	2002-04-30	2021-11-16	251	18.71	16.00	230.00	2.04	20.83	52.36	8.55	22.00	6.24
BC1	2003-01-16	2010-01-28	51	18.88	15.00	74.30	4.40	13.80	6.36	10.89	22.80	2.26
BC2	2011-07-19	2021-11-16	111	15.56	11.00	140.00	0.15	20.51	24.34	5.55	17.00	4.56
LC1	2012-01-17	2021-11-16	104	12.42	5.05	230.00	0.16	27.10	42.41	3.90	8.60	5.97
FR14	2003-03-19	2009-09-22	50	44.55	36.50	282.00	2.40	46.97	13.73	20.20	50.00	3.25

Data Factsheet for Cholorphyll-A, corrected (µg/L)

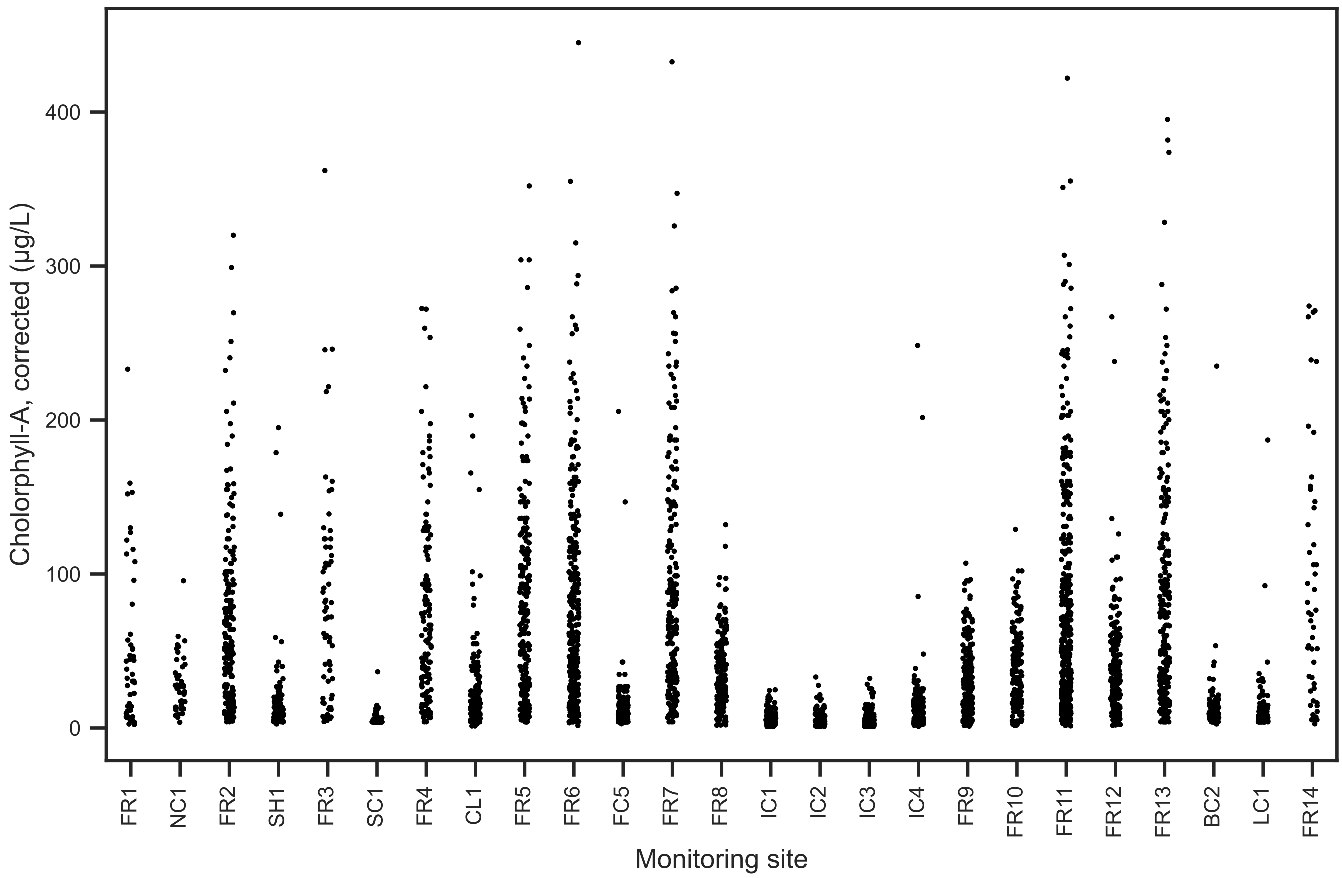




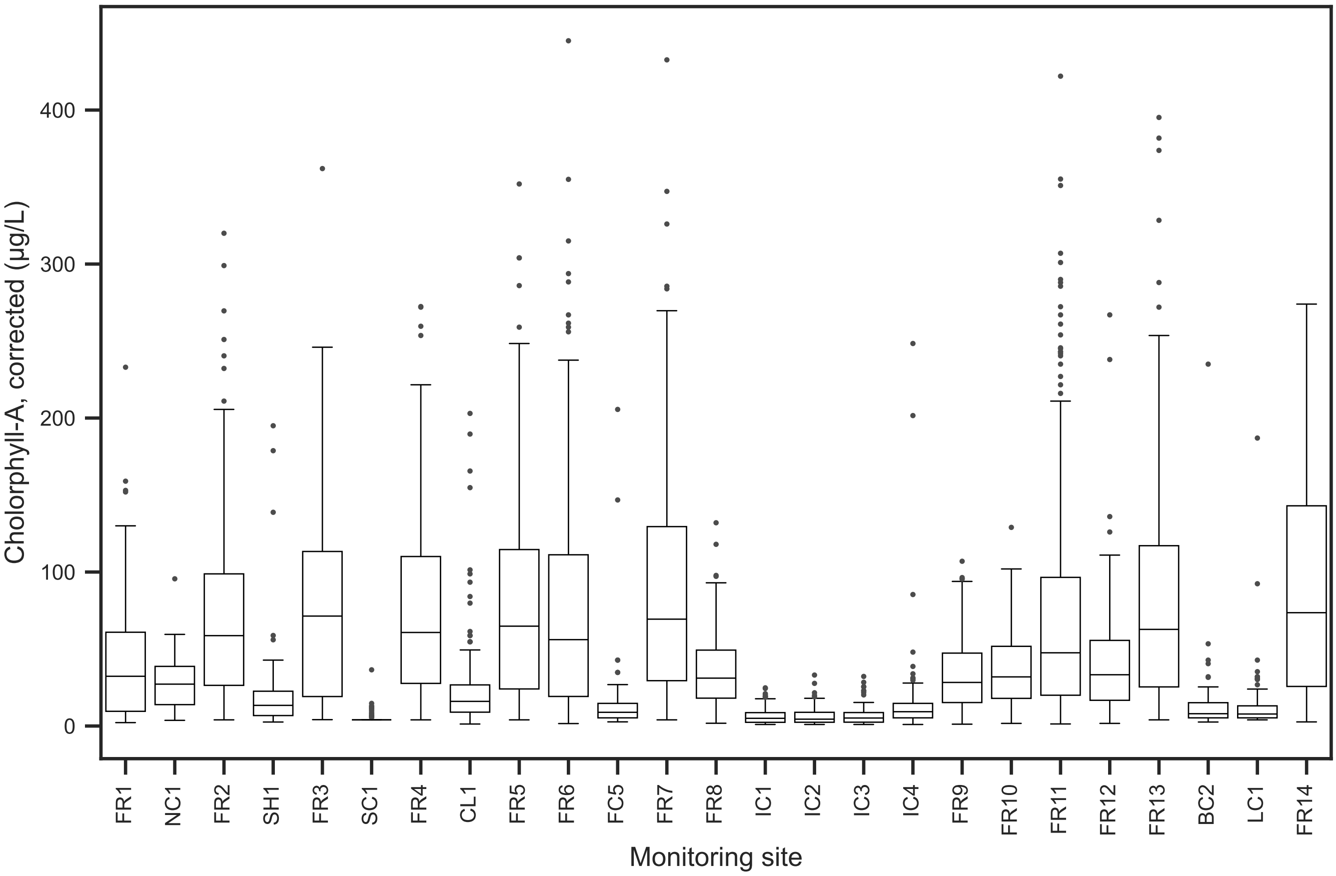
Cholorphyll-A, corrected (μg/L) availability by monitoring site and year



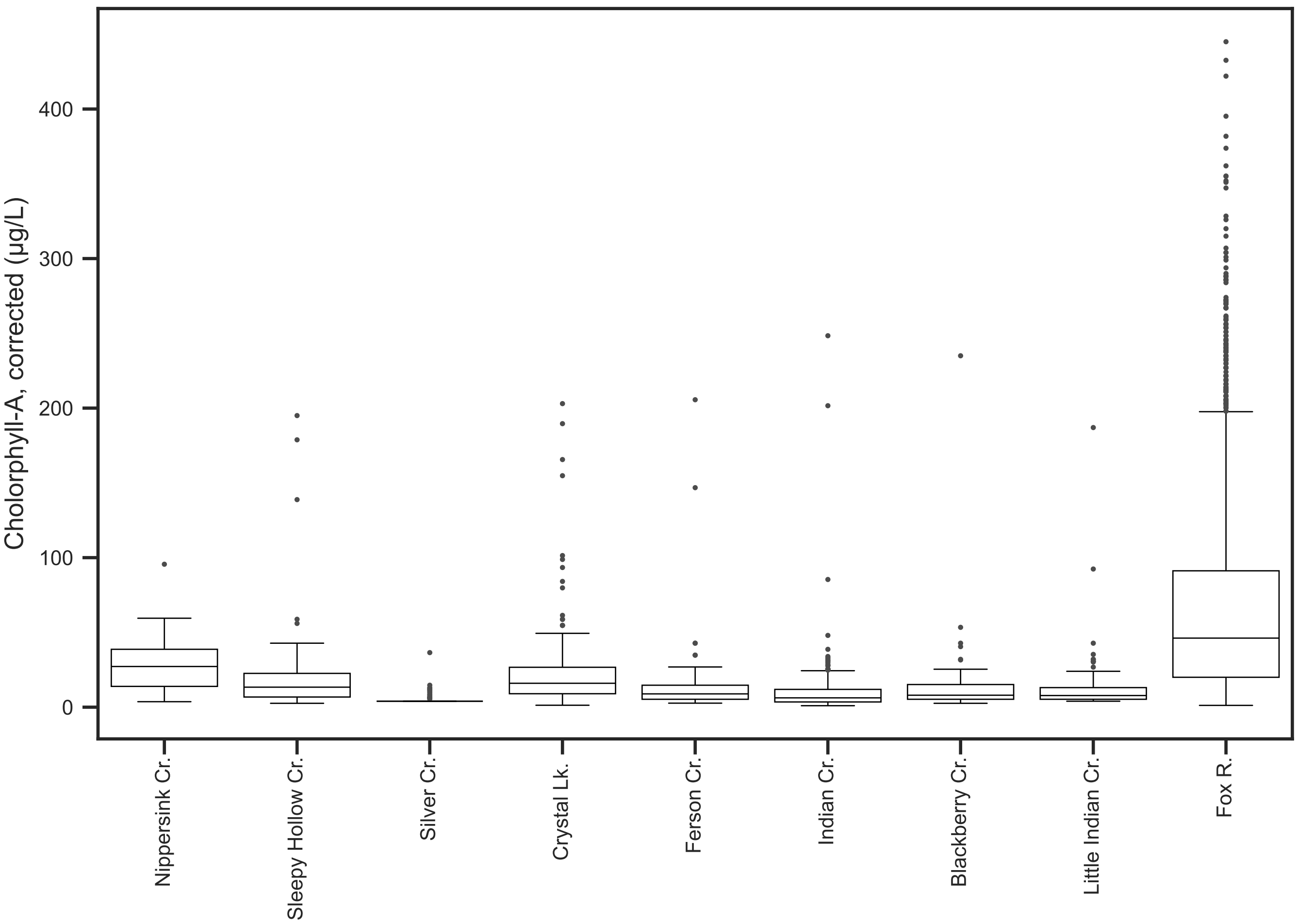
Strip chart of Cholorphyll-A, corrected (μg/L) by monitoring site



Boxplots of Cholorphyll-A, corrected (µg/L) by monitoring site



Boxplots of Cholorphyll-A, corrected (µg/L) by waterbody



Summary statistics for Cholorphyll-A, corrected (µg/L) by monitoring site

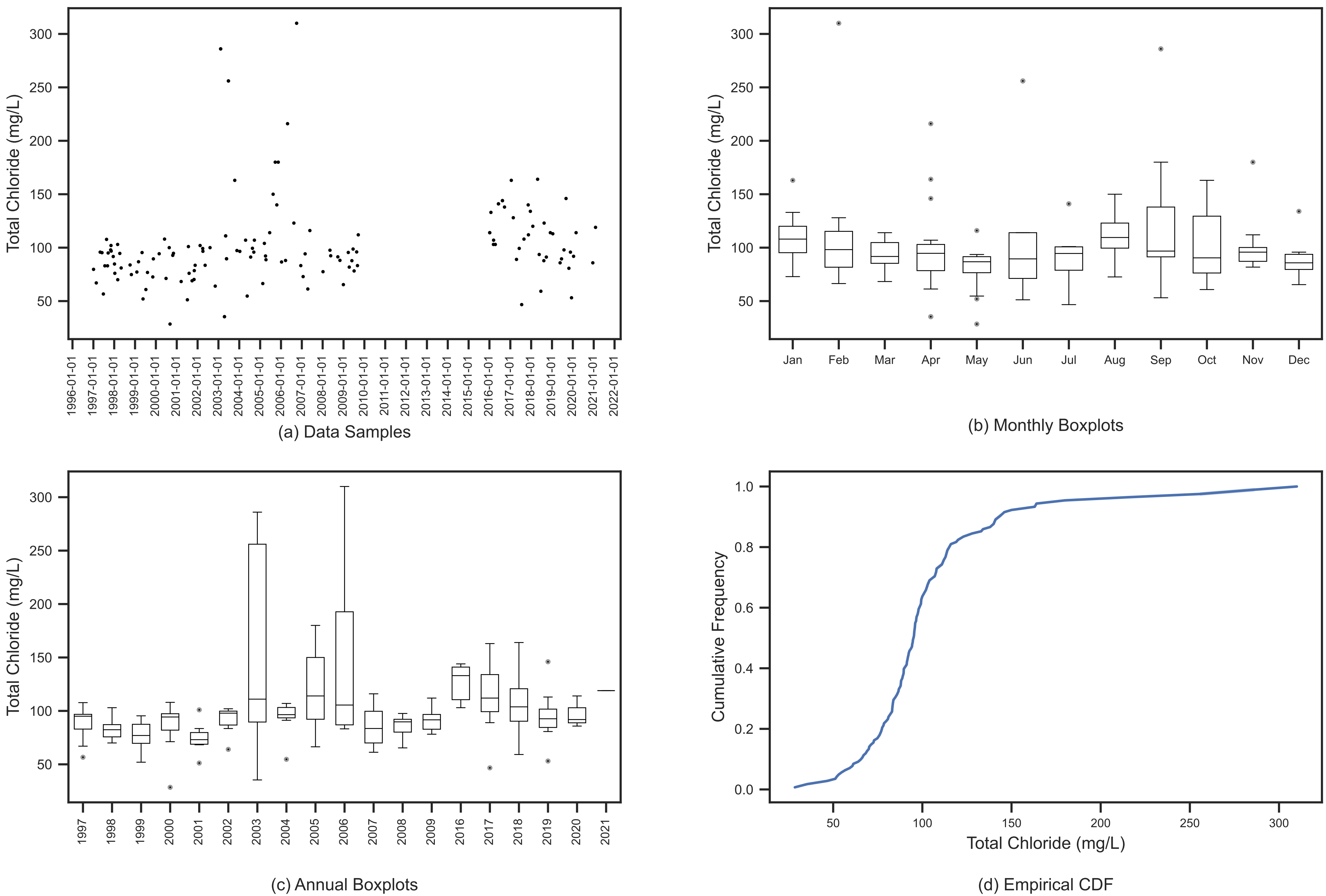
Station_PIDlabel	Start Date	End Date	N	Mean	Median	Max	Min	StdDev	Kurtosis	1st Quart	3rd Quart	Skewness
FR1	2003-04-17	2016-09-21	49	51.00	32.30	233.00	2.22	53.03	1.75	9.55	60.90	1.44
NC1	2005-02-16	2016-09-21	42	29.10	27.20	95.60	3.68	18.36	2.73	13.90	38.73	1.30
FR2	2002-04-30	2021-11-16	189	71.79	58.70	320.00	4.00	59.07	2.87	26.40	98.80	1.51
SH1	2012-01-17	2021-11-16	79	21.72	13.40	195.00	2.60	32.45	18.15	6.80	22.60	4.11
FR3	2002-04-30	2016-09-21	68	79.47	71.40	362.00	4.14	69.94	3.23	19.15	113.35	1.50
SC1	2012-02-21	2021-08-17	90	5.23	4.00	36.50	4.00	4.04	40.80	4.00	4.00	5.74
FR4	2003-08-05	2021-11-16	132	75.94	60.75	272.40	4.00	62.57	0.97	27.68	110.08	1.15
CL1	2003-06-24	2021-11-16	165	24.30	16.00	203.00	1.30	30.62	15.52	9.00	26.70	3.61
FR5	2002-04-30	2021-11-16	242	78.83	64.85	352.00	4.00	66.36	1.64	24.07	114.60	1.22
FR6	2001-08-16	2021-11-16	337	74.00	56.10	445.00	1.60	68.43	3.44	19.20	111.20	1.55
FC5	2003-06-24	2021-11-16	181	12.80	8.90	205.60	2.70	19.13	70.13	5.30	14.70	7.73
FR7	2002-04-30	2021-11-16	219	89.64	69.40	432.60	4.00	76.52	1.88	29.45	129.50	1.32
FR8	2008-04-29	2021-08-17	173	35.84	31.10	132.00	1.80	23.95	1.41	18.10	49.30	1.06
IC1	2008-05-14	2018-10-16	132	6.53	5.00	24.80	1.00	5.36	1.52	2.40	8.70	1.37
IC2	2008-05-14	2018-10-16	90	6.66	4.45	33.10	1.00	5.94	5.02	2.45	8.90	1.96
IC3	2008-05-14	2018-10-16	115	6.92	5.20	32.20	1.00	6.32	3.47	2.50	8.75	1.81
IC4	2008-04-29	2021-11-16	203	13.50	9.30	248.40	1.00	23.17	73.45	5.30	14.70	8.05
FR9	2008-04-29	2021-08-17	179	33.55	28.30	107.00	1.20	23.41	0.20	15.25	47.35	0.85
FR10	2008-04-30	2021-08-17	171	37.28	31.90	129.00	1.70	25.03	0.48	17.95	51.75	0.87
FR11	2002-04-30	2021-11-16	420	71.38	47.55	422.00	1.34	70.54	2.93	20.00	96.53	1.65
FR12	2007-06-06	2018-10-16	183	40.02	33.30	267.00	1.70	34.86	14.34	16.70	55.60	2.88
FR13	2002-04-30	2021-11-16	248	83.97	62.75	395.20	4.00	74.64	2.42	25.40	117.10	1.45
BC2	2011-07-19	2021-11-16	111	13.06	8.00	235.00	2.60	22.89	81.98	5.30	15.15	8.52
LC1	2012-01-17	2021-11-16	105	12.88	7.80	187.00	4.00	20.55	51.78	5.30	13.10	6.58
FR14	2003-03-19	2016-09-14	49	93.40	73.60	274.00	2.67	81.63	-0.14	25.70	143.00	0.93

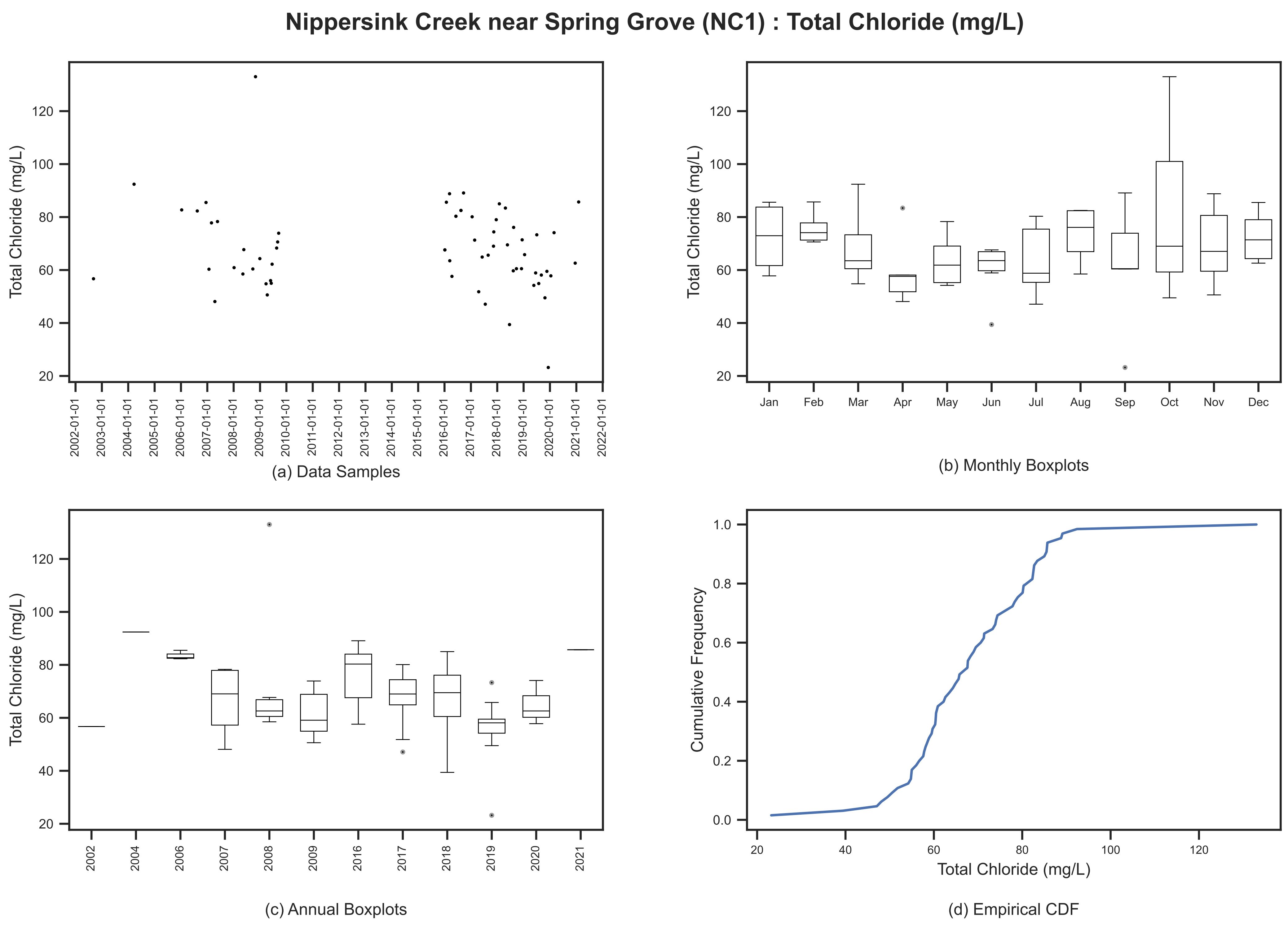
Table A1. EDA Outputs for Water Quality Consituents

Code in FoxDB	Water Quality Constituent	Number of Sites
940	Total chloride (mg/L)	44
406	pH (su)	45
10	Water temperature (^{0}C)	45
95	Specific conductance (µmhos/cm @ 25^{0}C)	28
82079	Turbidity(NTU)	21
32209	Chlorophyll-A, corrected (µg/L)	25

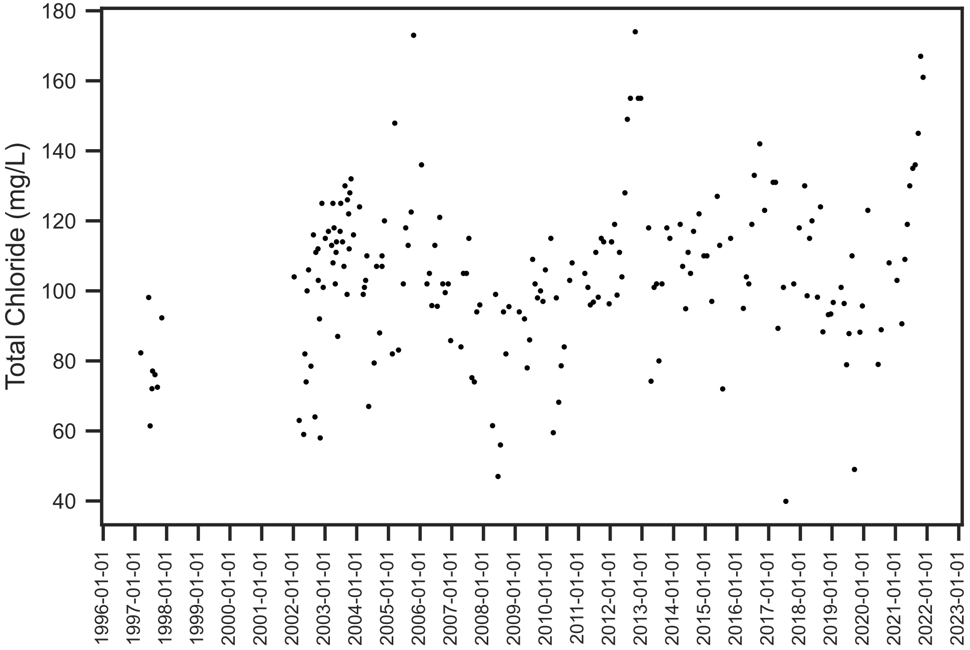
EDA Outputs for Total Chloride

Fox River at Rt. 173 near Channel Lake (FR1) : Total Chloride (mg/L)

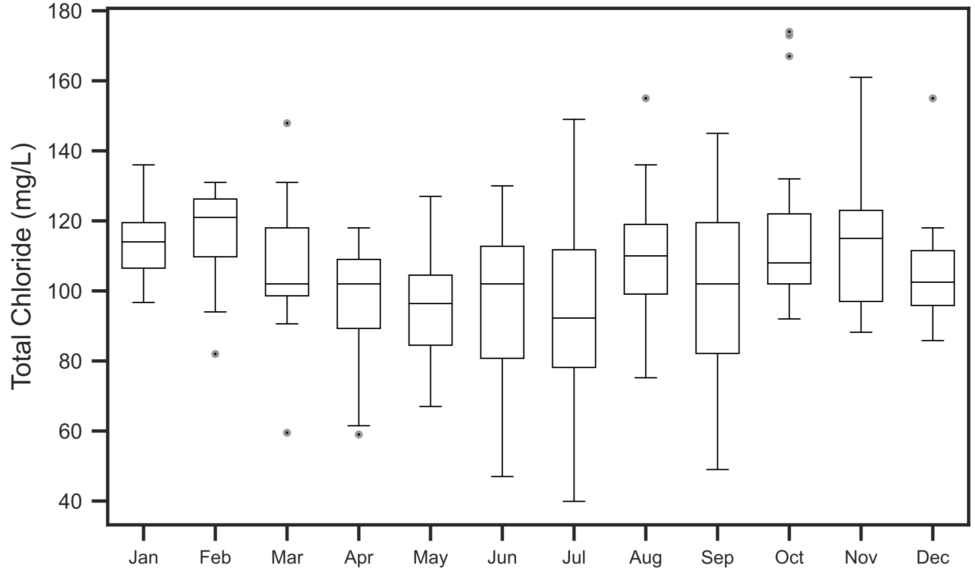



Nippersink Creek near Spring Grove (NC1) : Total Chloride (mg/L)
Total Chloride (mg/L)
(a) Data Samples
(b) Monthly Boxplots
(c) Annual Boxplots
Cumulative Frequency
Total Chloride (mg/L)
(d) Empirical CDF

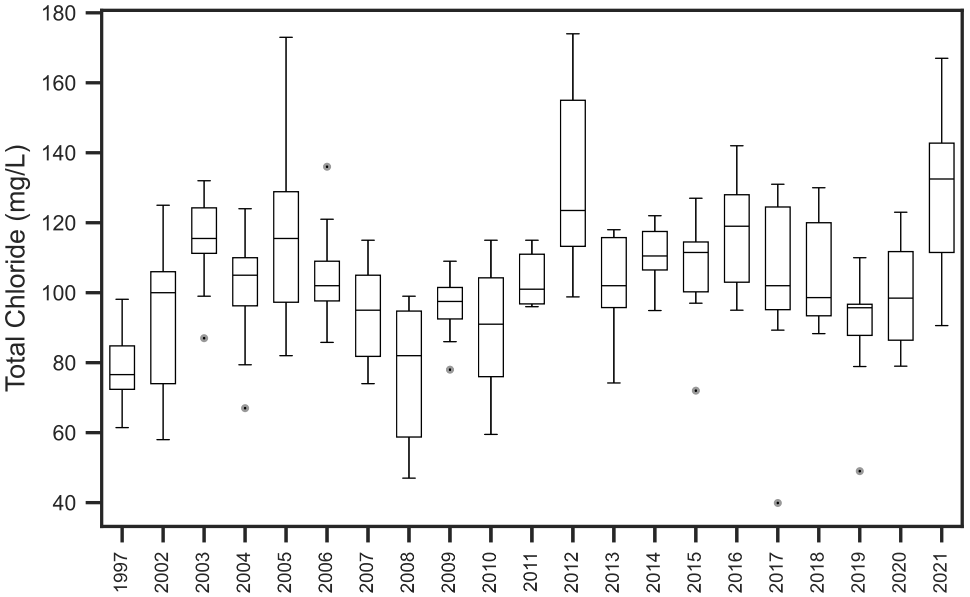
Fox River at Chapel Rd, Johnsburg (FR2) : Total Chloride (mg/L)



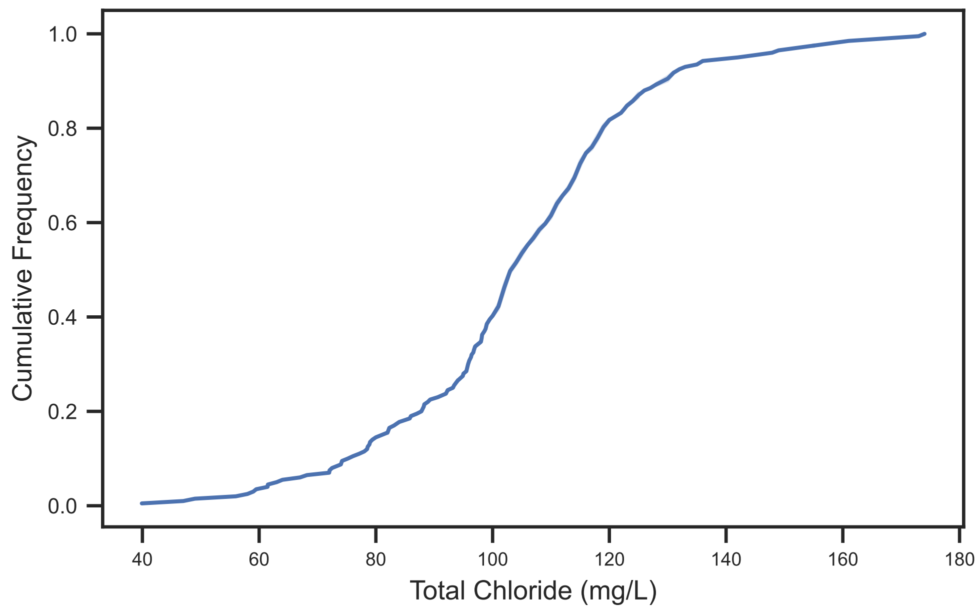
(a) Data Samples



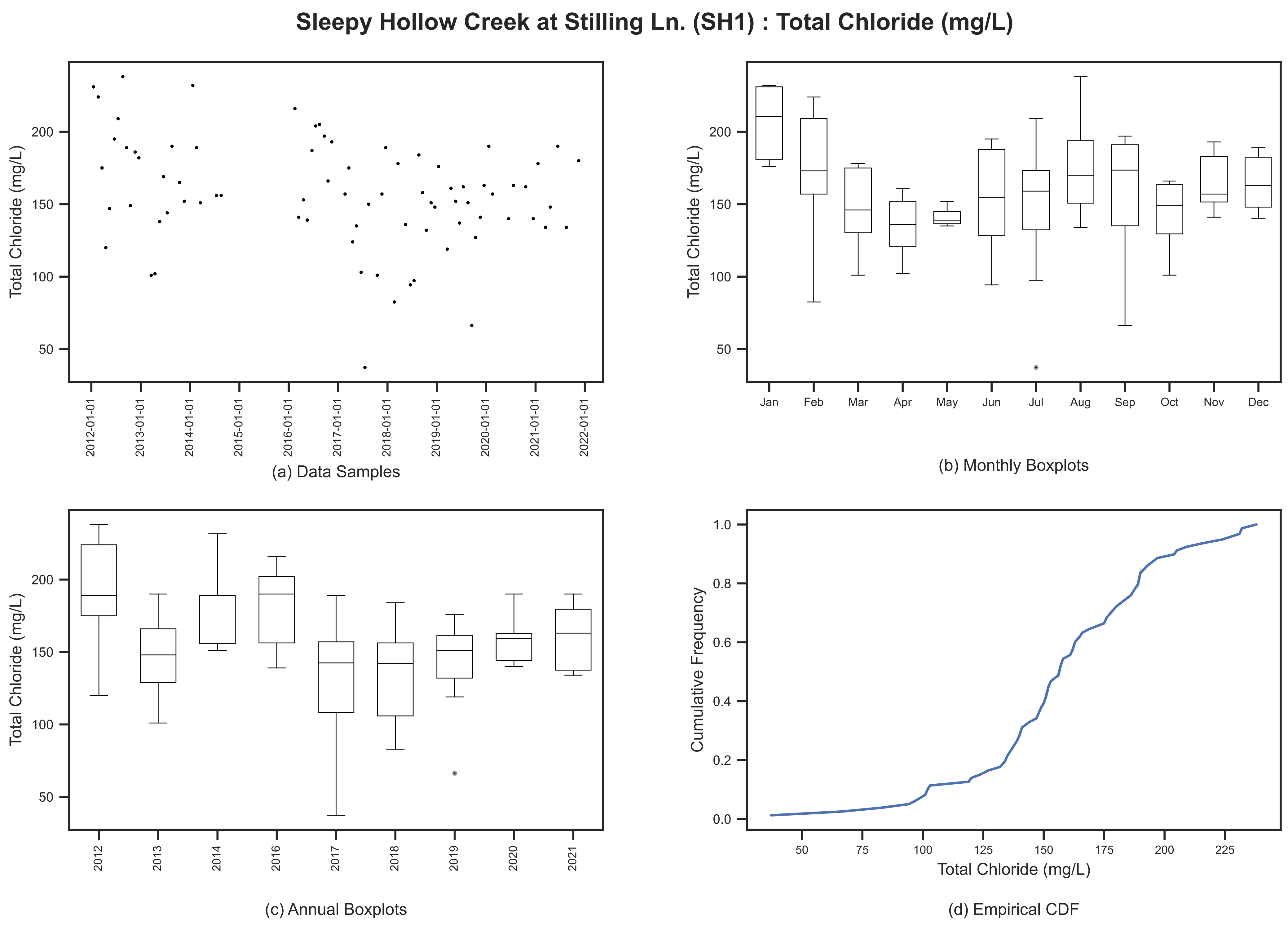
(b) Monthly Boxplots



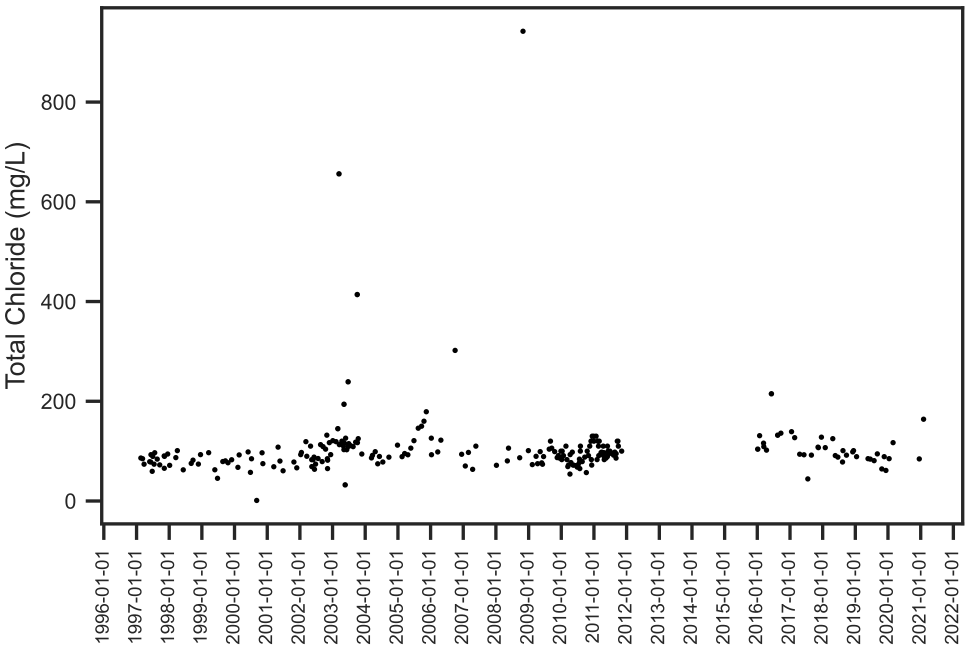
(c) Annual Boxplots



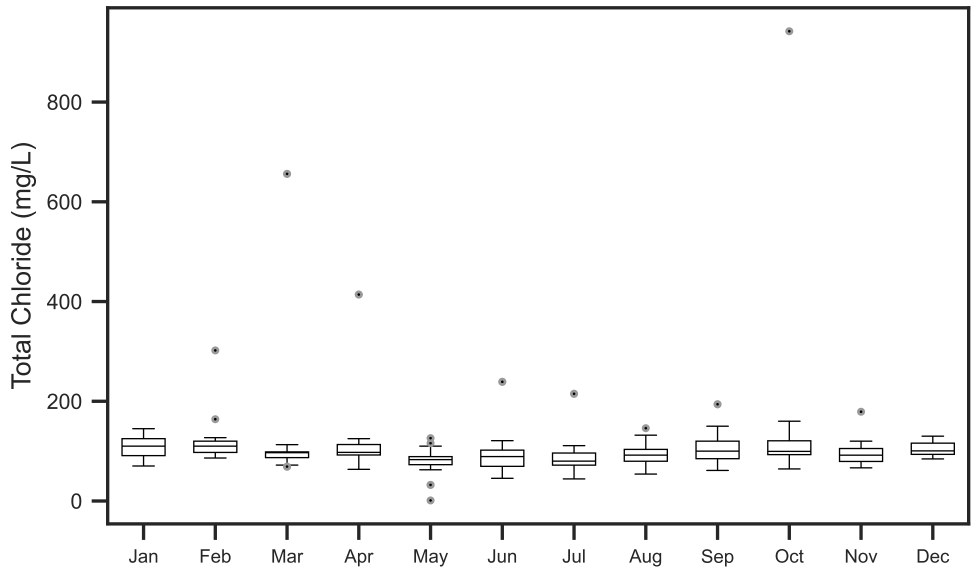
(d) Empirical CDF


Sleepy Hollow Creek at Stilling Ln. (SH1) : Total Chloride (mg/L)
Total Chloride (mg/L)
(a) Data Samples
(b) Monthly Boxplots
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(c) Annual Boxplots
Cumulative Frequency
Total Chloride (mg/L)
(d) Empirical CDF

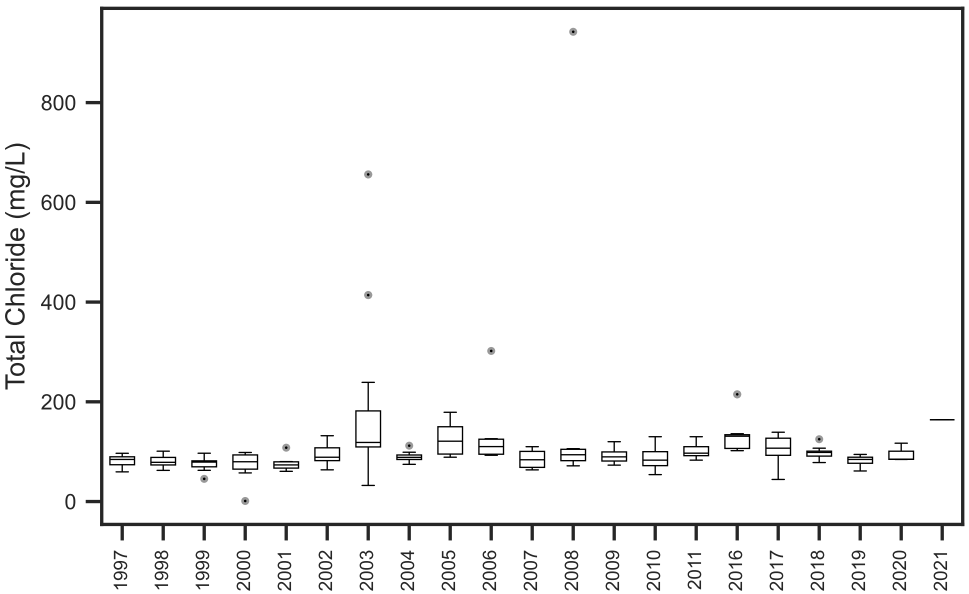
Fox River at Burtons Br. (FR3) : Total Chloride (mg/L)



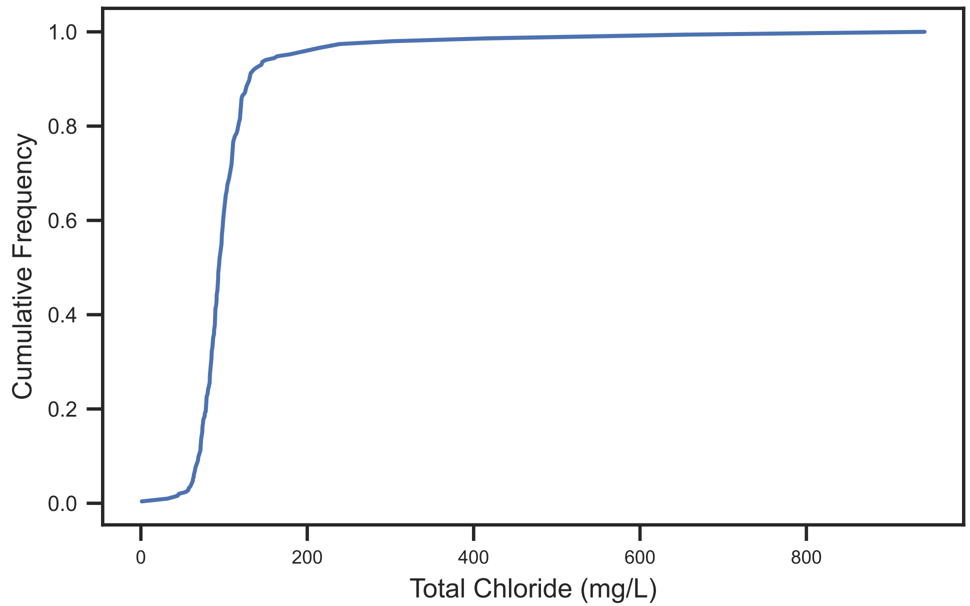
(a) Data Samples



(b) Monthly Boxplots

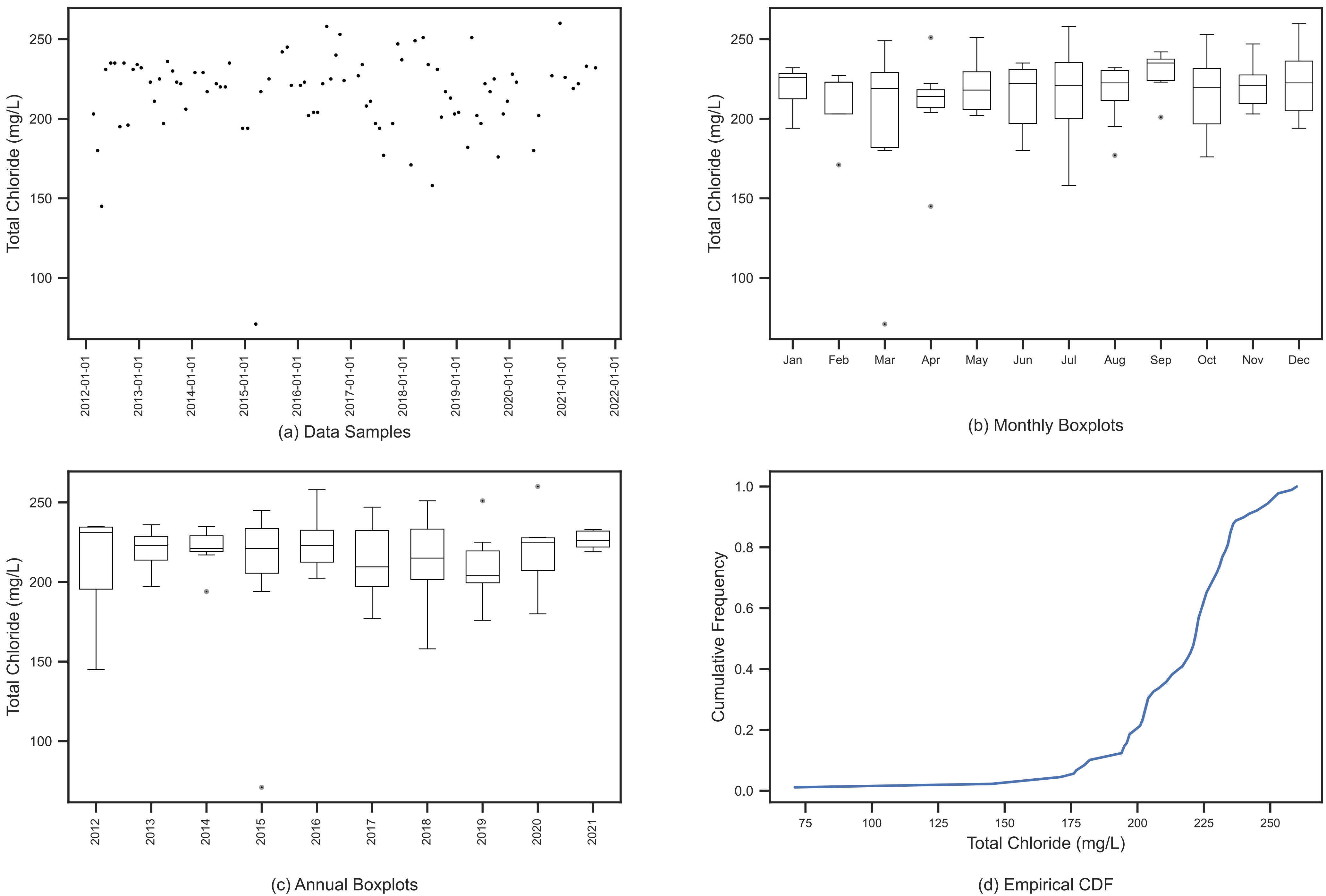


(c) Annual Boxplots

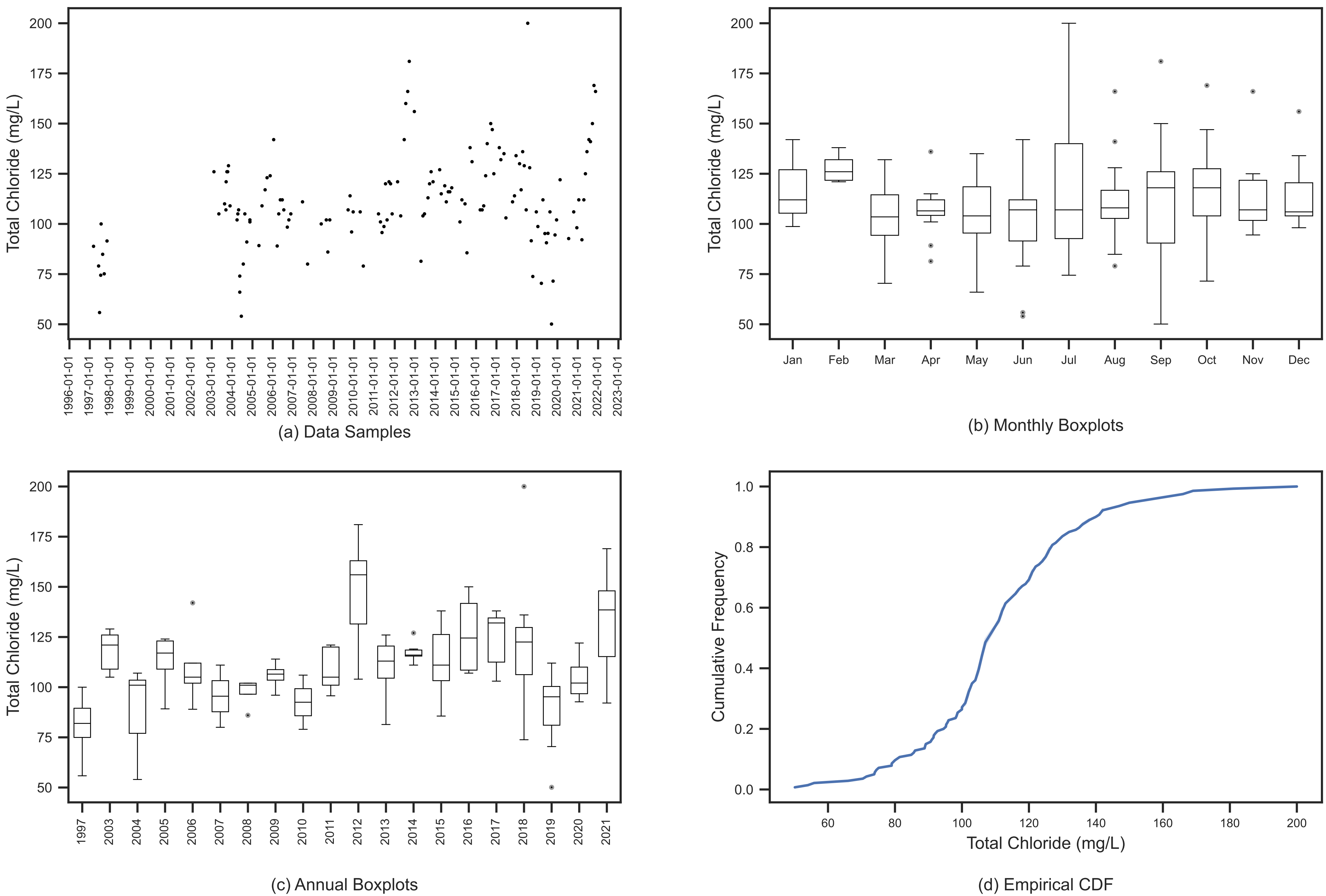


(d) Empirical CDF

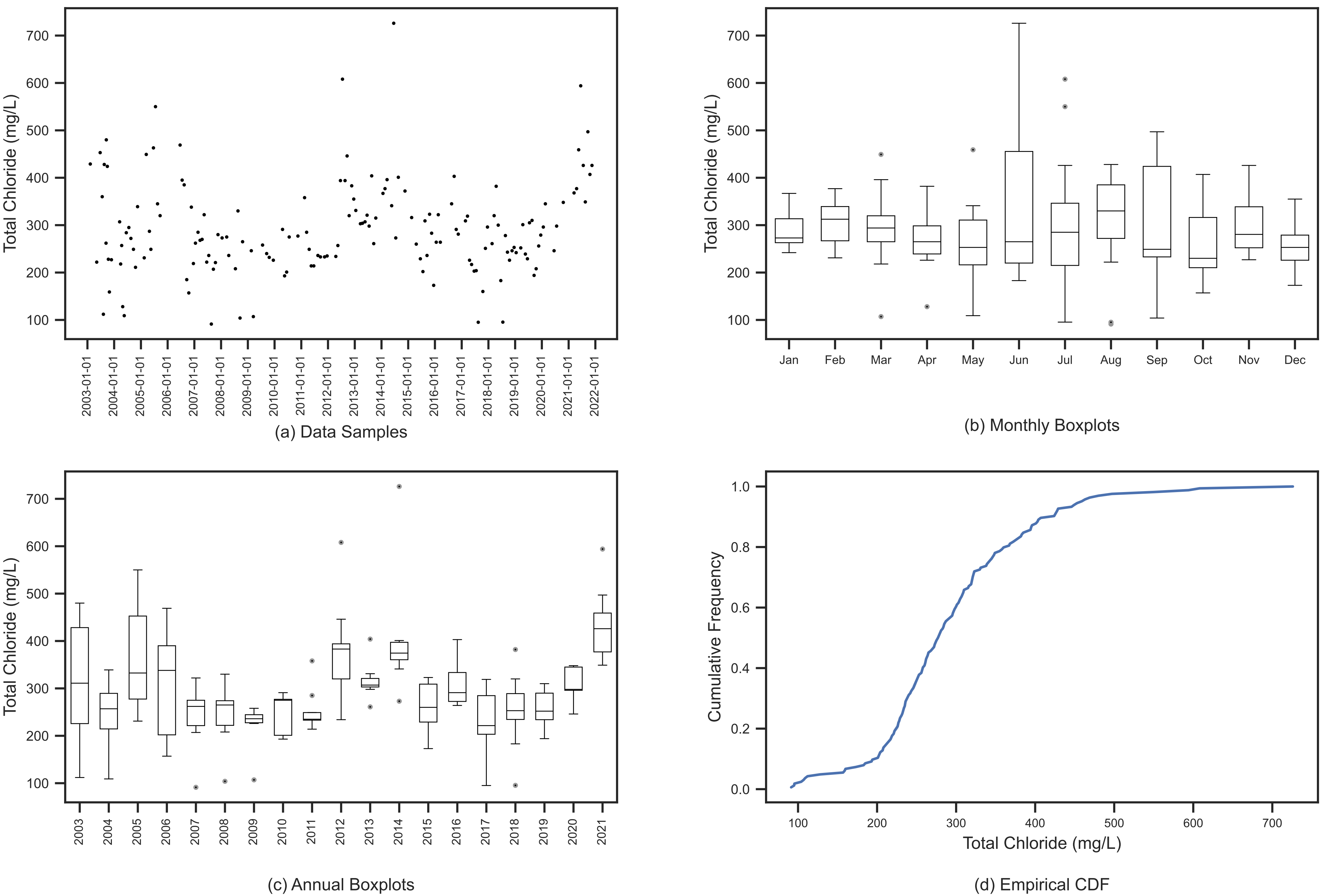
Silver Creek at Lk shore Dr. & E. Park Ln. (SC1) : Total Chloride (mg/L)



Fox River at Rawson Rd., E Oakwood Hills (FR4) : Total Chloride (mg/L)



Crystal Lk Outlet-Rt 31, Algonquin (CL1) : Total Chloride (mg/L)



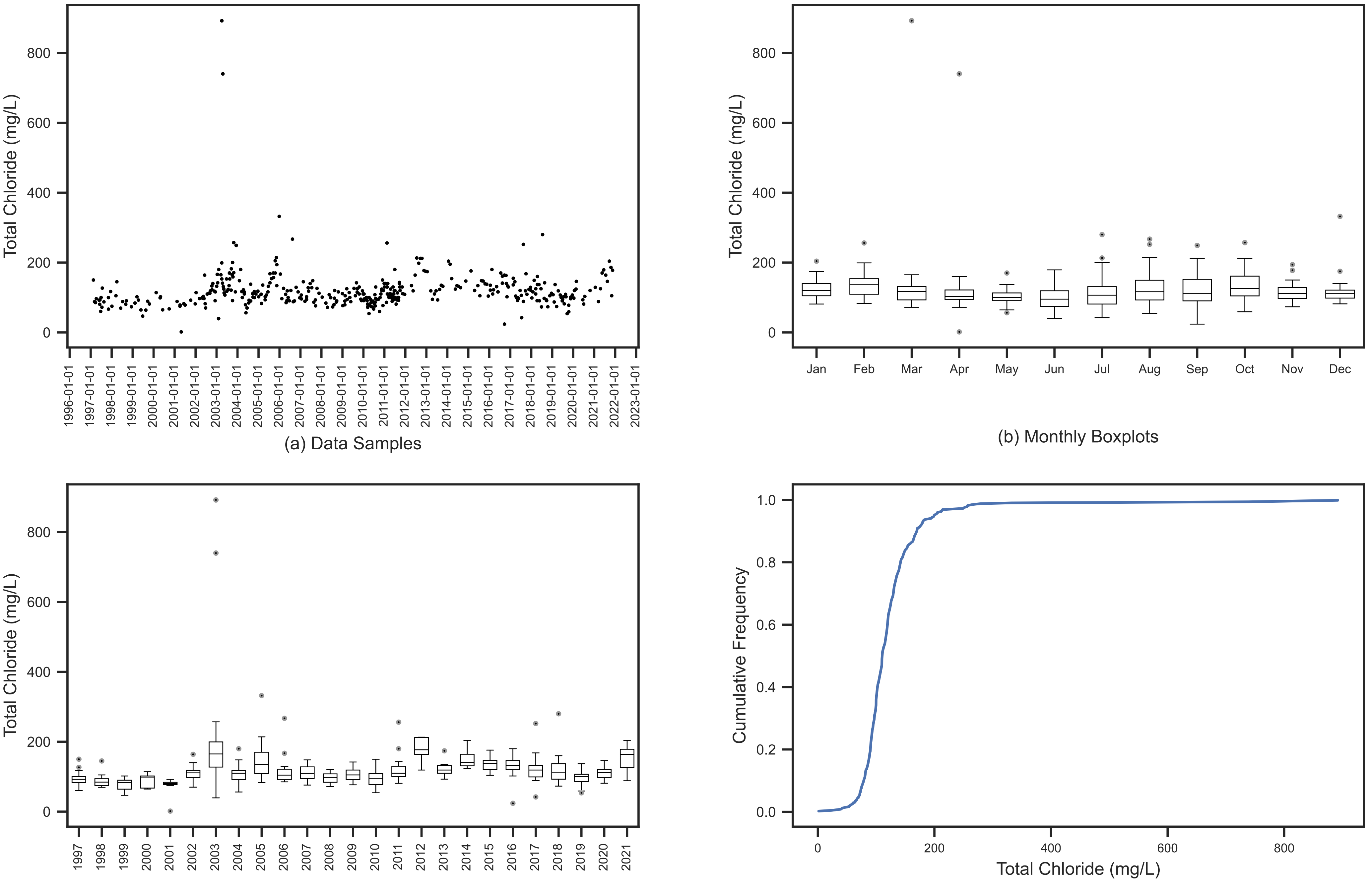
(a) Data Samples

(b) Monthly Boxplots

(c) Annual Boxplots

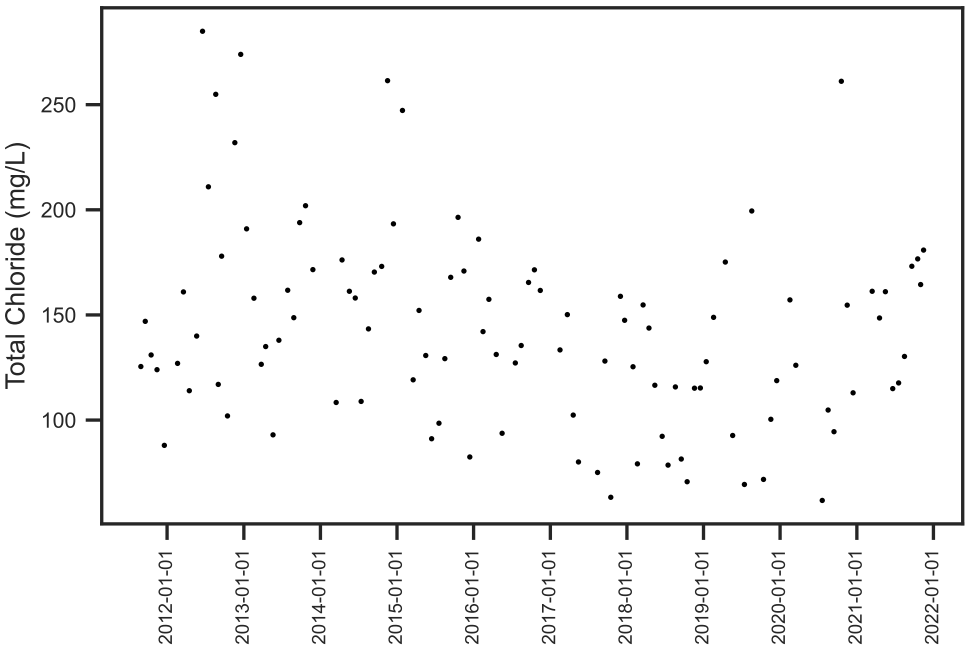
(d) Empirical CDF

Fox River at Algonquin (FR5) : Total Chloride (mg/L)

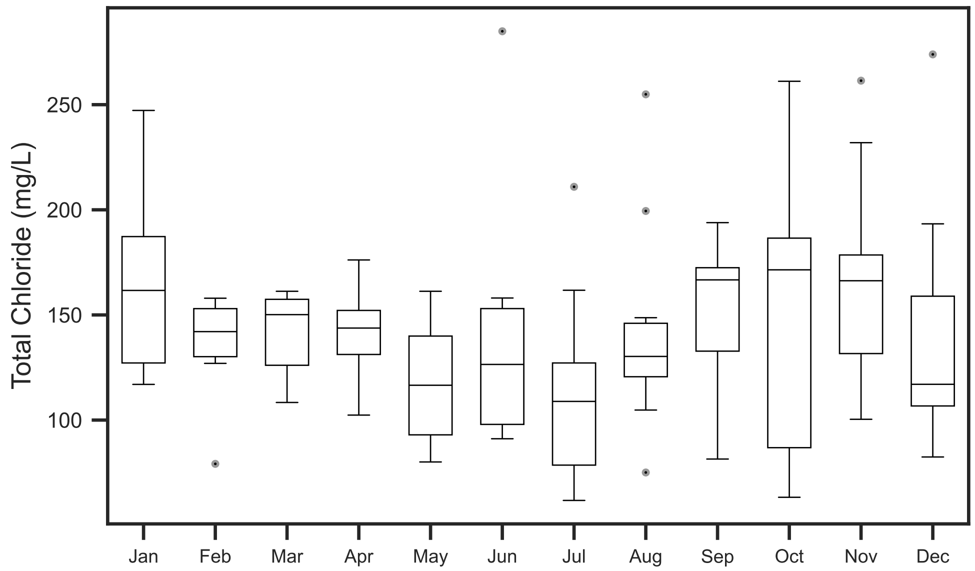


(a) Data Samples (b) Monthly Boxplots (c) Annual Boxplots (d) Empirical CDF

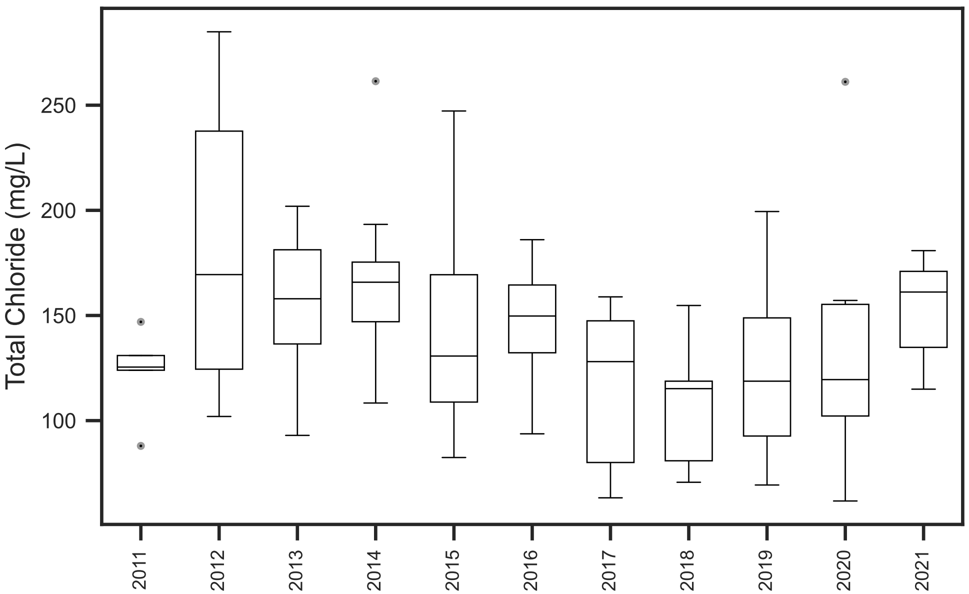
Tyler Creek at Damisch (TC1) : Total Chloride (mg/L)



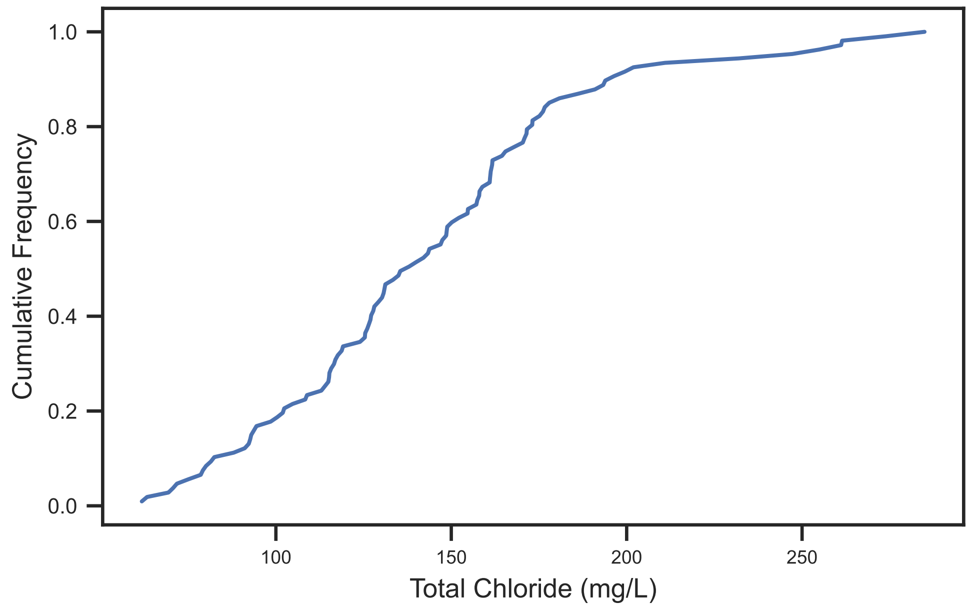
(a) Data Samples



(b) Monthly Boxplots

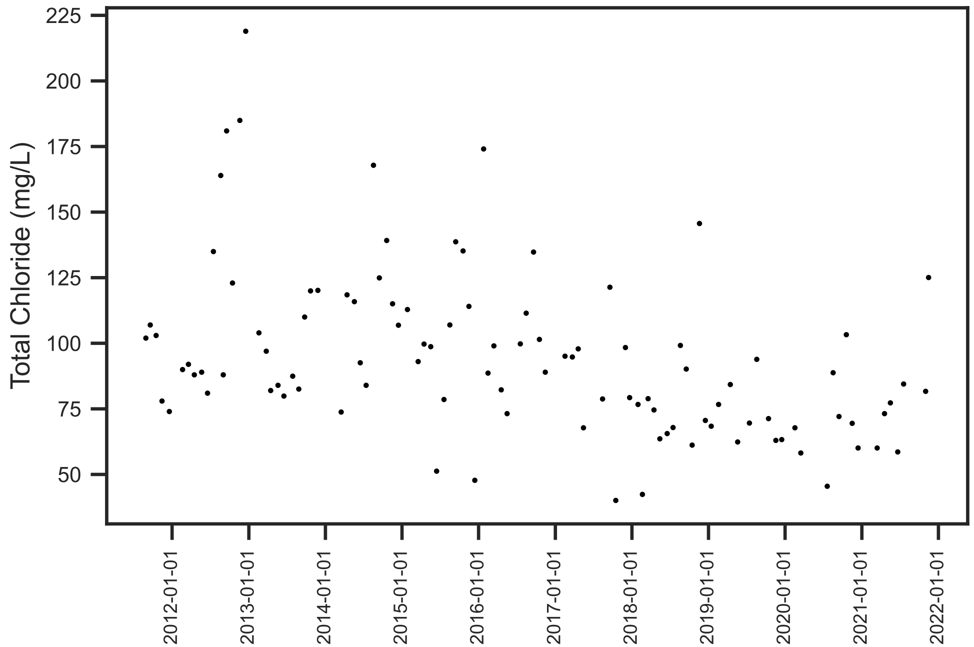


(c) Annual Boxplots

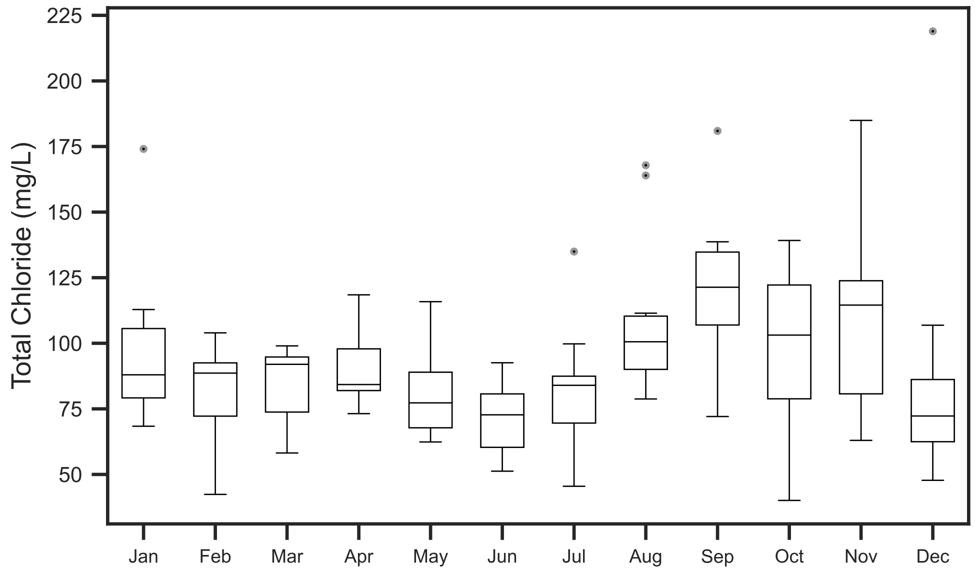


(d) Empirical CDF

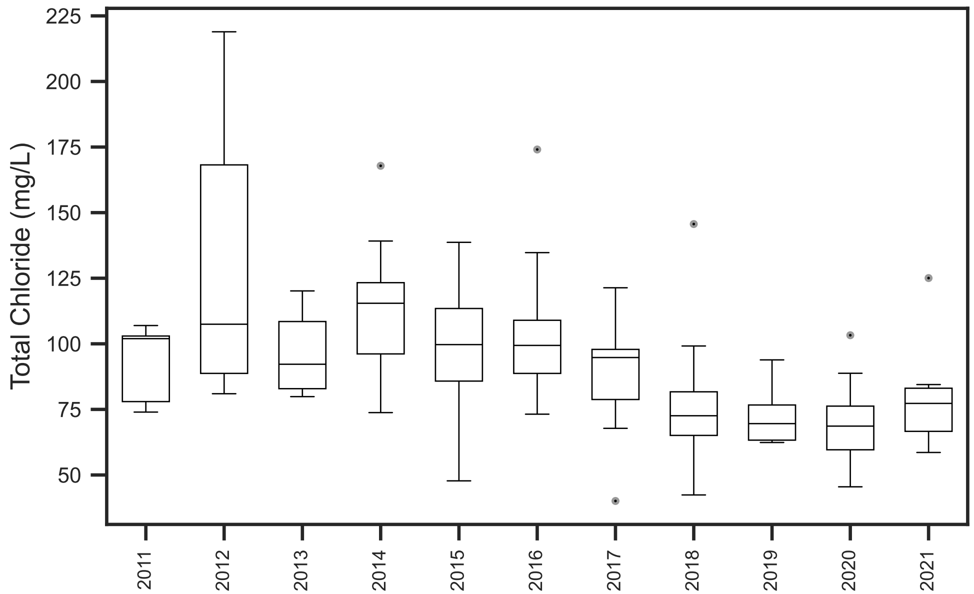
Tyler Creek at Highland (TC2) : Total Chloride (mg/L)



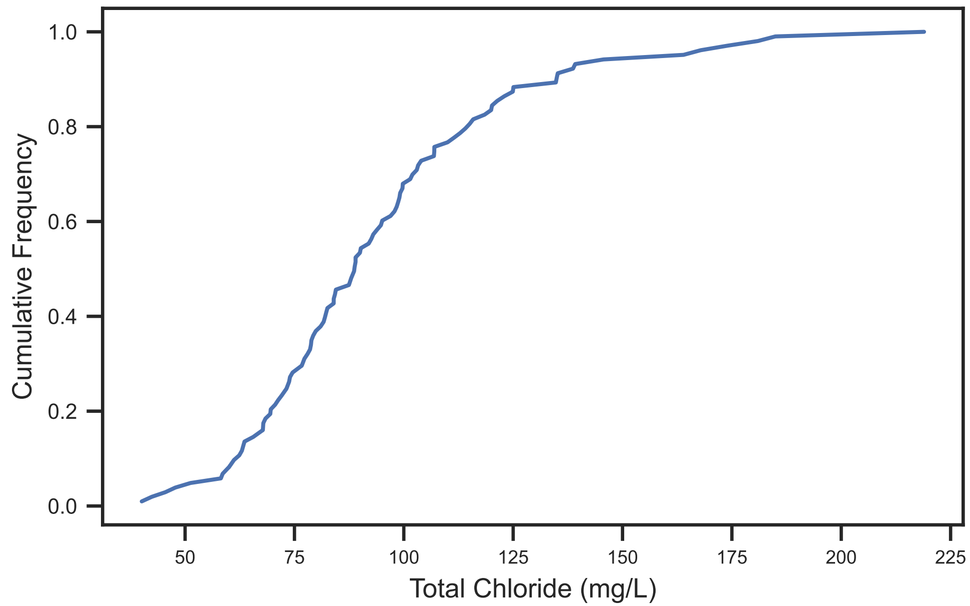
(a) Data Samples



(b) Monthly Boxplots

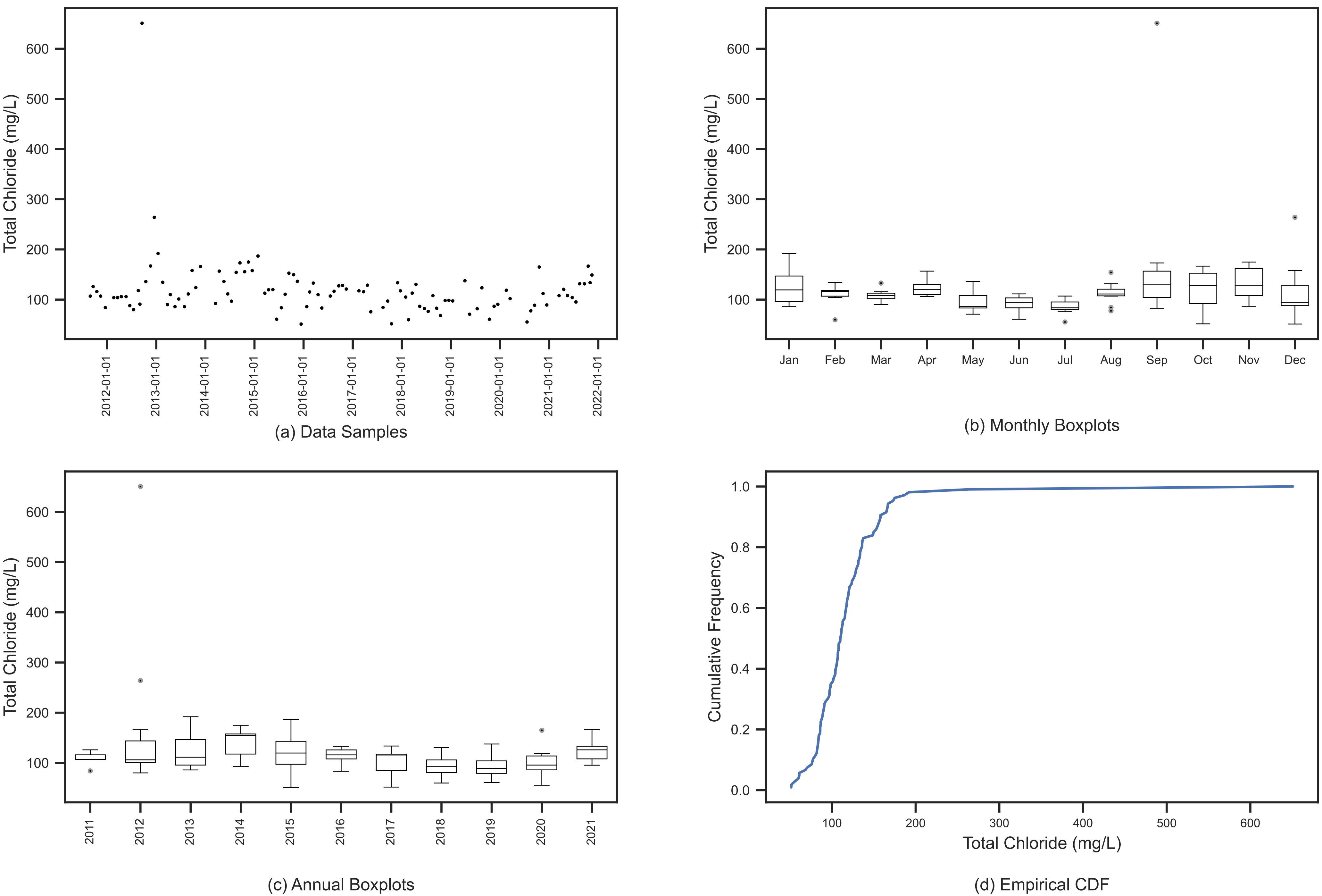


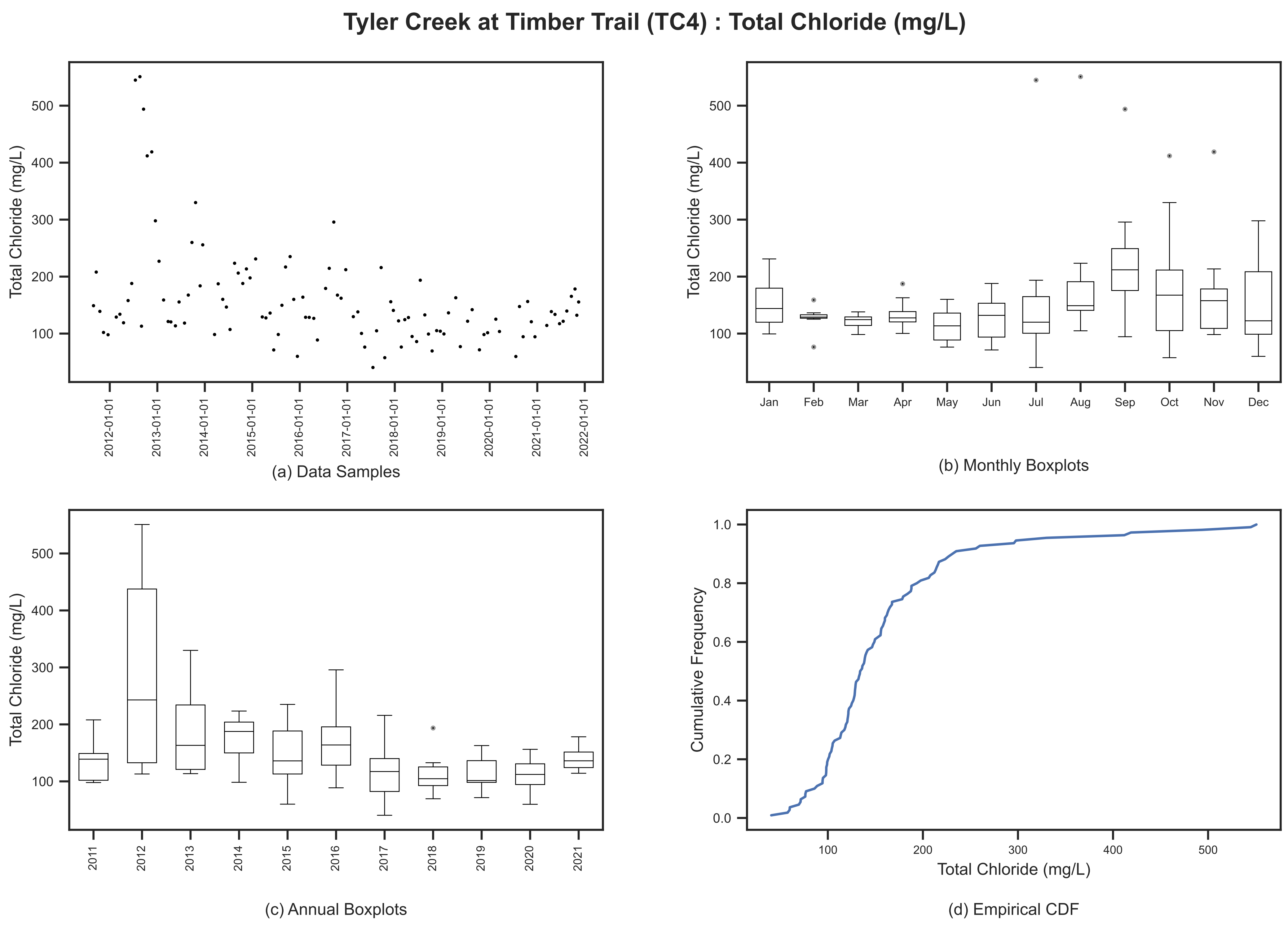
(c) Annual Boxplots

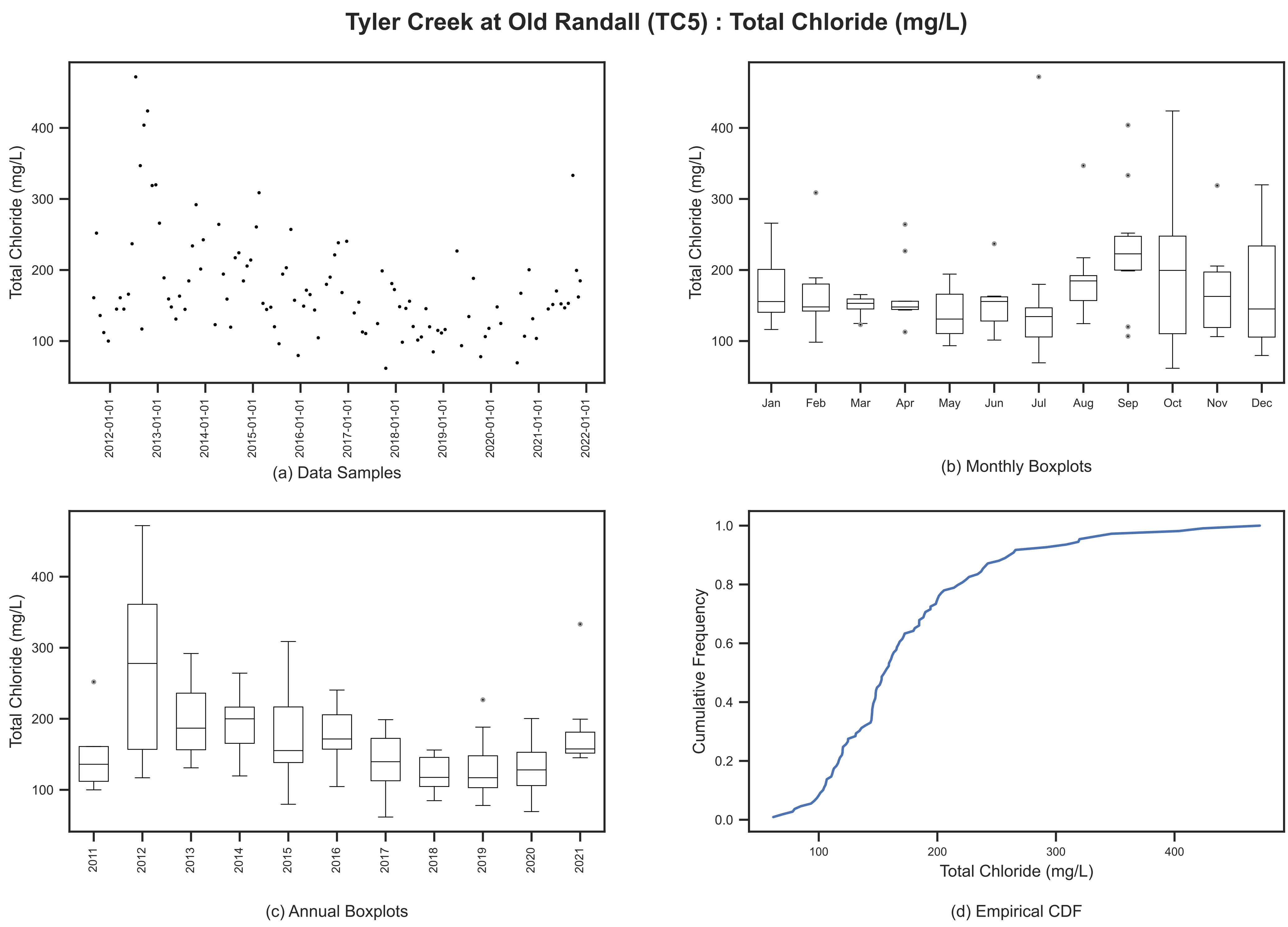


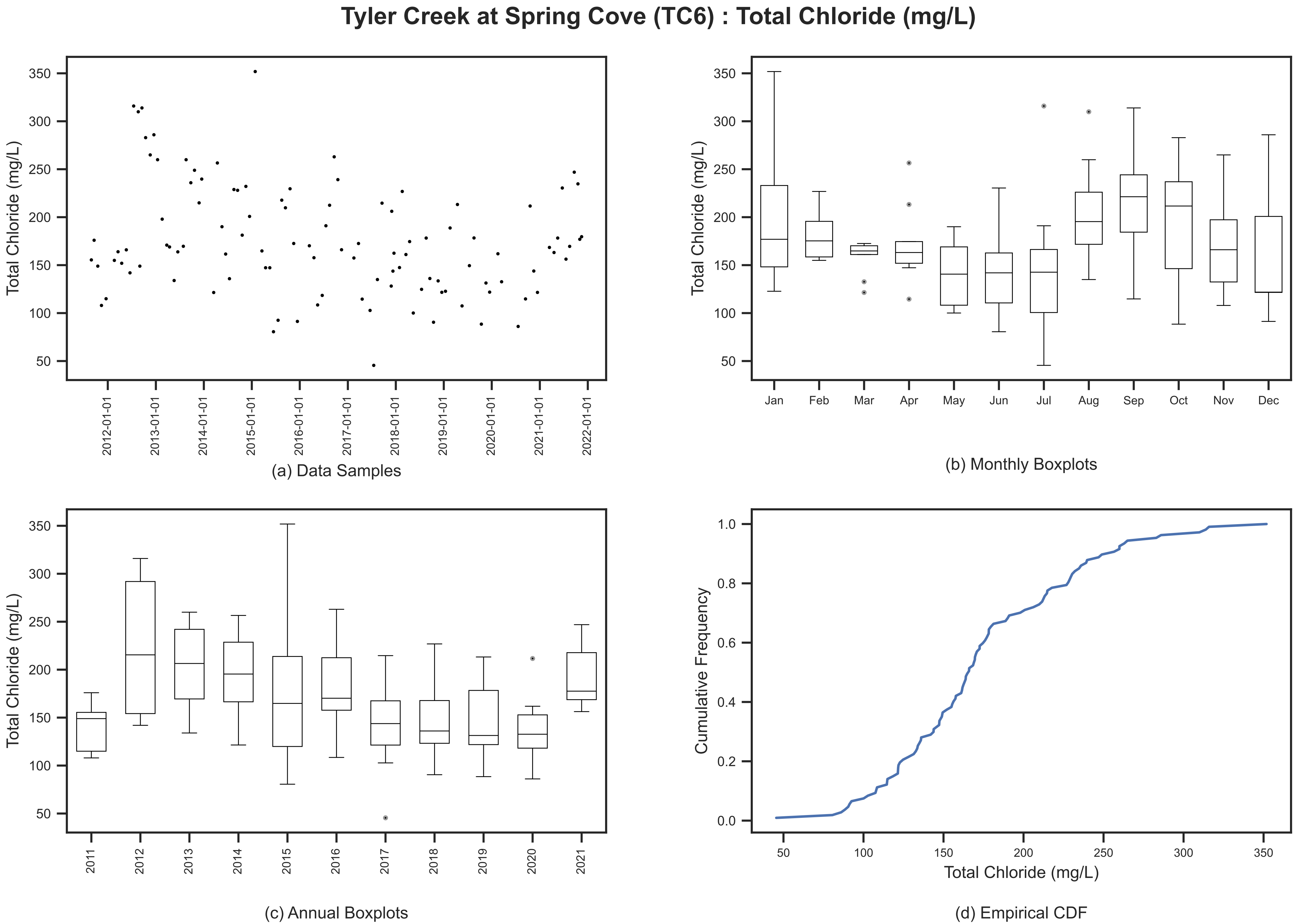
(d) Empirical CDF

Tyler Creek at McCornack (TC3) : Total Chloride (mg/L)

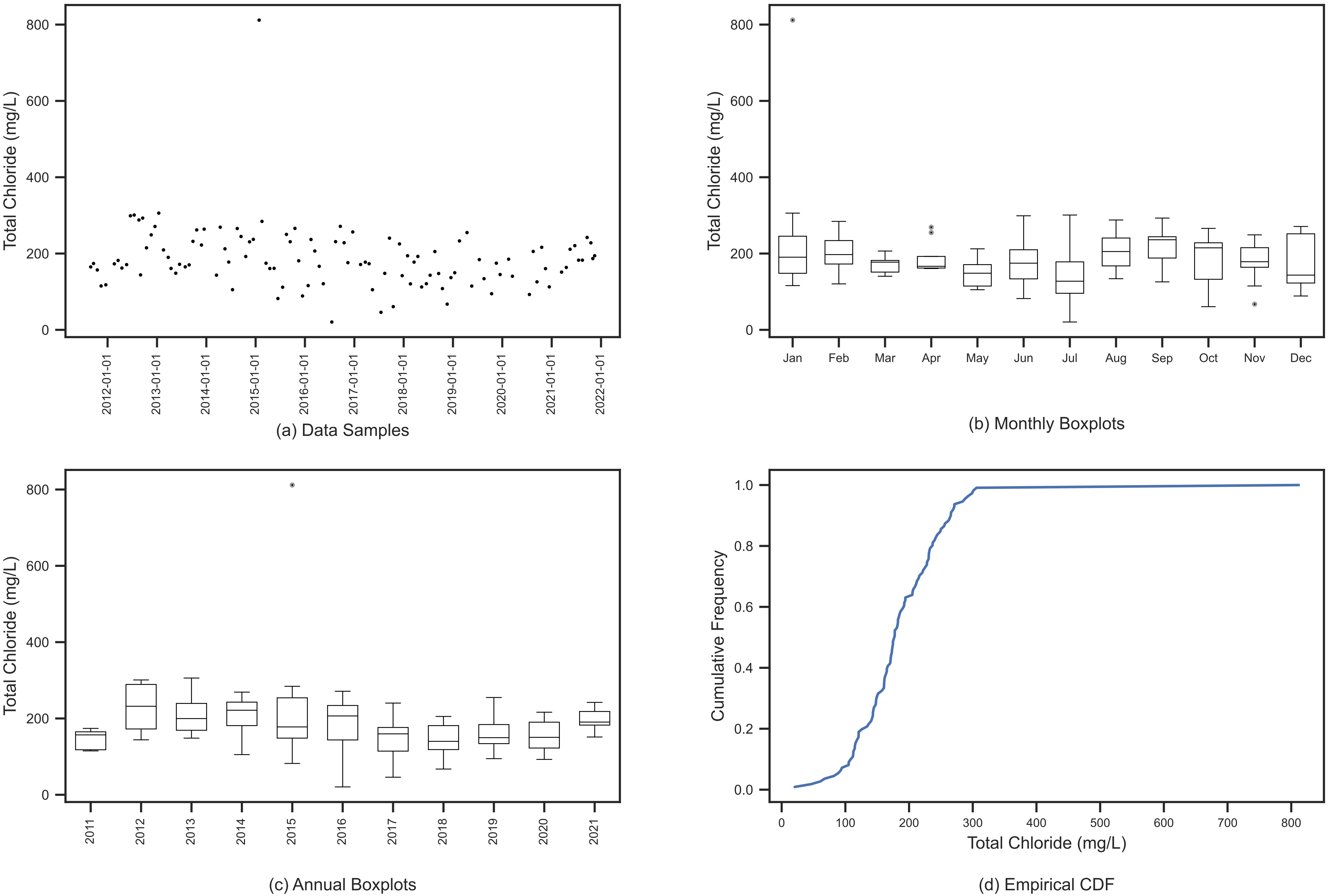



Tyler Creek at Timber Trail (TC4) : Total Chloride (mg/L)
Total Chloride (mg/L)
100
200
300
400
500
2012-01-01
2013-01-01
2014-01-01
2015-01-01
2016-01-01
2017-01-01
2018-01-01
2019-01-01
2020-01-01
2021-01-01
2022-01-01
(a) Data Samples
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(b) Monthly Boxplots
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
(c) Annual Boxplots
Cumulative Frequency
0.0
0.2
0.4
0.6
0.8
1.0
(d) Empirical CDF


Tyler Creek at Old Randall (TC5) : Total Chloride (mg/L)
Total Chloride (mg/L)
400
300
200
100
2012-01-01
2013-01-01
2014-01-01
2015-01-01
2016-01-01
2017-01-01
2018-01-01
2019-01-01
2020-01-01
2021-01-01
2022-01-01
(a) Data Samples
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(b) Monthly Boxplots
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
(c) Annual Boxplots
Cumulative Frequency
0.0
0.2
0.4
0.6
0.8
1.0
(d) Empirical CDF


Tyler Creek at Spring Cove (TC6) : Total Chloride (mg/L)
Total Chloride (mg/L)
(a) Data Samples
(b) Monthly Boxplots
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(c) Annual Boxplots
Cumulative Frequency
(d) Empirical CDF

Tyler Creek at Judson (TC7) : Total Chloride (mg/L)



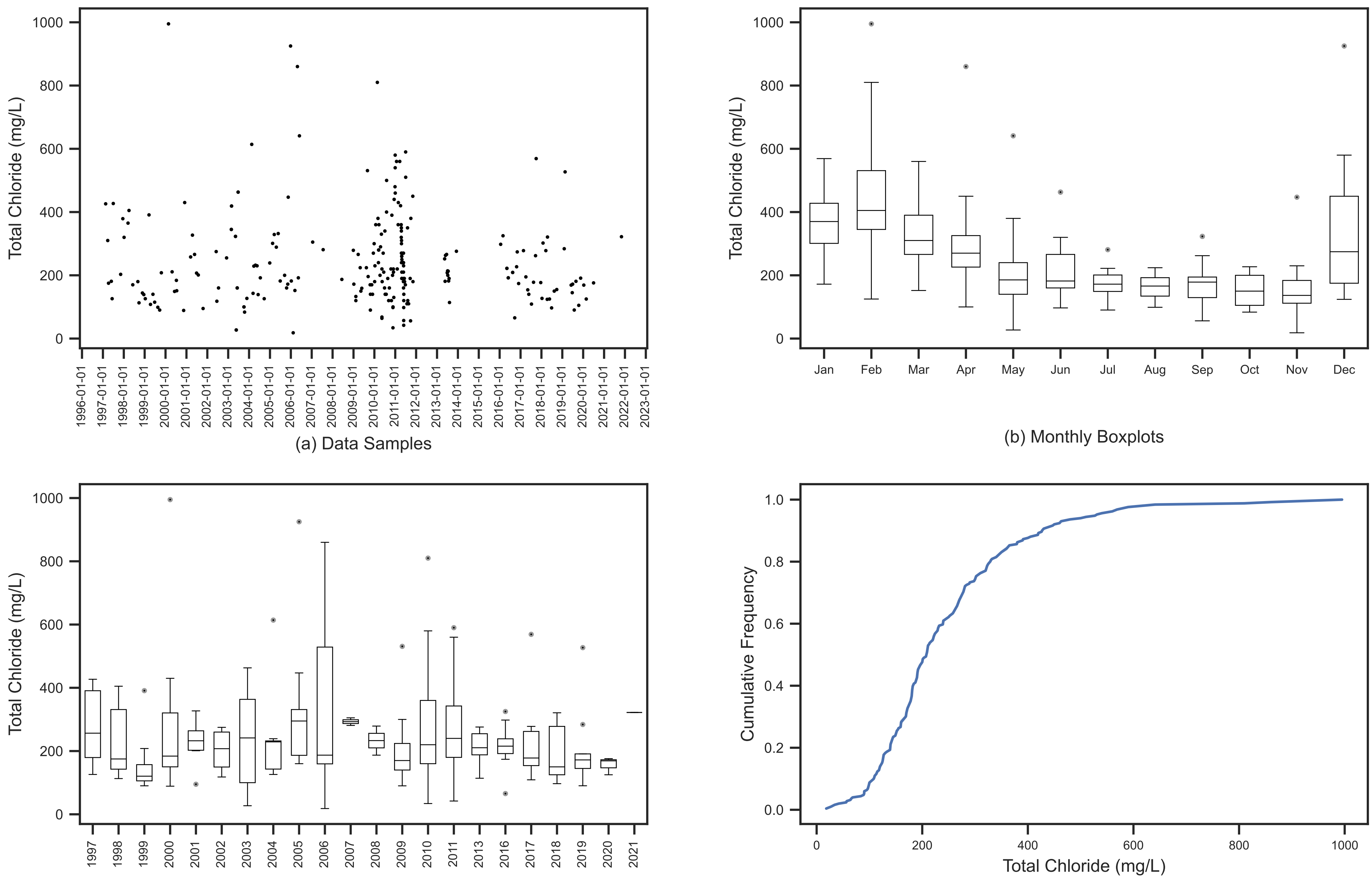
(a) Data Samples

(b) Monthly Boxplots

(c) Annual Boxplots

(d) Empirical CDF

Poplar Creek at Elgin (PC1) : Total Chloride (mg/L)



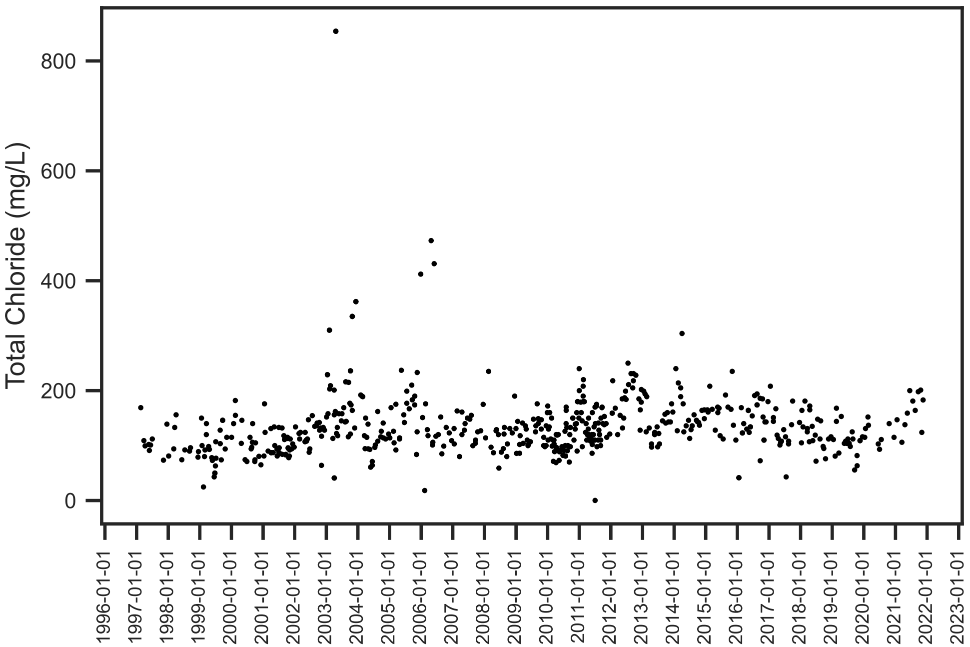
(a) Data Samples

(b) Monthly Boxplots

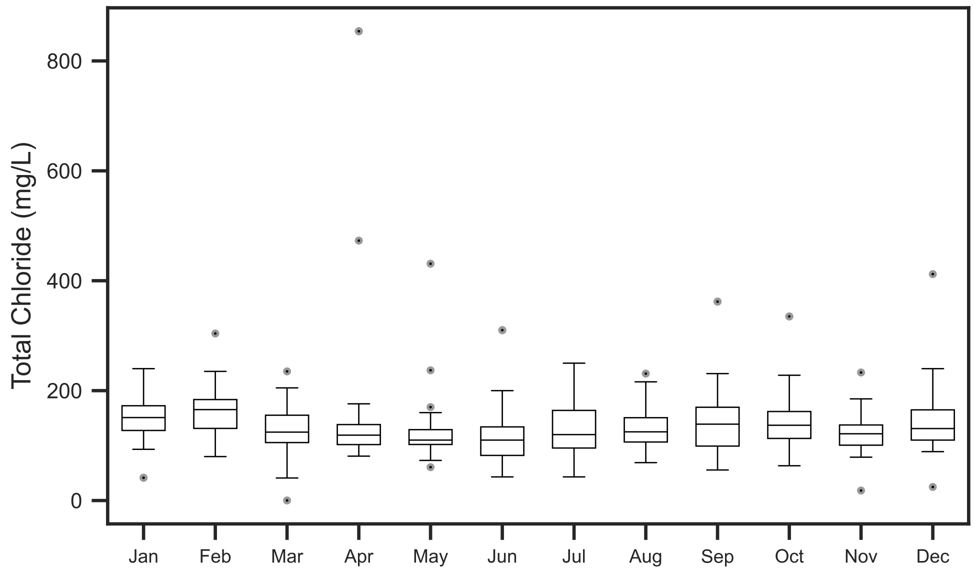
(c) Annual Boxplots

(d) Empirical CDF

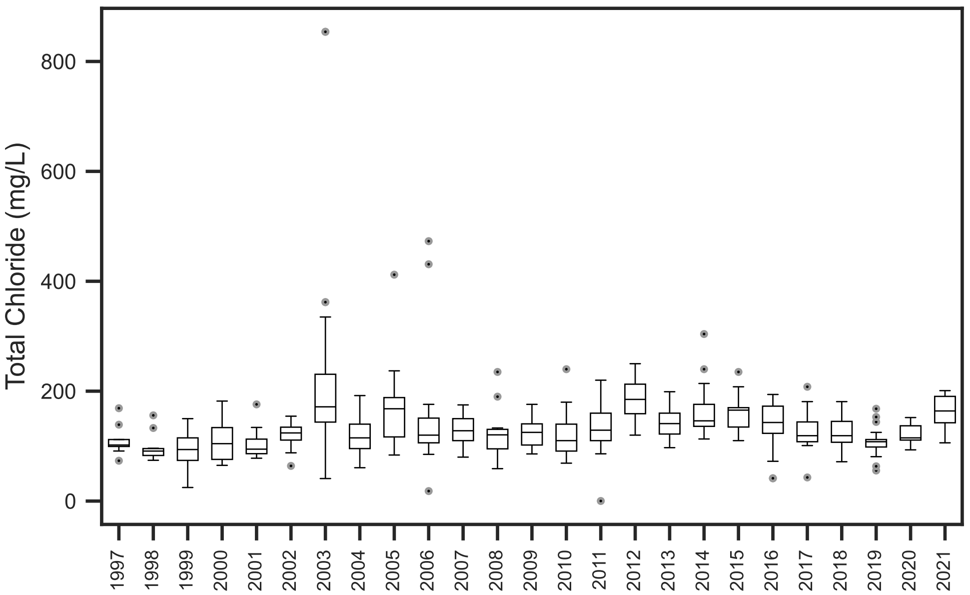
Fox River at South Elgin (FR6) : Total Chloride (mg/L)



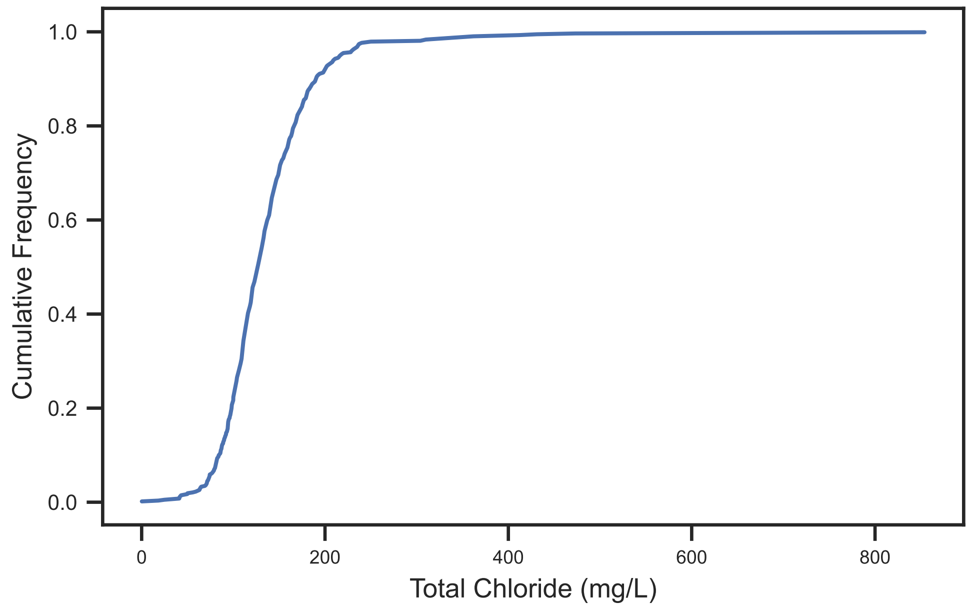
(a) Data Samples



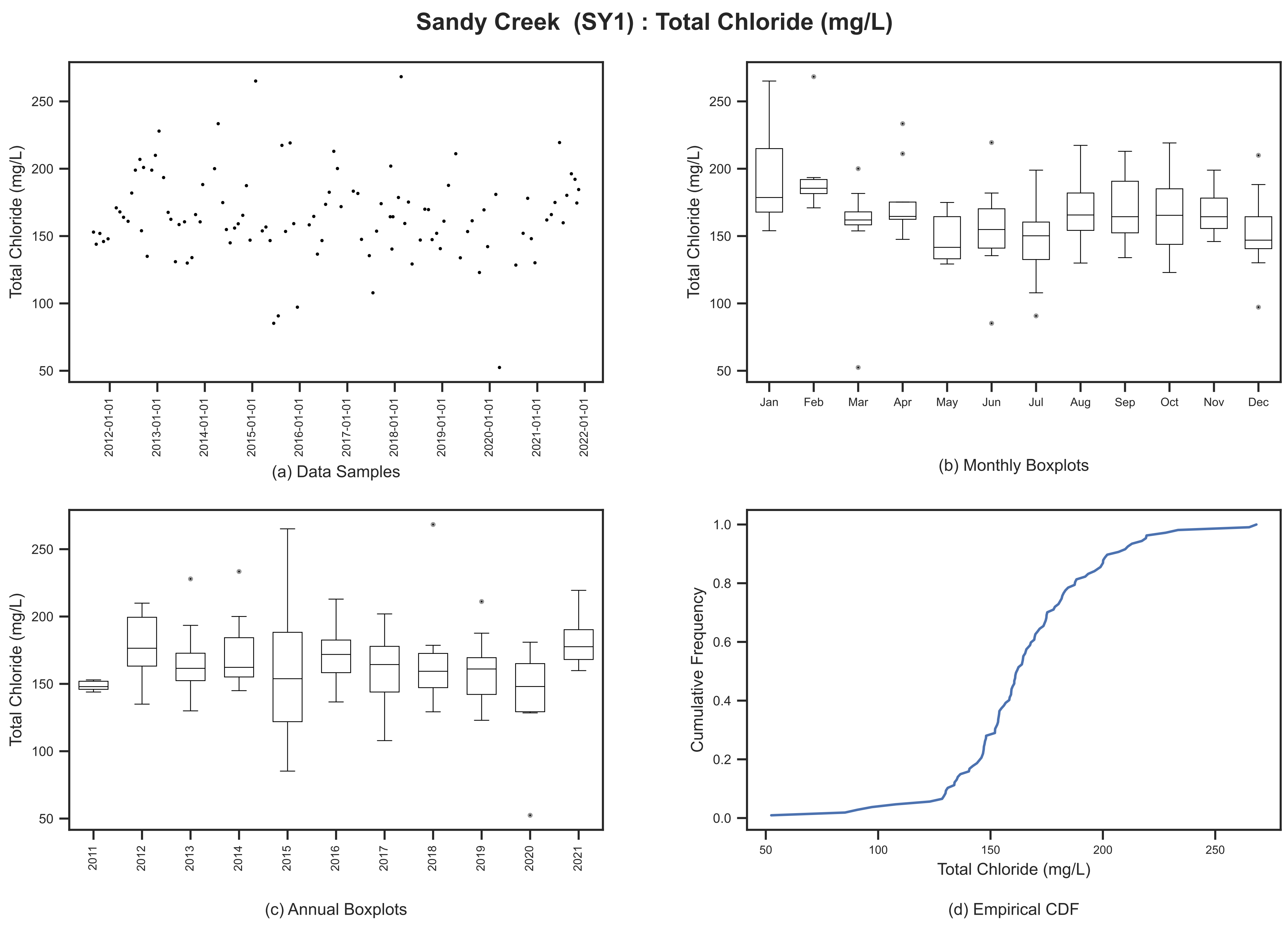
(b) Monthly Boxplots

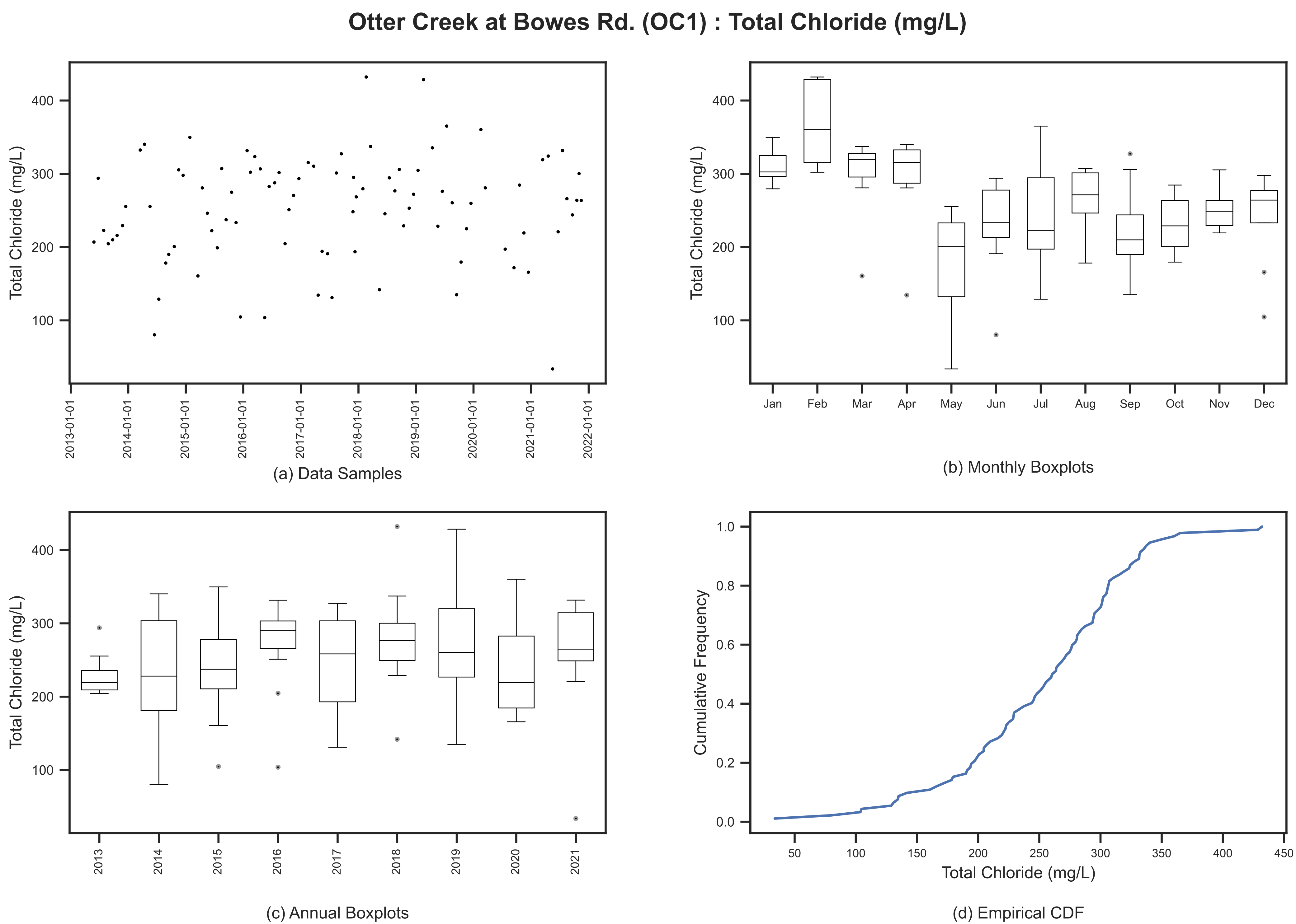


(c) Annual Boxplots

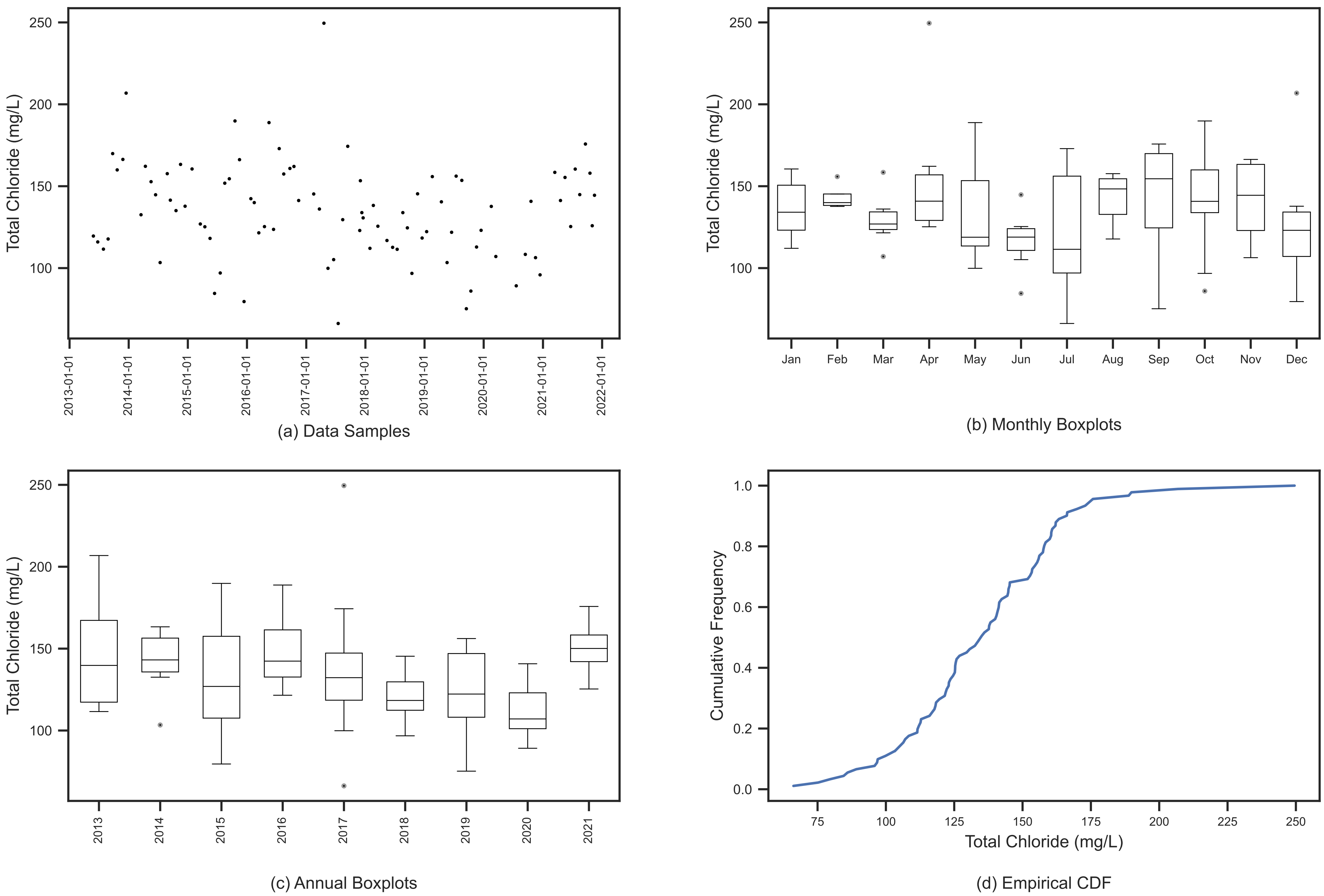


(d) Empirical CDF

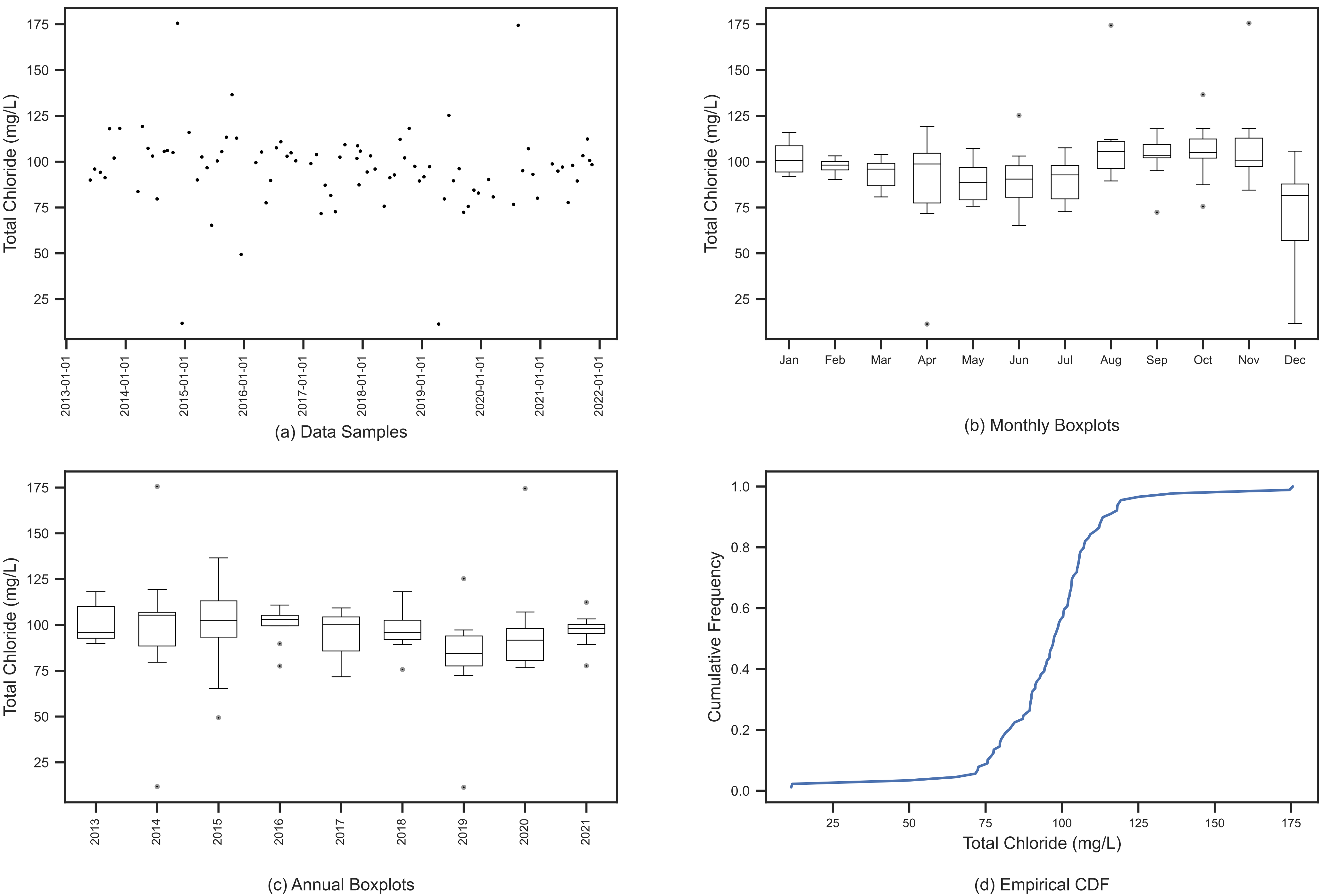

Sandy Creek (SY1) : Total Chloride (mg/L)
Total Chloride (mg/L)
(a) Data Samples
(b) Monthly Boxplots
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(c) Annual Boxplots
Cumulative Frequency
(d) Empirical CDF

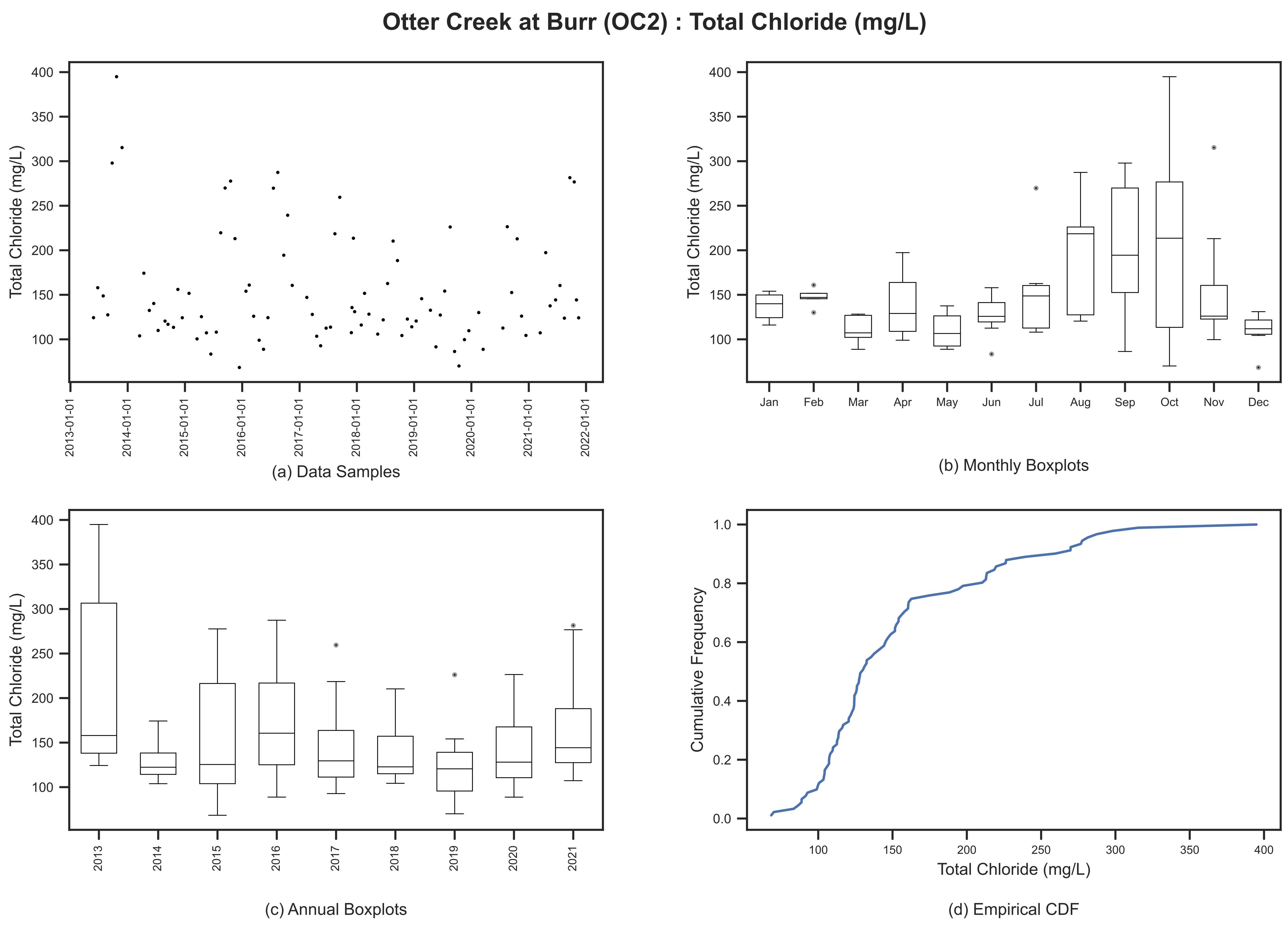

Otter Creek at Bowes Rd. (OC1) : Total Chloride (mg/L)
Total Chloride (mg/L)
2013-01-01
2014-01-01
2015-01-01
2016-01-01
2017-01-01
2018-01-01
2019-01-01
2020-01-01
2021-01-01
2022-01-01
(a) Data Samples
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(b) Monthly Boxplots
2013
2014
2015
2016
2017
2018
2019
2020
2021
(c) Annual Boxplots
Cumulative Frequency
Total Chloride (mg/L)
(d) Empirical CDF

Fitchie Creek at Bowes Rd. (FT1) : Total Chloride (mg/L)

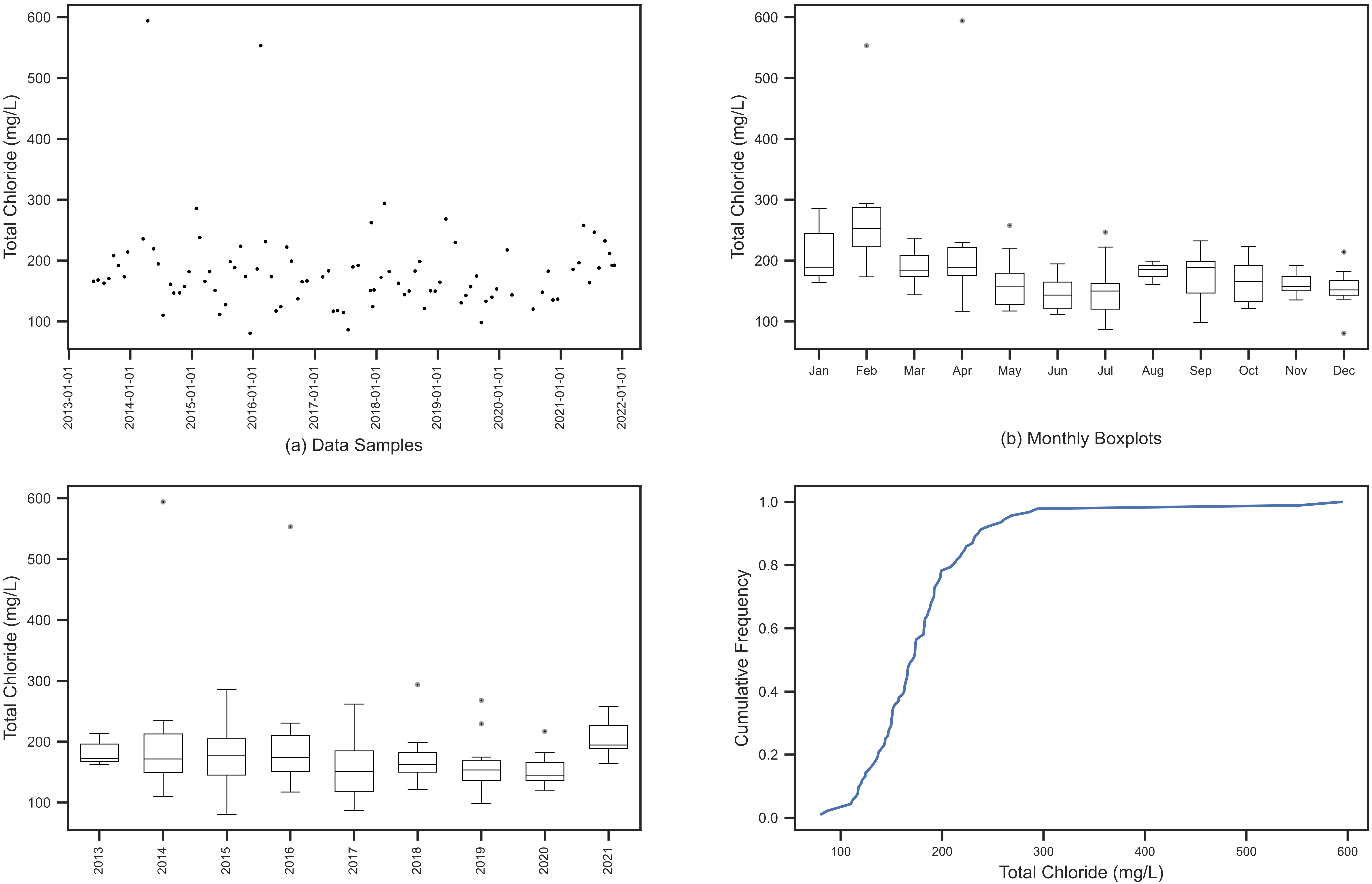


Stoney Creek at Stevens Rd. (ST1) : Total Chloride (mg/L)




Otter Creek at Burr (OC2) : Total Chloride (mg/L)
Total Chloride (mg/L)
(a) Data Samples
(b) Monthly Boxplots
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(c) Annual Boxplots
Cumulative Frequency
Total Chloride (mg/L)
(d) Empirical CDF

Otter Creek at Silver Glen Rd. (OC3) : Total Chloride (mg/L)



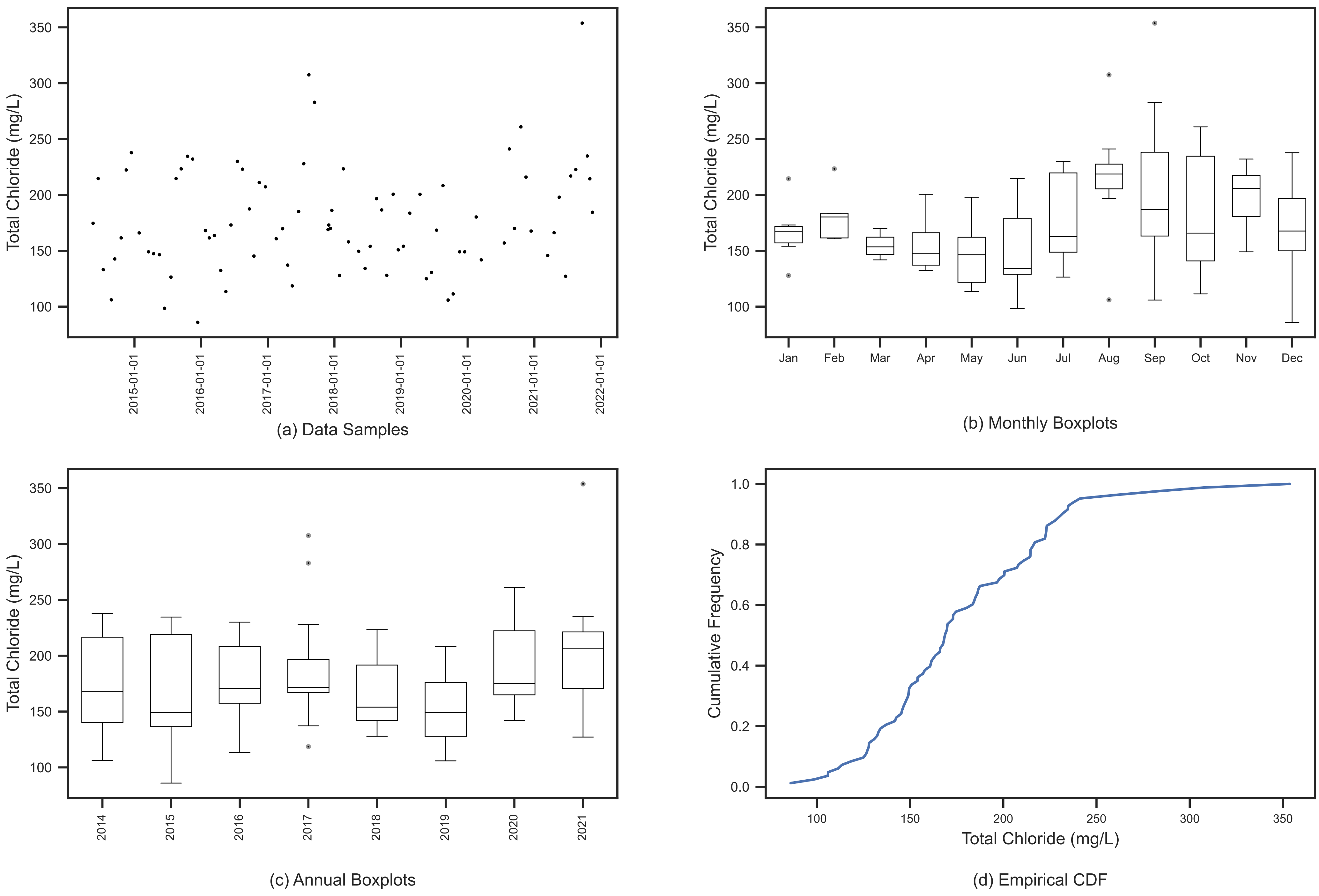
(a) Data Samples

(b) Monthly Boxplots

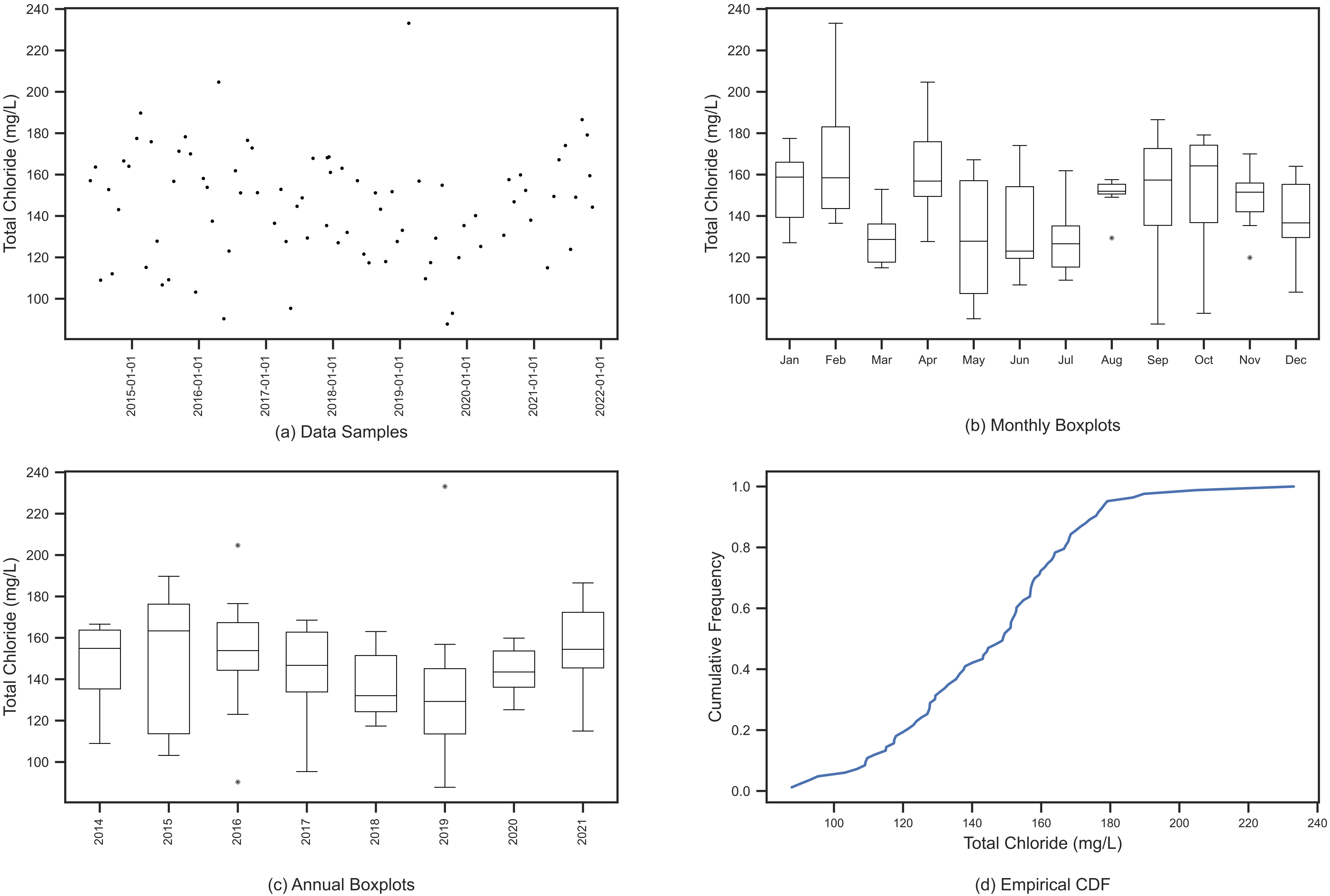
(c) Annual Boxplots

(d) Empirical CDF

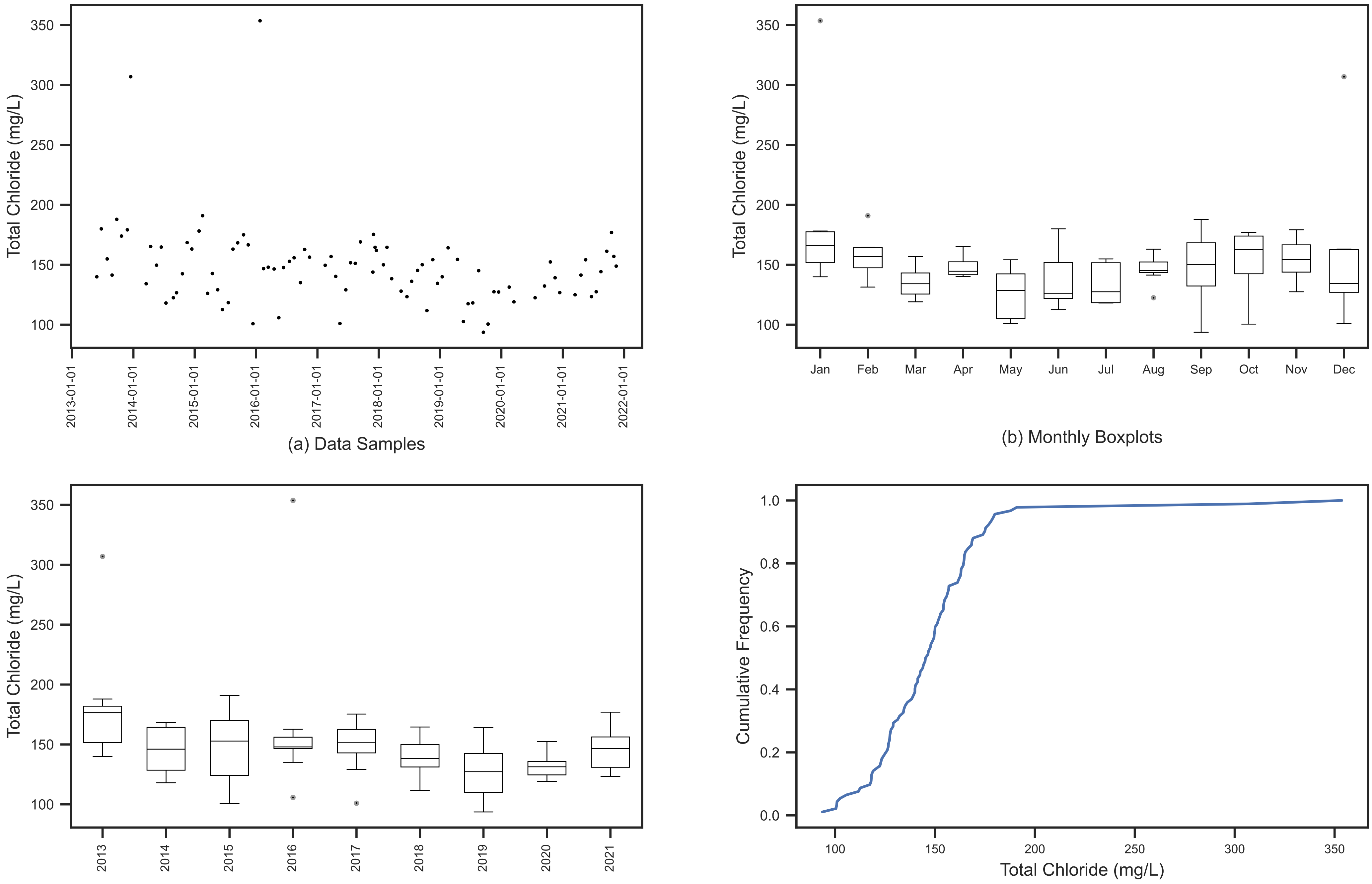
Ferson Creek at Hidden Springs (FC1) : Total Chloride (mg/L)



Ferson Creek at Burlington & Corran Rds. (FC2) : Total Chloride (mg/L)



Ferson Creek at Burr (FC3) : Total Chloride (mg/L)



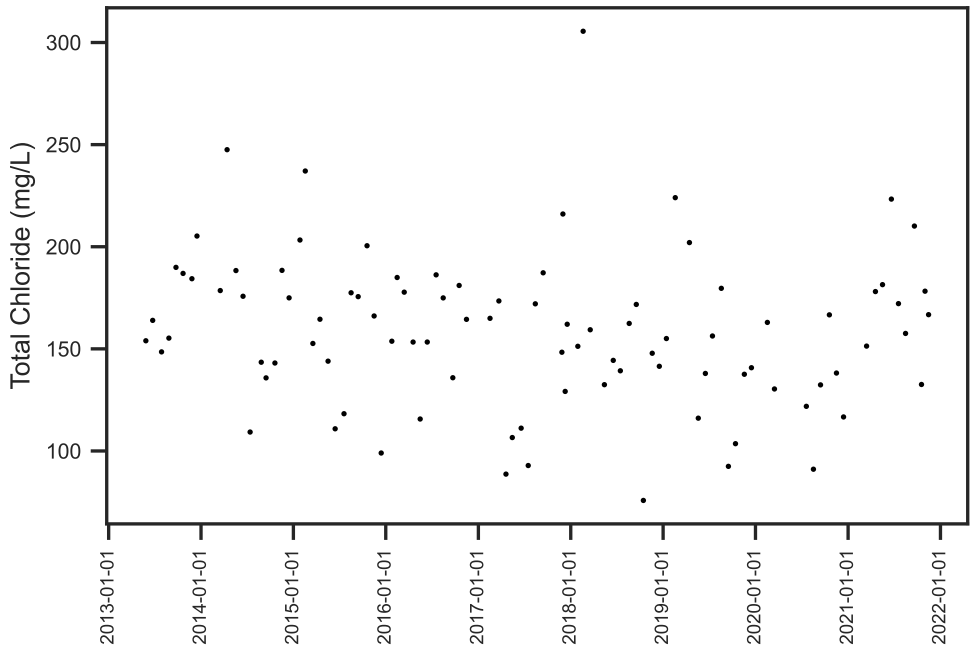
(a) Data Samples

(b) Monthly Boxplots

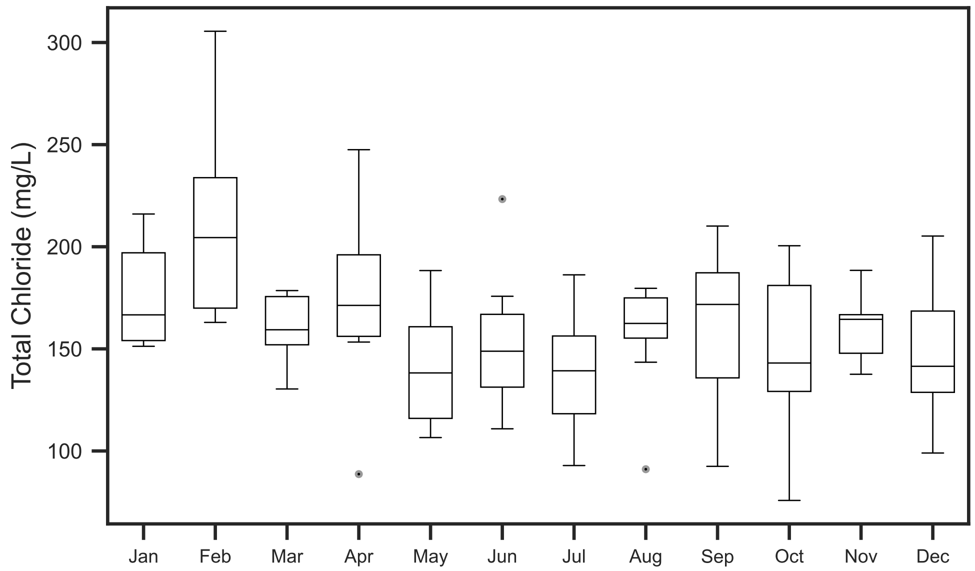
(c) Annual Boxplots

(d) Empirical CDF

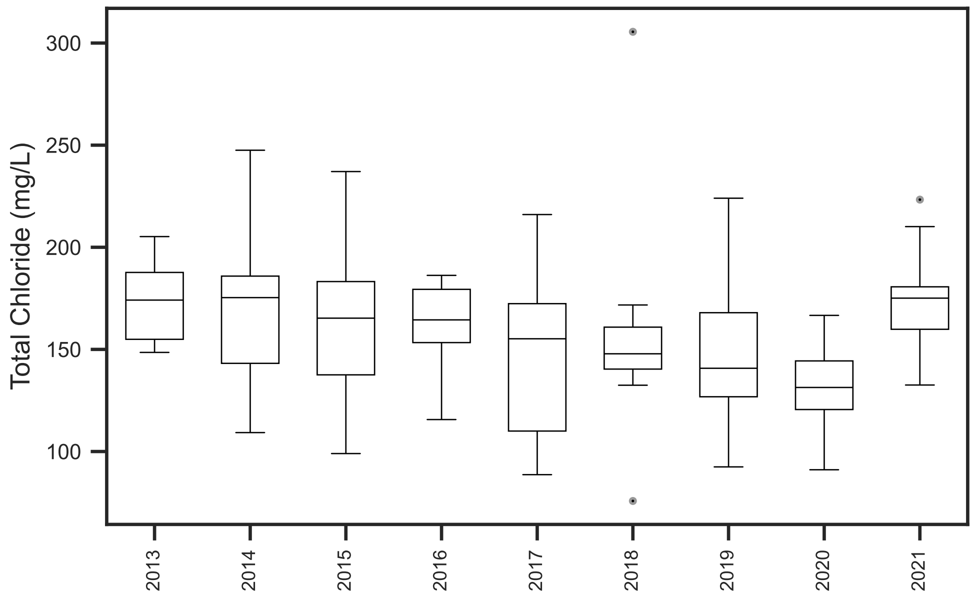
Ferson Creek at Randall Rd. (FC4) : Total Chloride (mg/L)



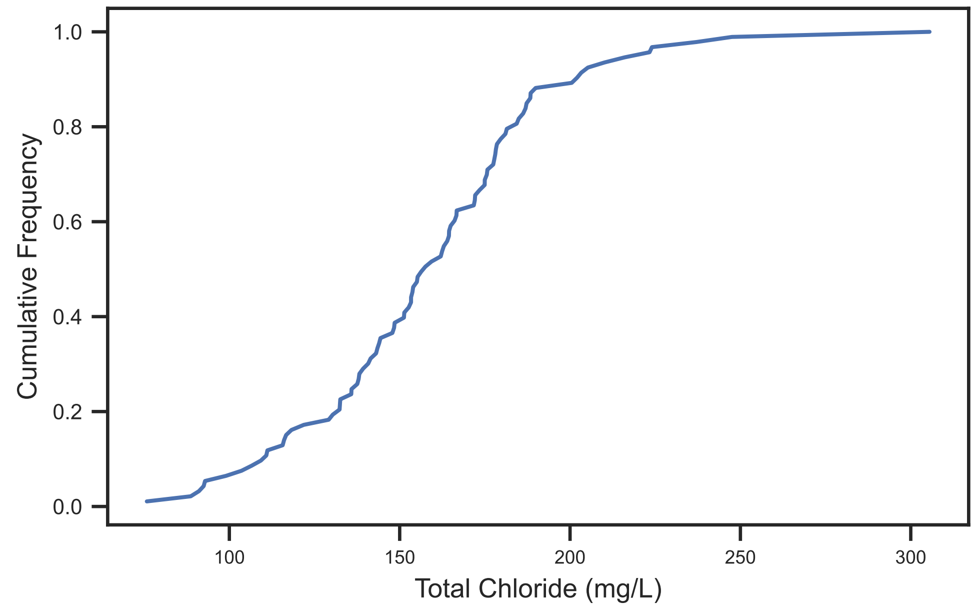
(a) Data Samples



(b) Monthly Boxplots

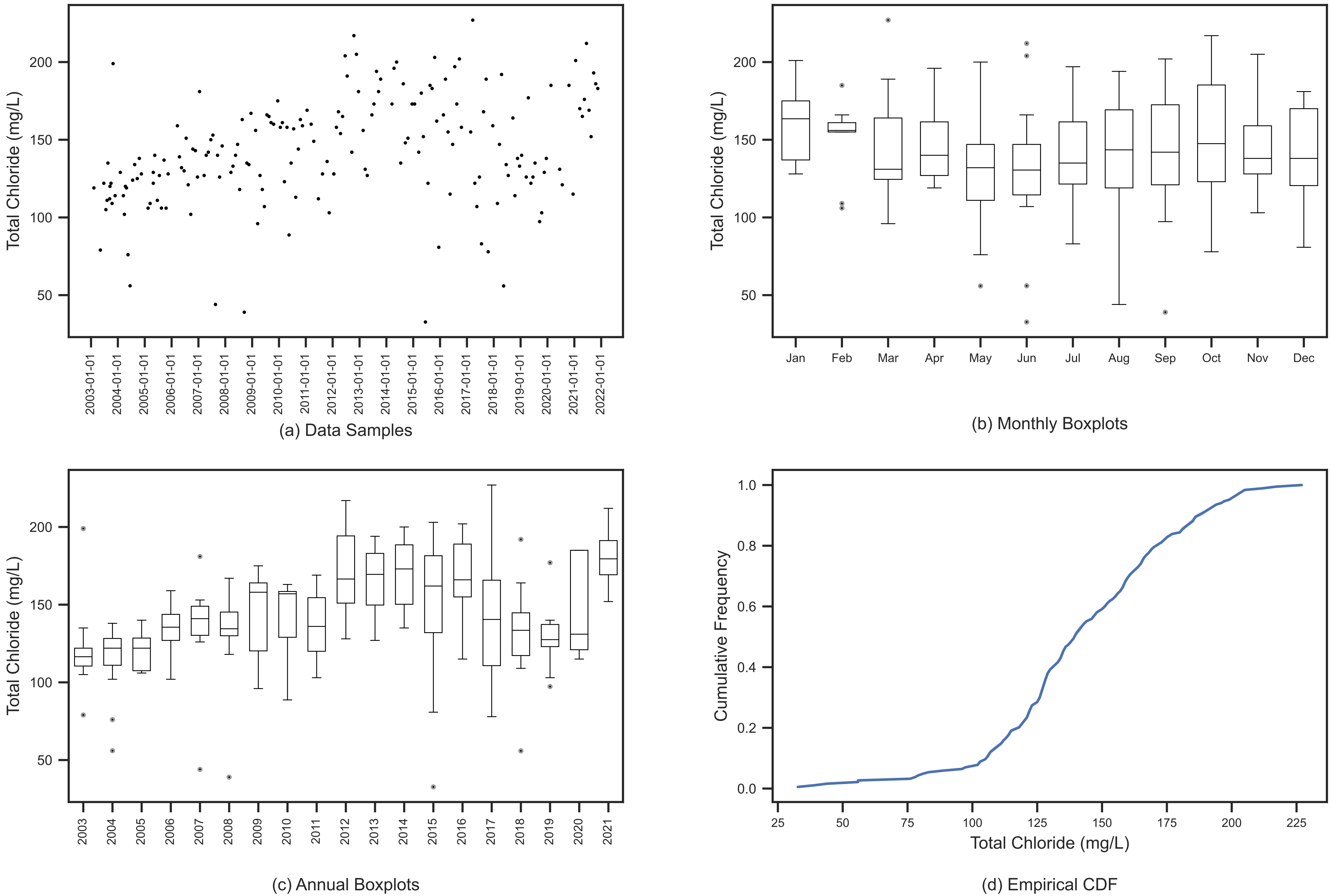


(c) Annual Boxplots

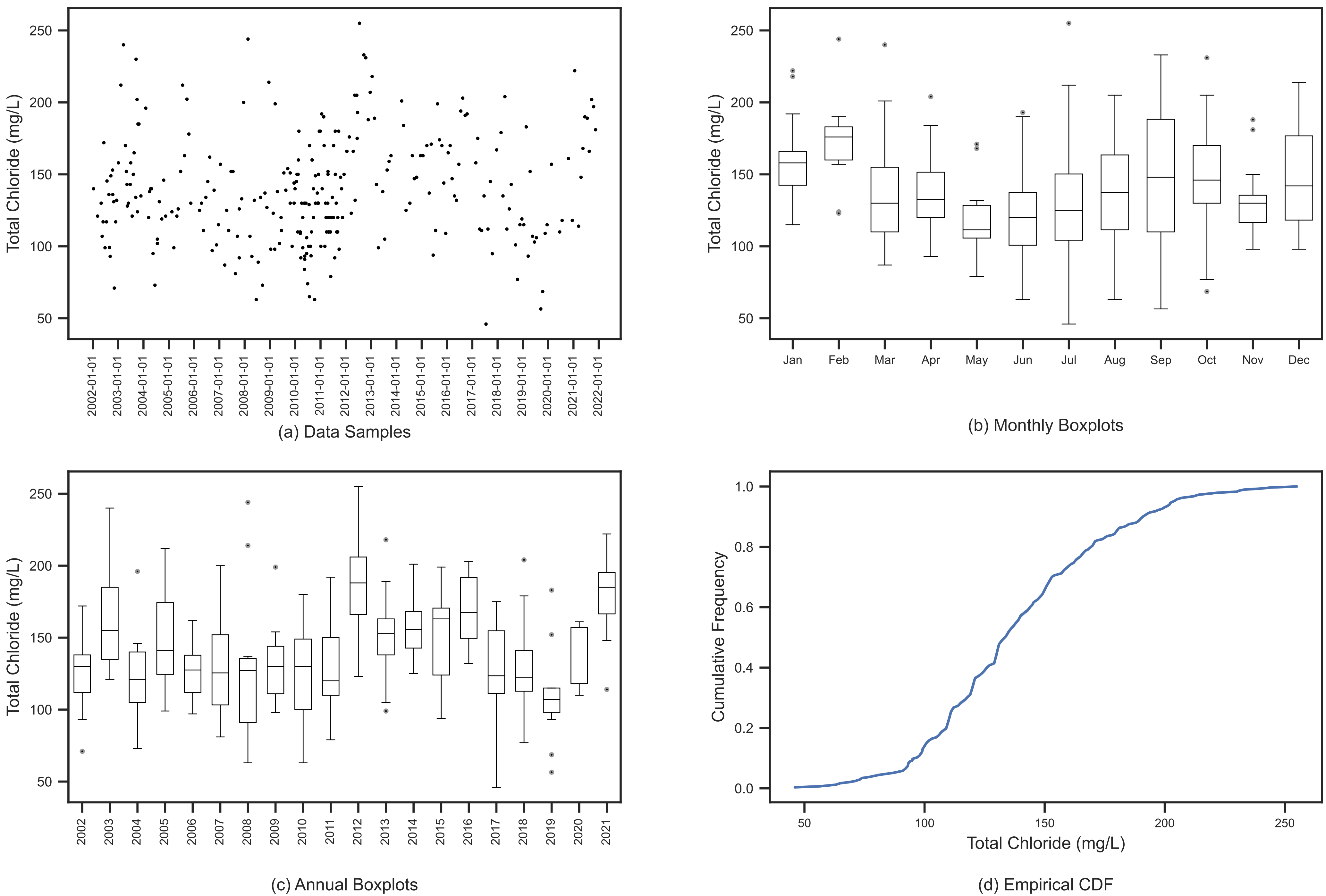


(d) Empirical CDF

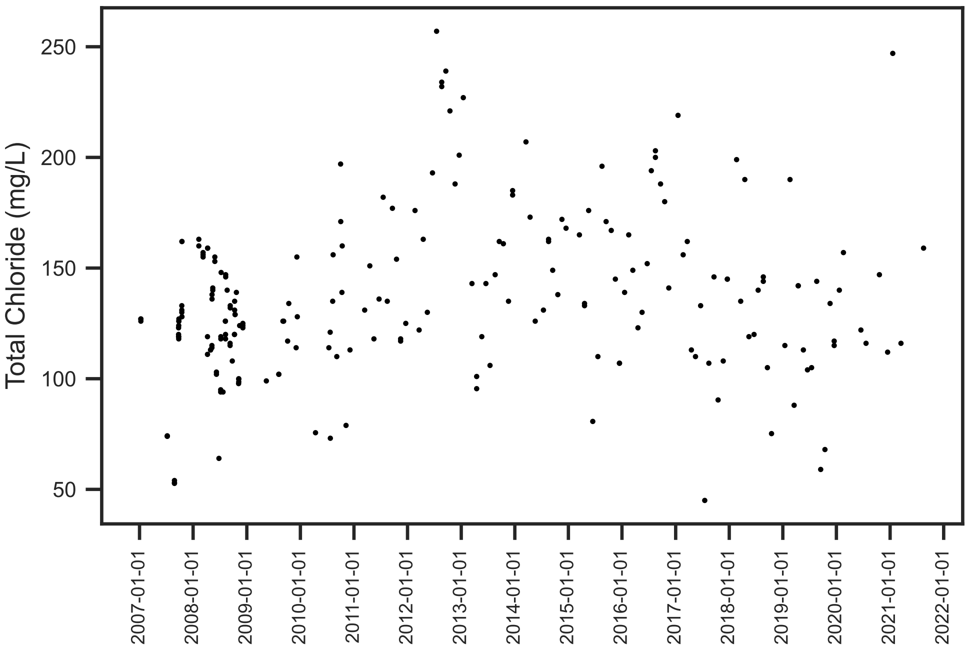
Ferson Creek near St. Charles (FC5) : Total Chloride (mg/L)



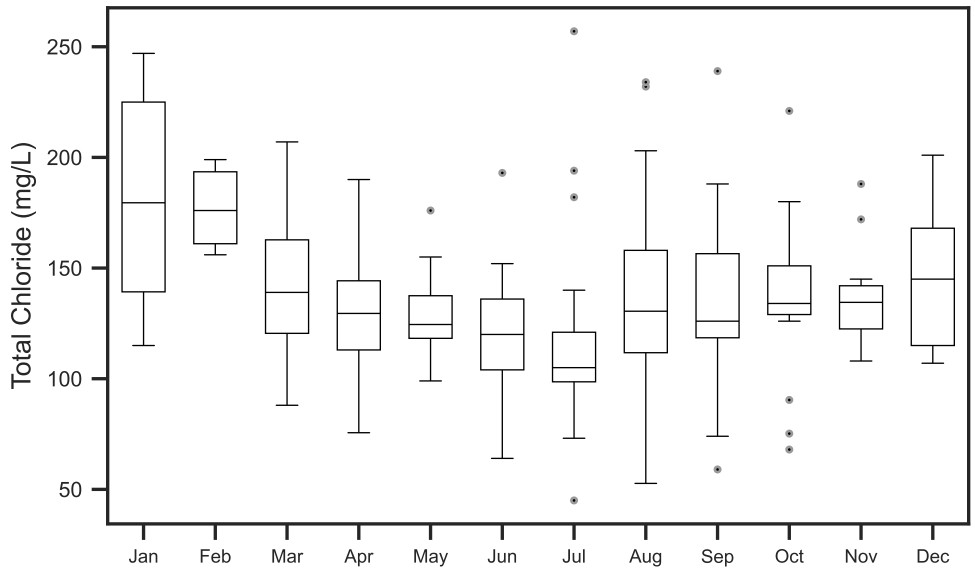
Fox River at Fabyan Pk-Geneva (FR7) : Total Chloride (mg/L)



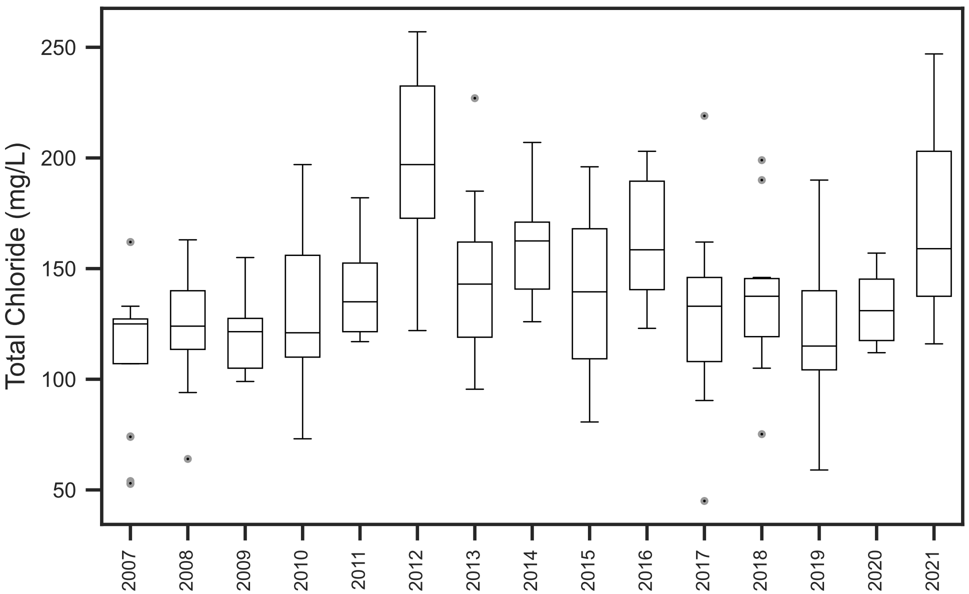
Fox River at Sullivan Br. (FR8) : Total Chloride (mg/L)



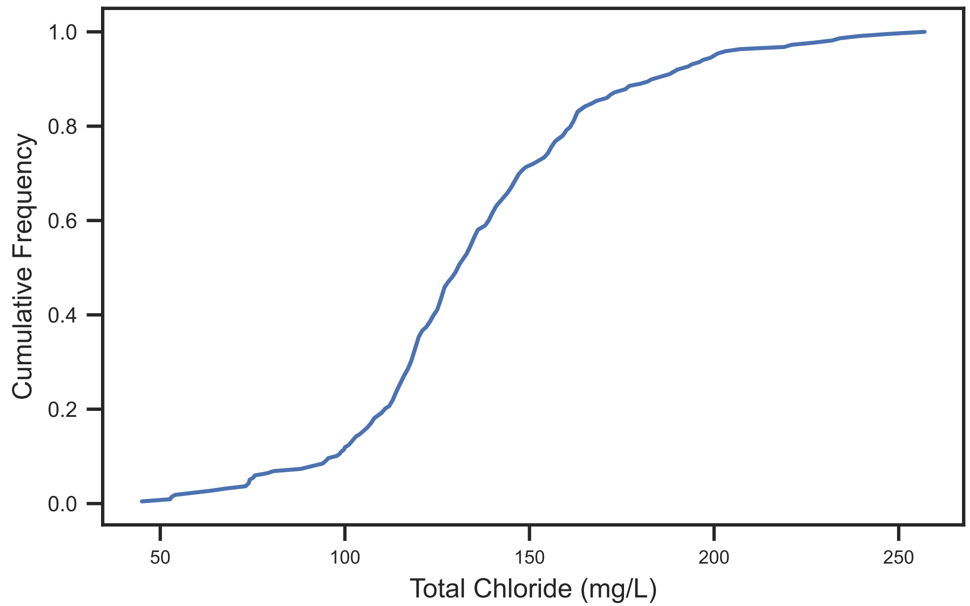
(a) Data Samples



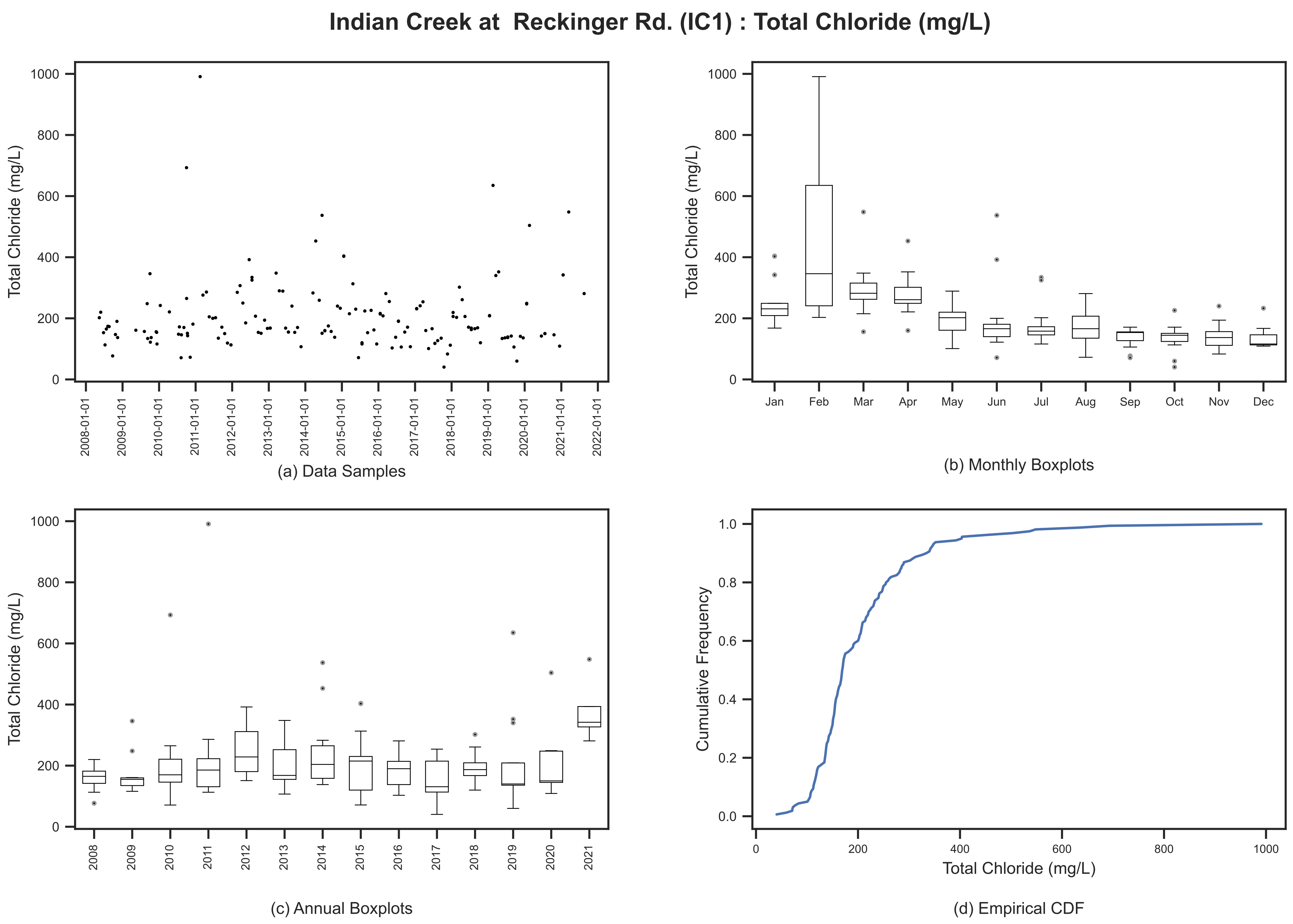
(b) Monthly Boxplots



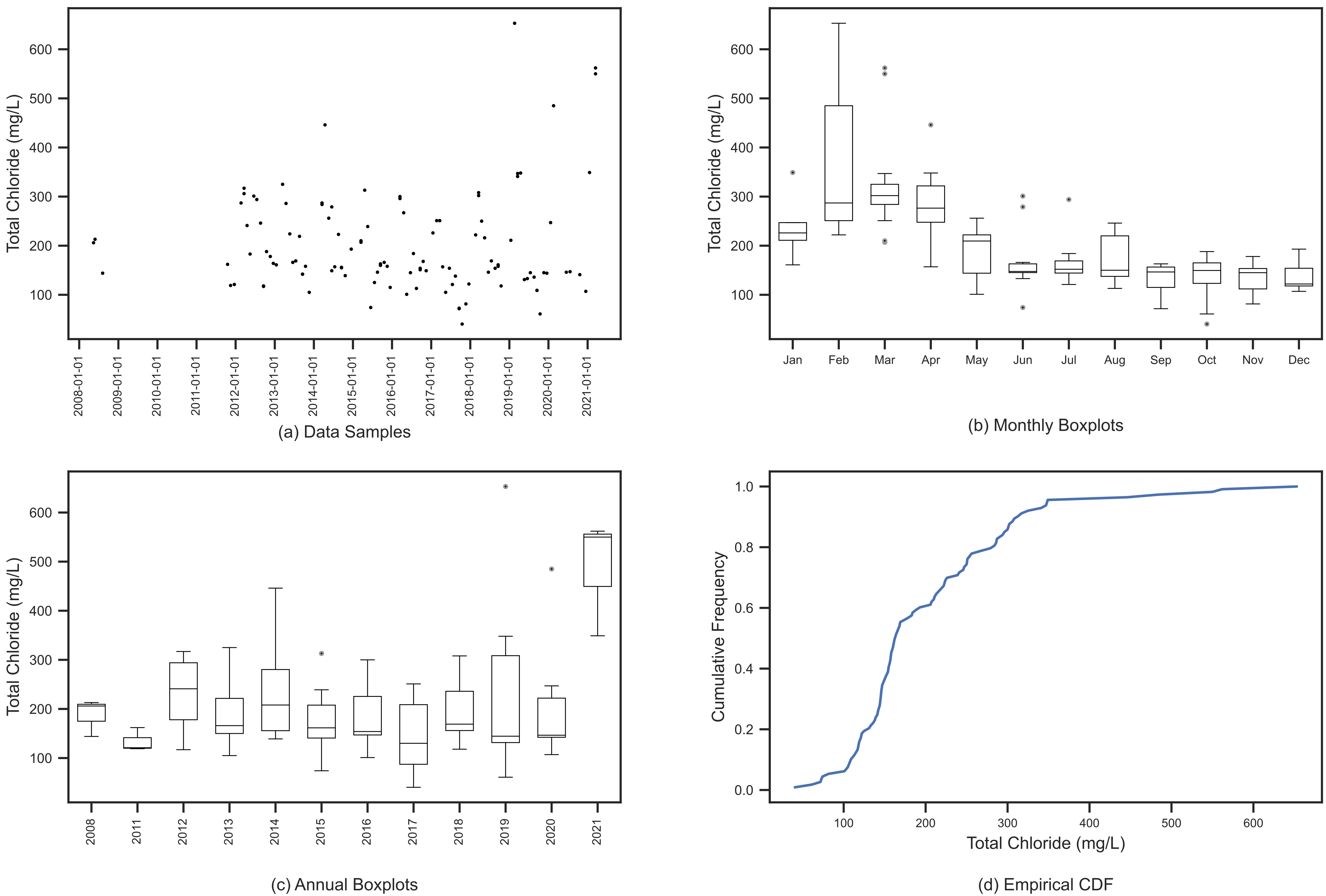
(c) Annual Boxplots



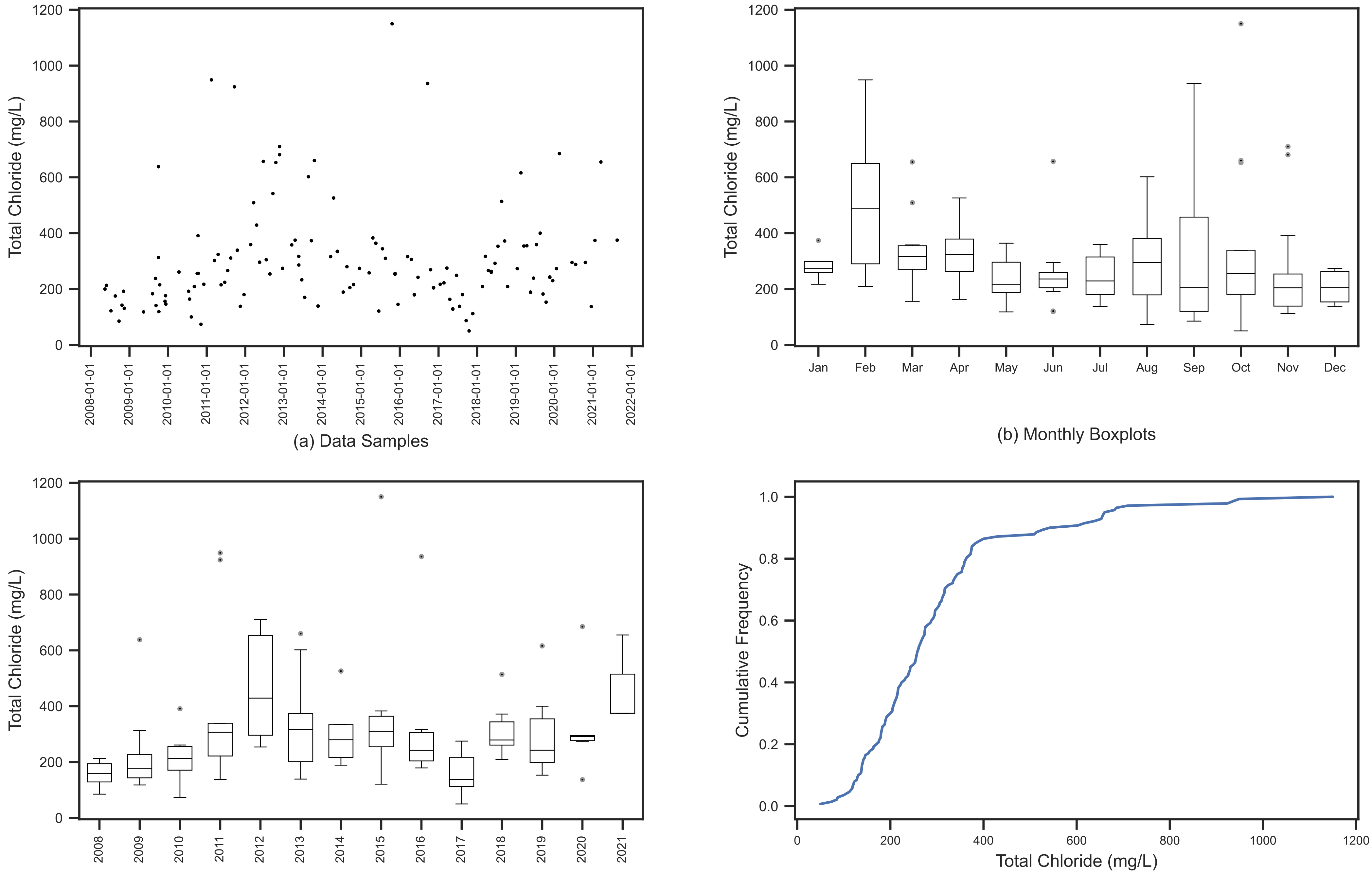
(d) Empirical CDF


Indian Creek at Reckinger Rd. (IC1) : Total Chloride (mg/L)
Total Chloride (mg/L)
(a) Data Samples
(b) Monthly Boxplots
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(c) Annual Boxplots
Cumulative Frequency
(d) Empirical CDF

Indian Creek ups Outfall (IC2) : Total Chloride (mg/L)



Indian Creek dns Outfall (IC3) : Total Chloride (mg/L)



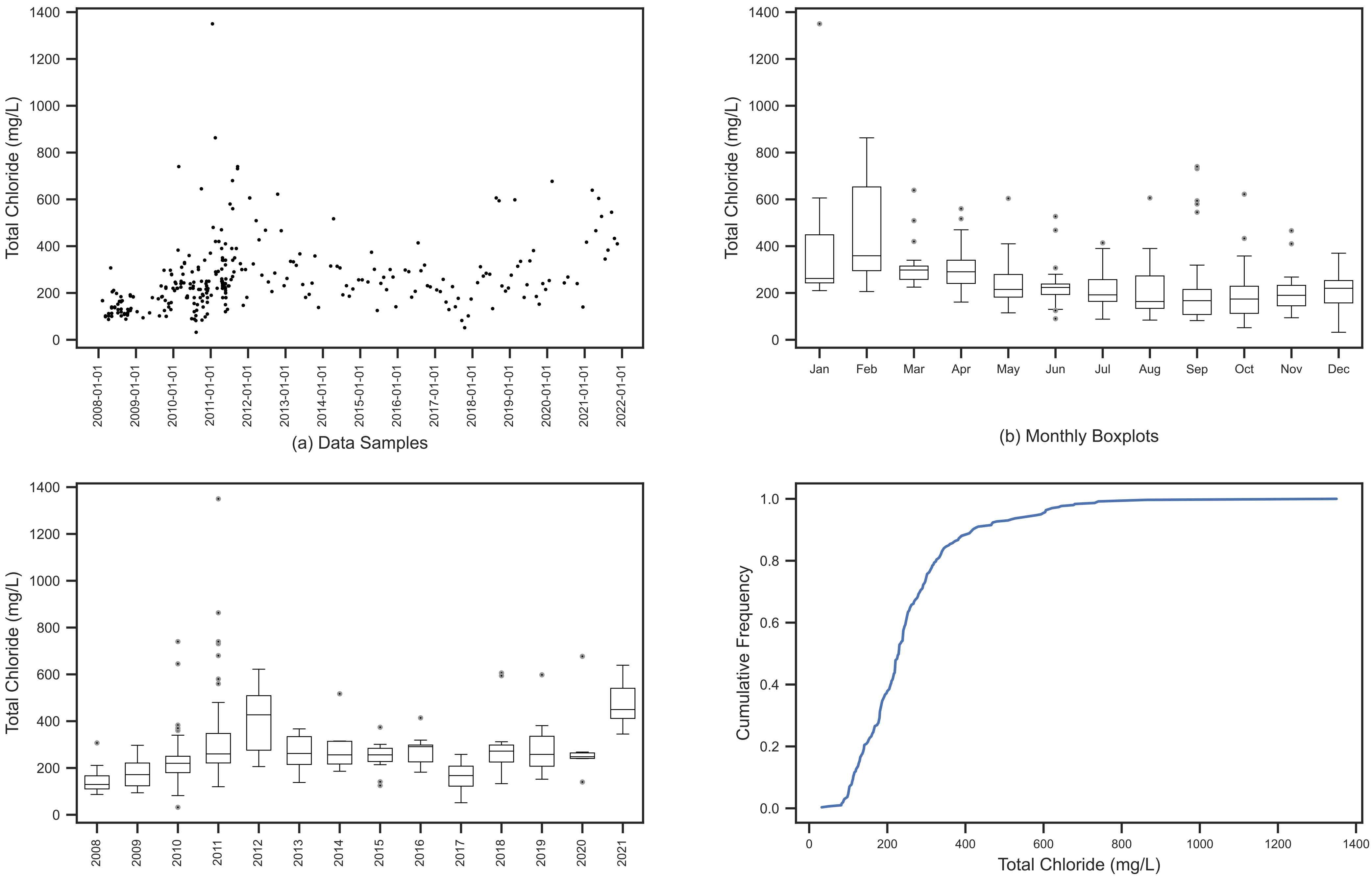
(a) Data Samples

(b) Monthly Boxplots

(c) Annual Boxplots

(d) Empirical CDF

Indian Creek u/s Rt. 25 (IC4) : Total Chloride (mg/L)



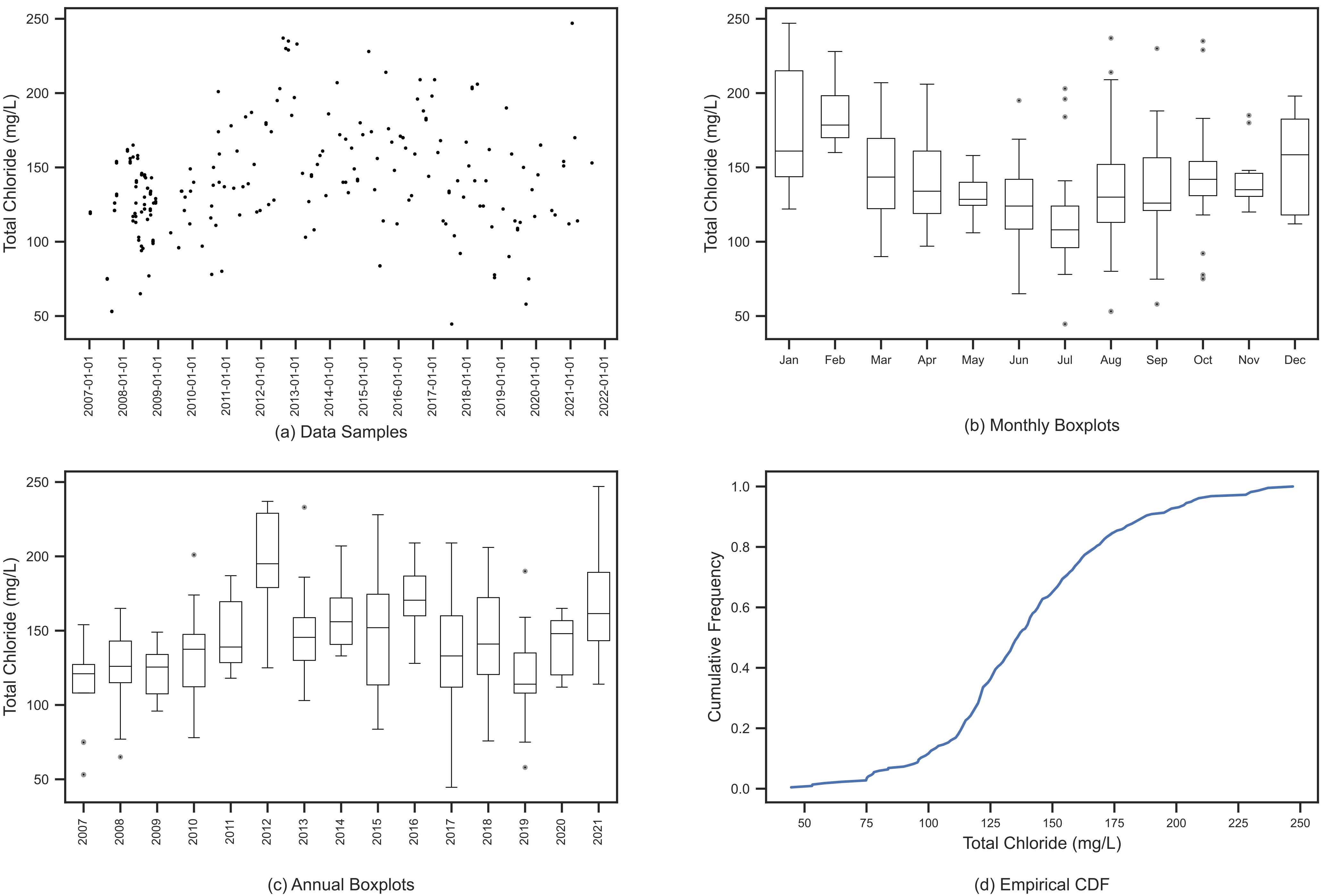
(a) Data Samples

(b) Monthly Boxplots

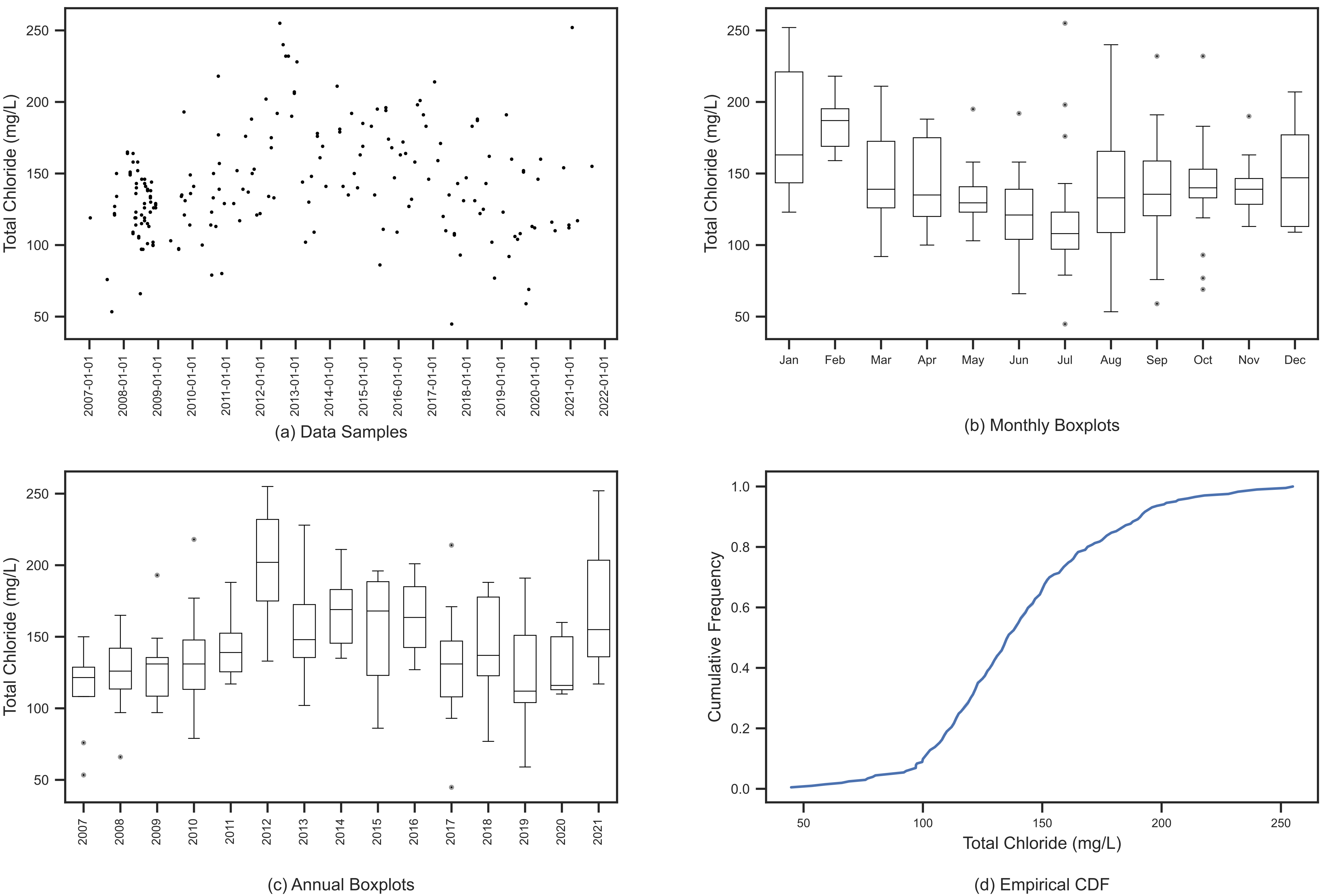
(c) Annual Boxplots

(d) Empirical CDF

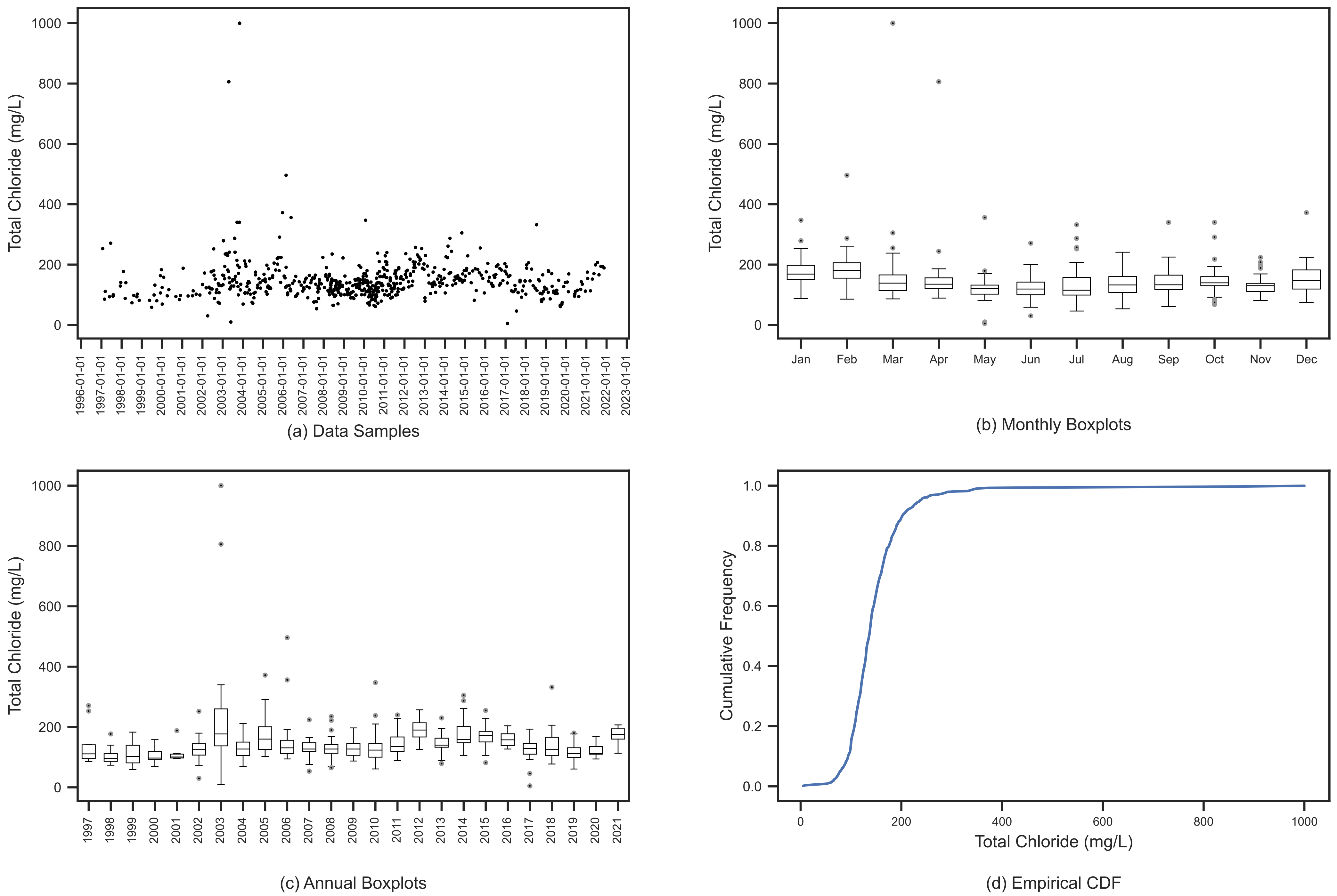
Fox River at North Ave. Br. (FR9) : Total Chloride (mg/L)



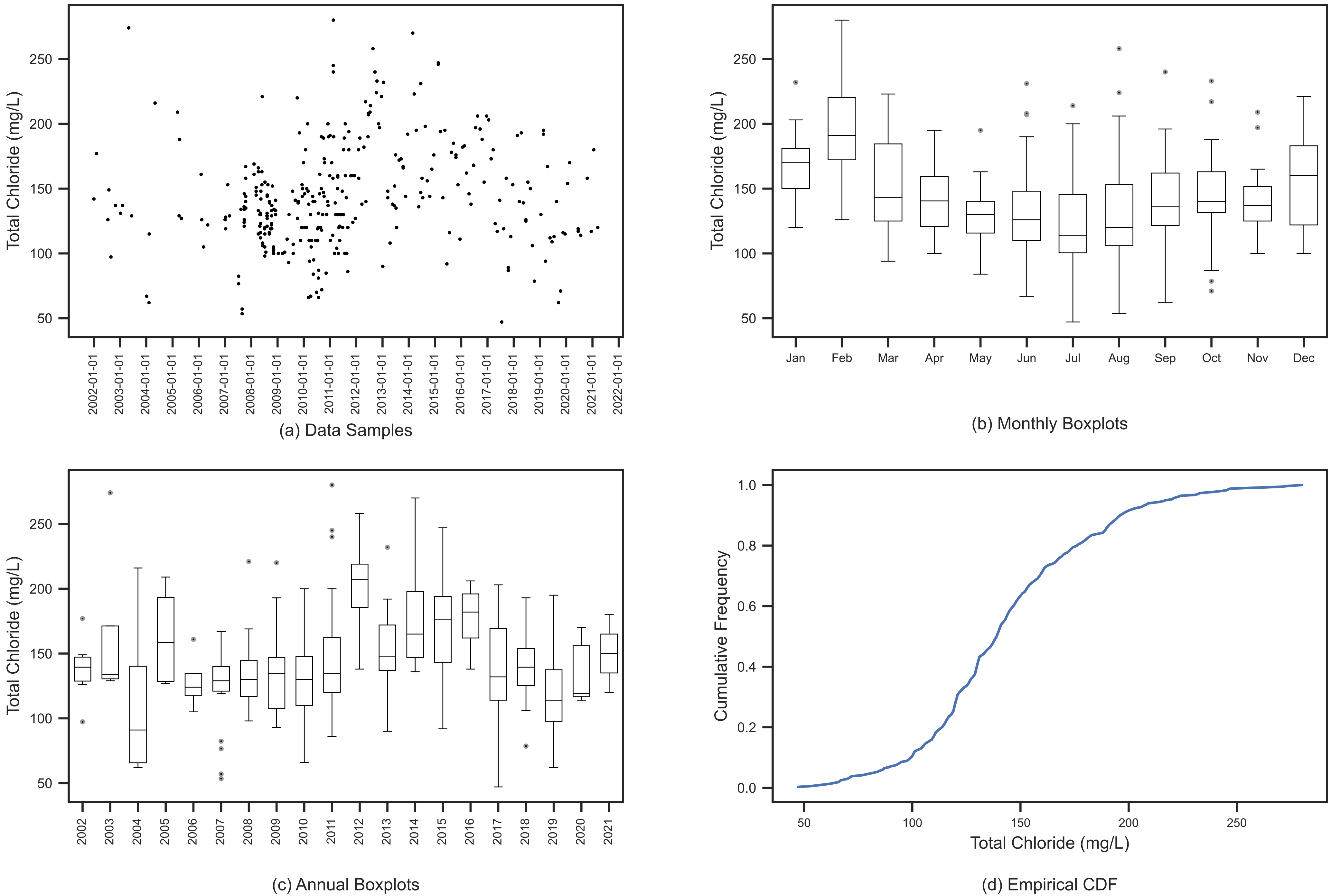
Fox River at Ashland Ave. (FR10) : Total Chloride (mg/L)

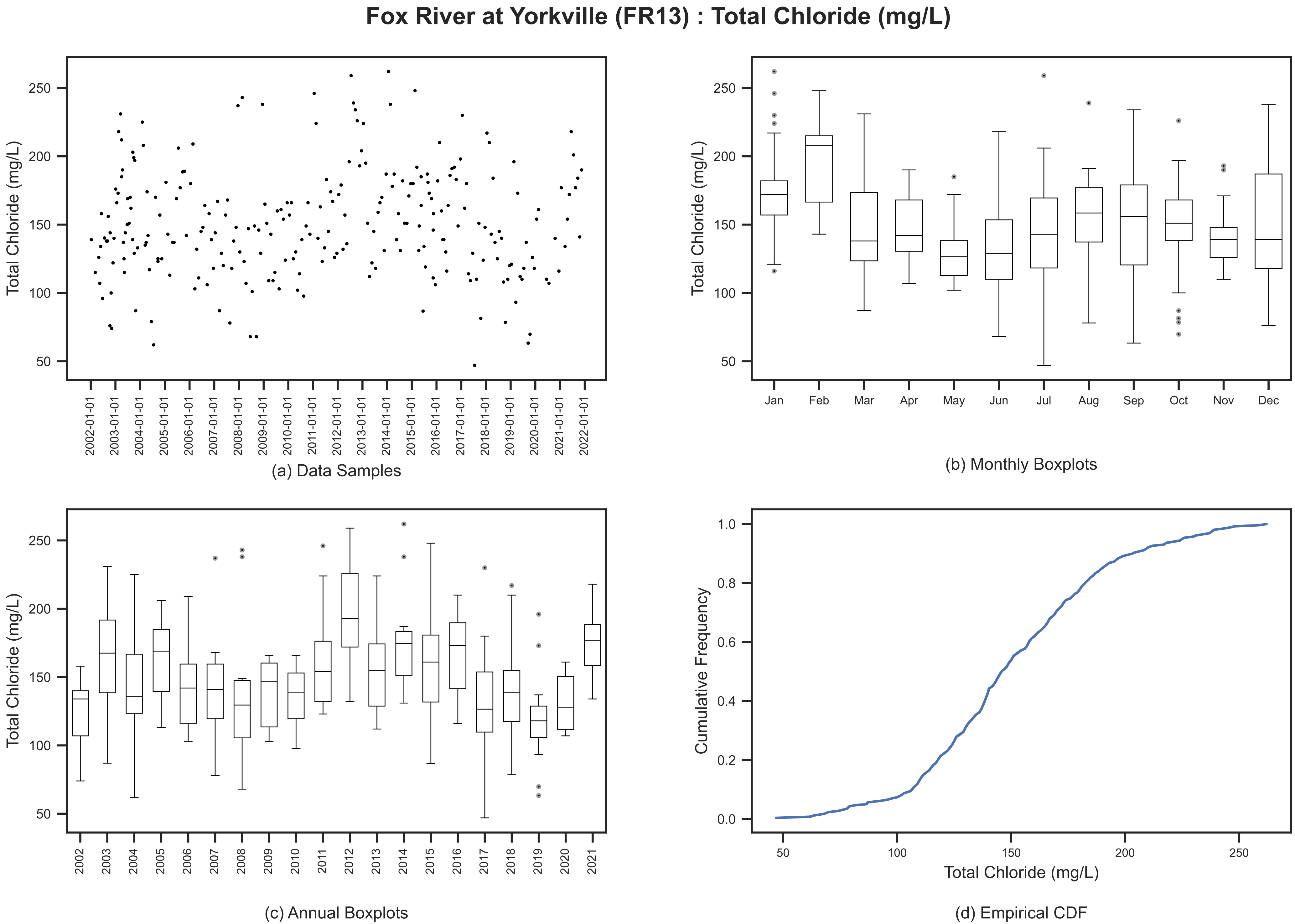


Fox River at Montgomery (FR11) : Total Chloride (mg/L)

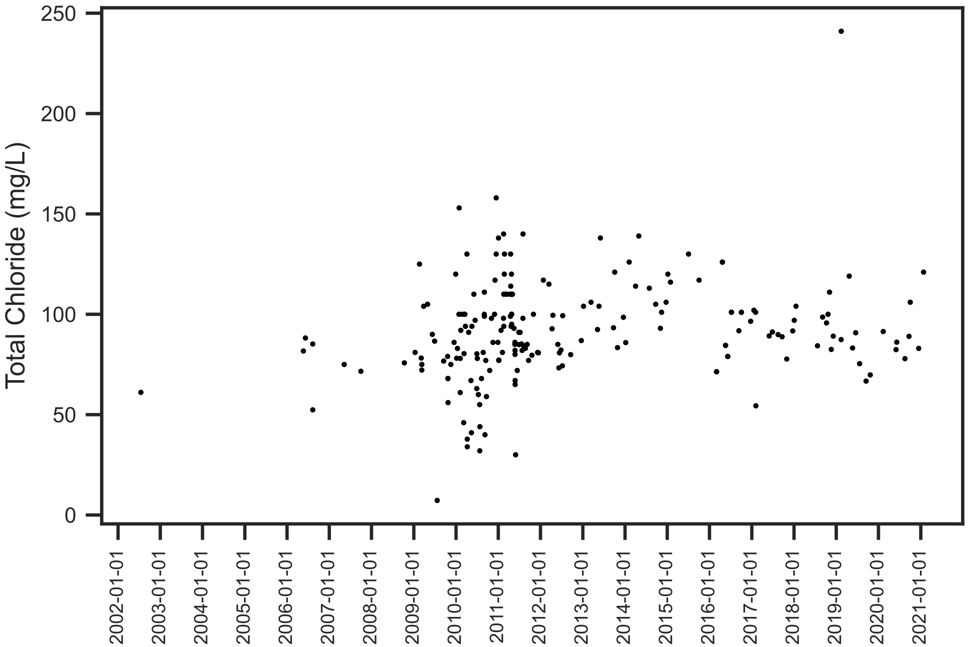


Fox River at Rt. 34, Oswego (FR12) : Total Chloride (mg/L)

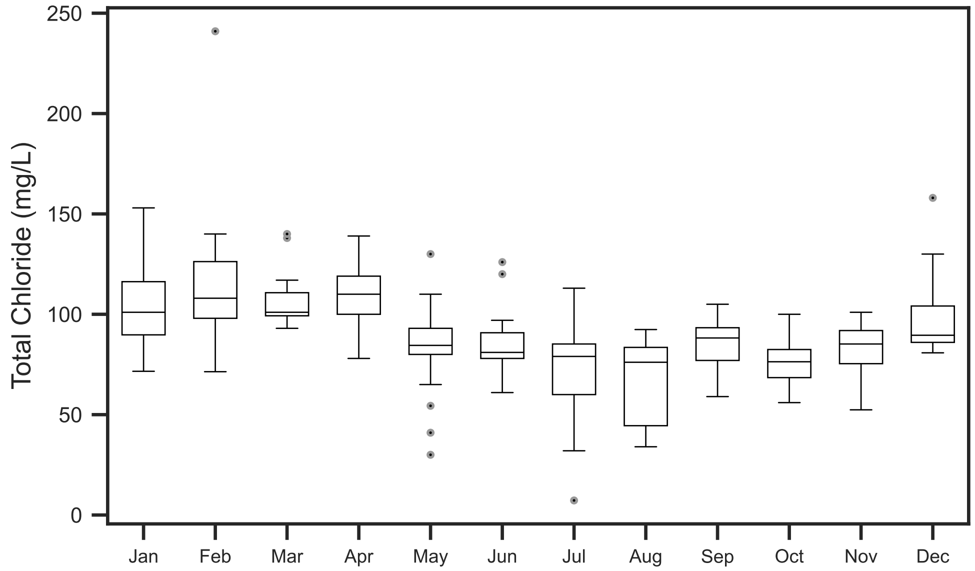



Fox River at Yorkville (FR13) : Total Chloride (mg/L)
Total Chloride (mg/L)
(a) Data Samples
(b) Monthly Boxplots
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(c) Annual Boxplots
Cumulative Frequency
(d) Empirical CDF

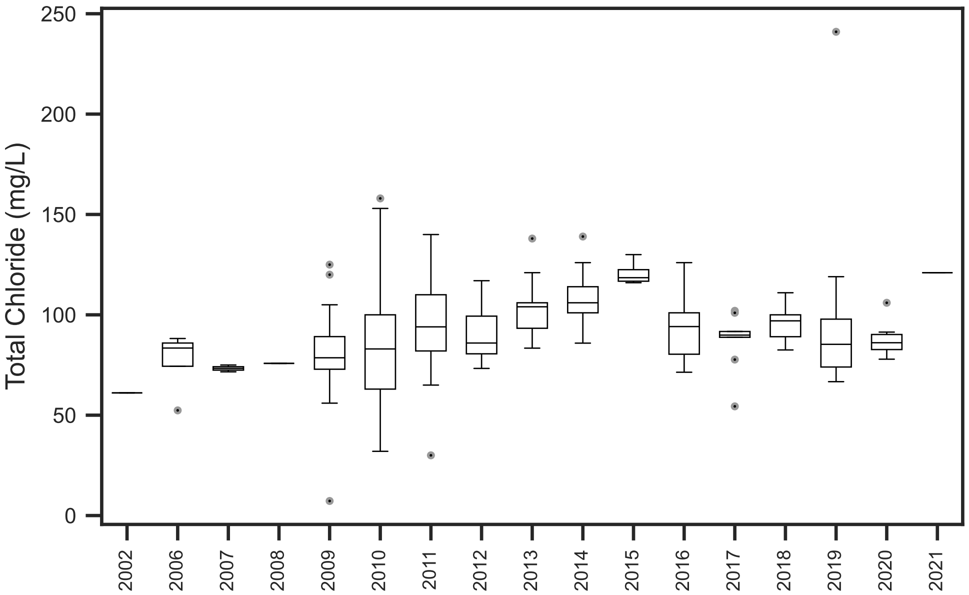
Blackberry Creek near Yorkville (BC1) : Total Chloride (mg/L)



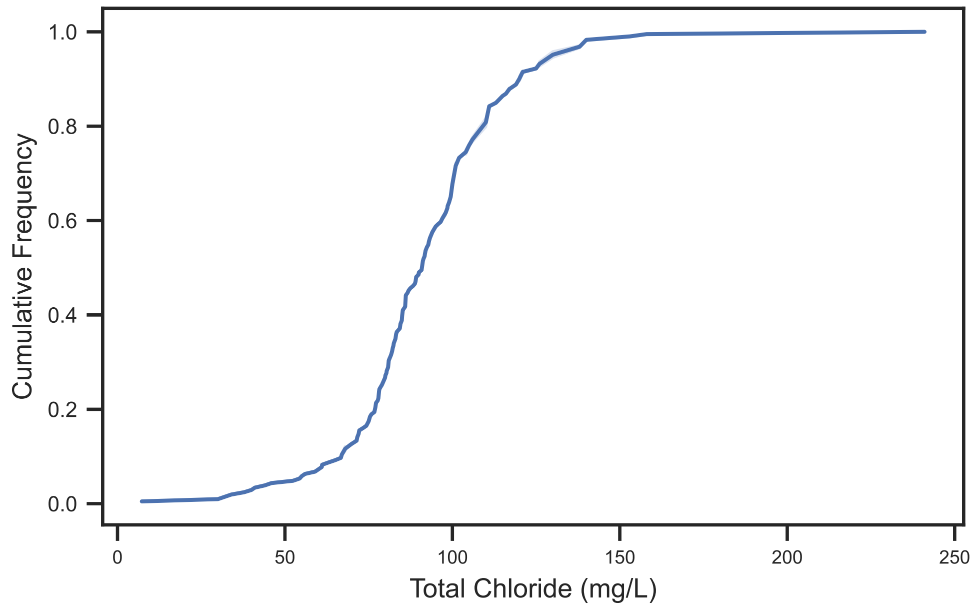
(a) Data Samples



(b) Monthly Boxplots

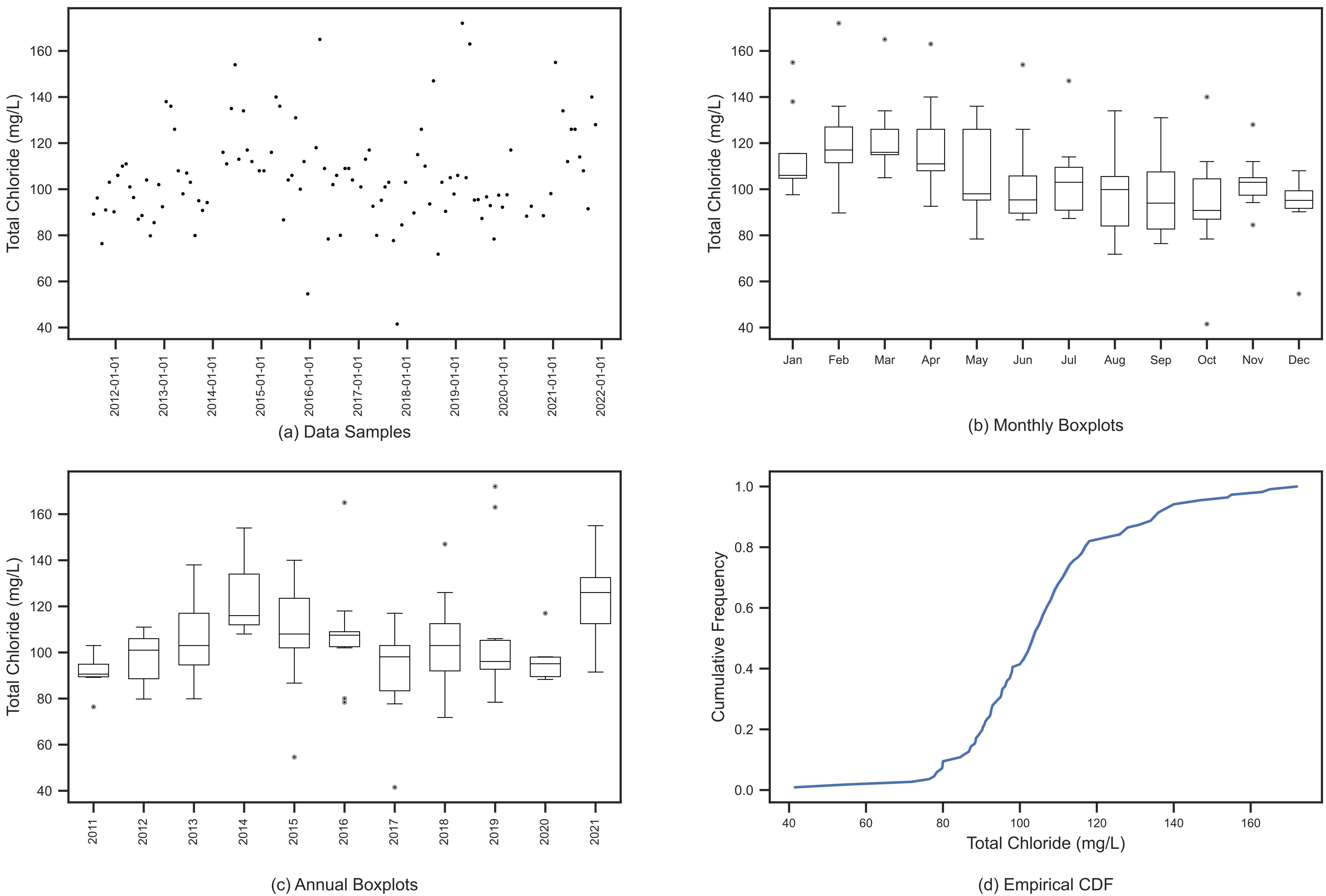


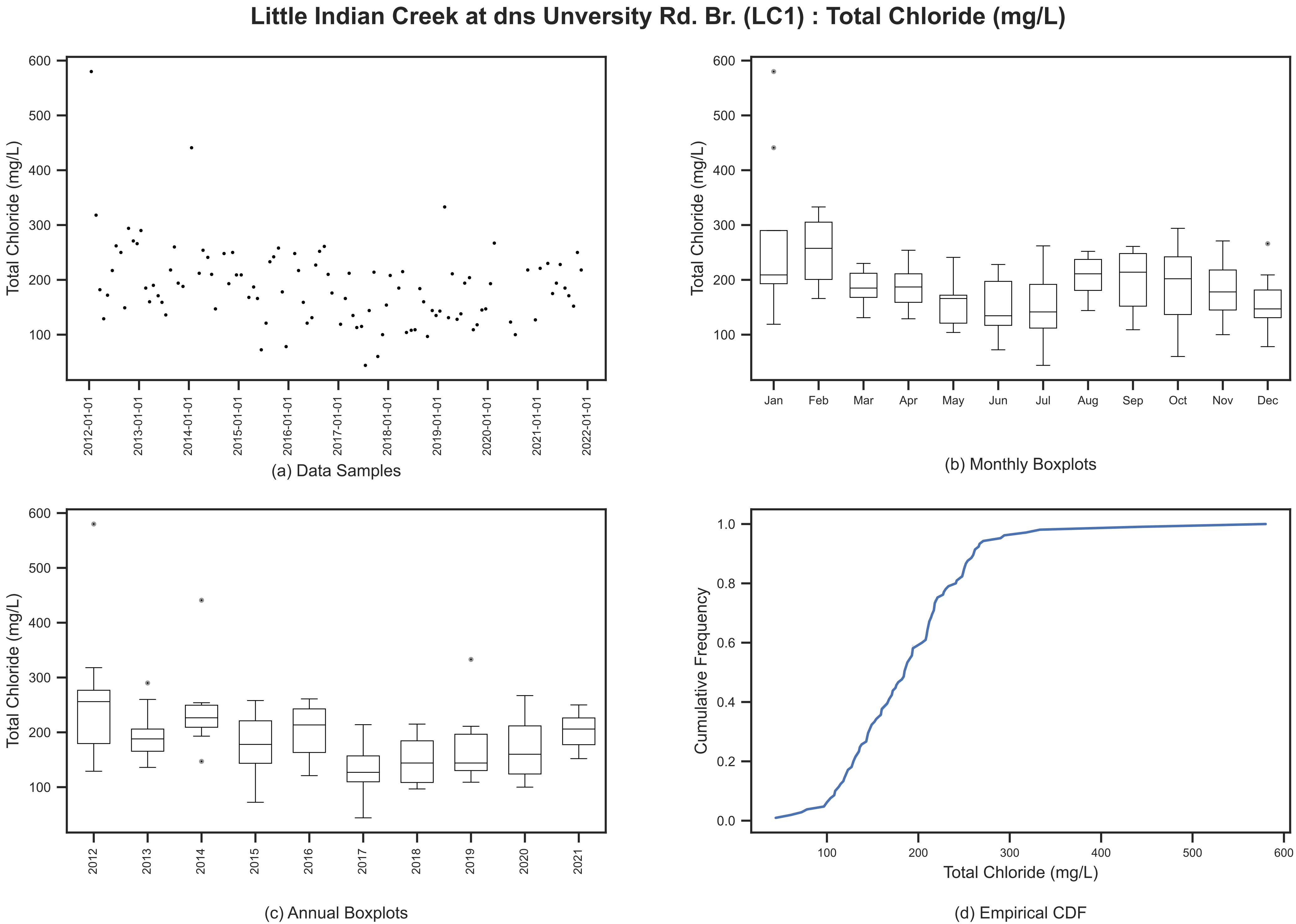
(c) Annual Boxplots



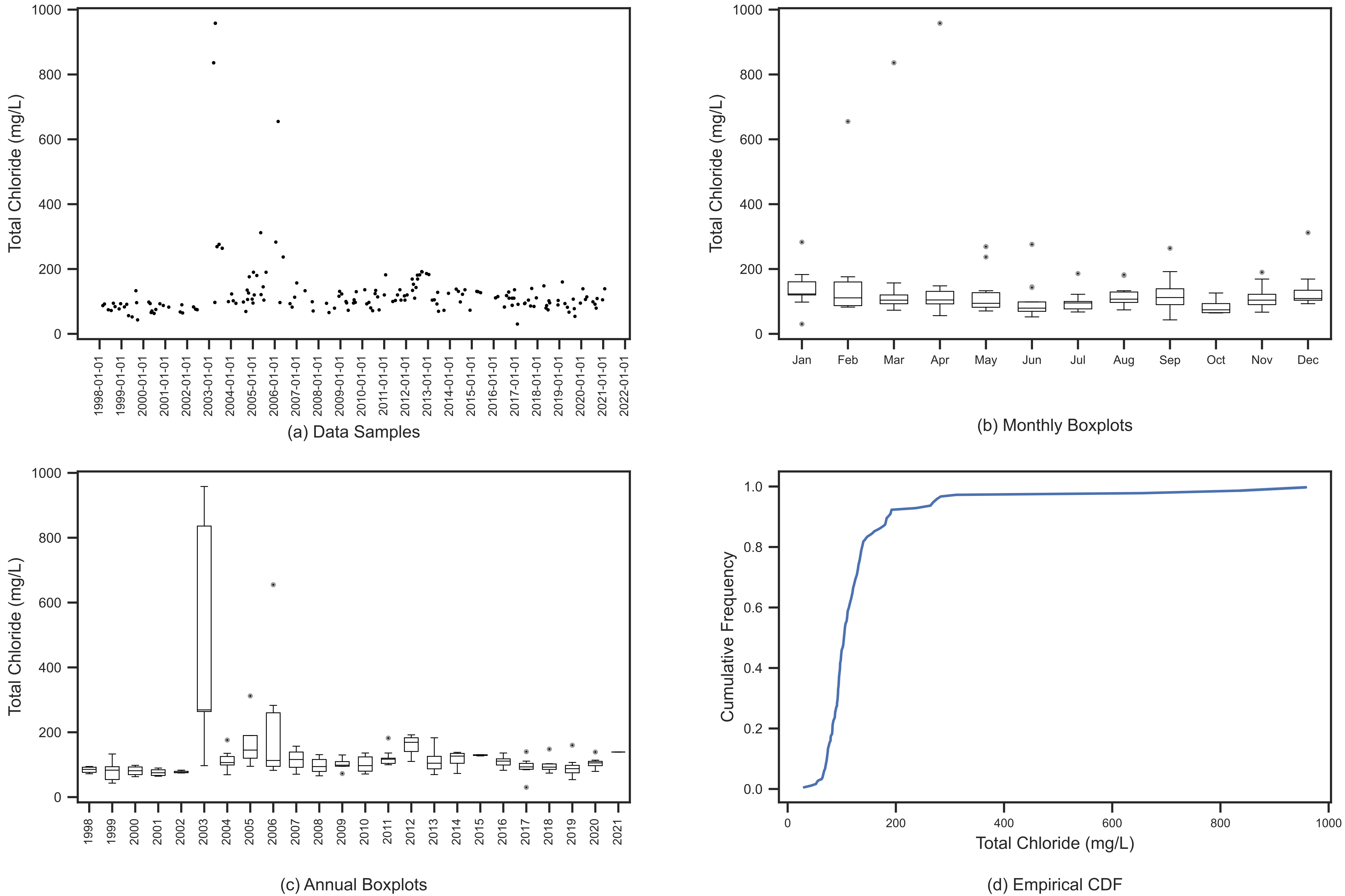
(d) Empirical CDF

Blackberry Creek near Yorkville Side Rd. (BC2) : Total Chloride (mg/L)



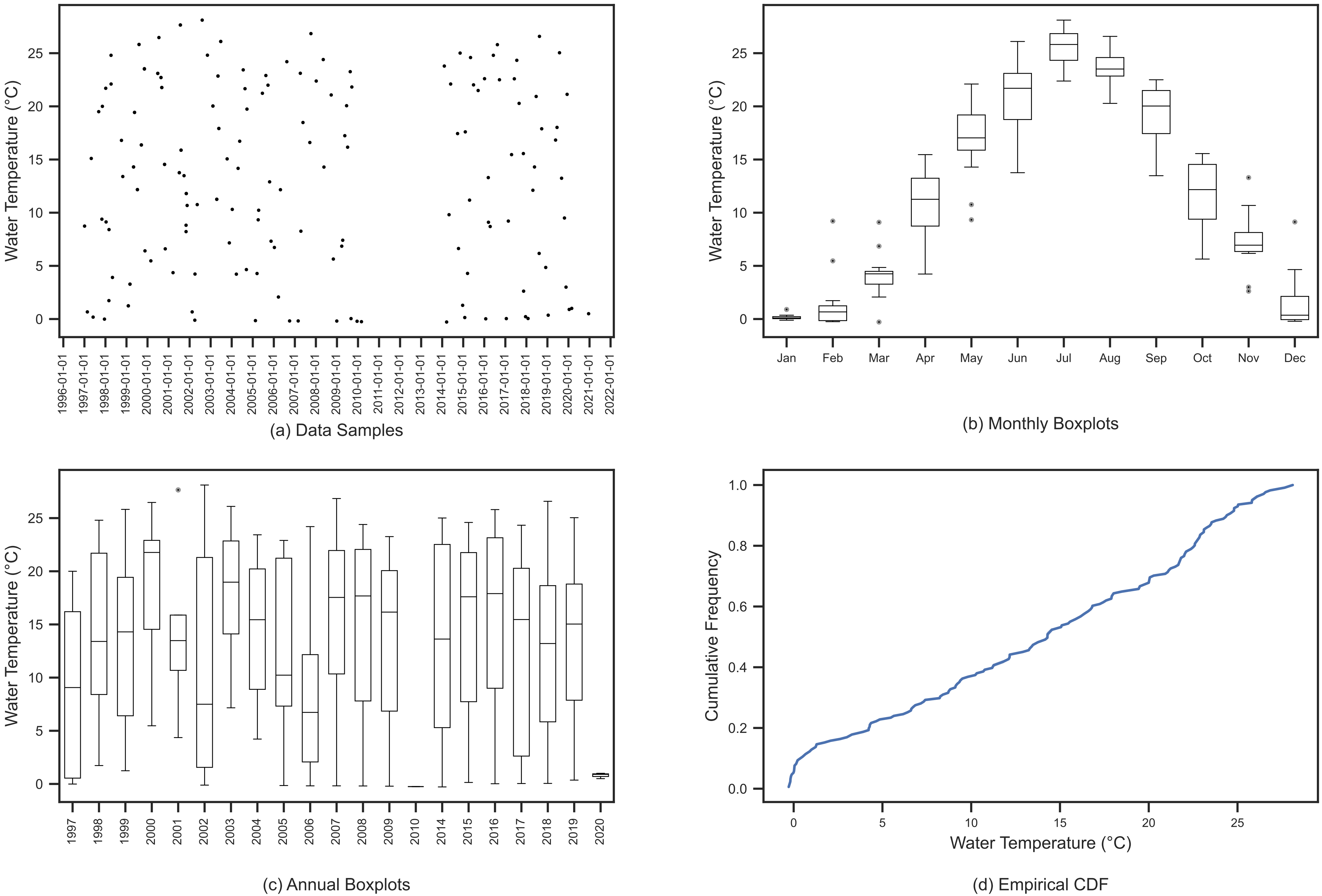

Little Indian Creek at dns Unversity Rd. Br. (LC1) : Total Chloride (mg/L)
Total Chloride (mg/L)
(a) Data Samples
(b) Monthly Boxplots
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(c) Annual Boxplots
Cumulative Frequency
(d) Empirical CDF

Fox River at Rt. 71 (FR14) : Total Chloride (mg/L)

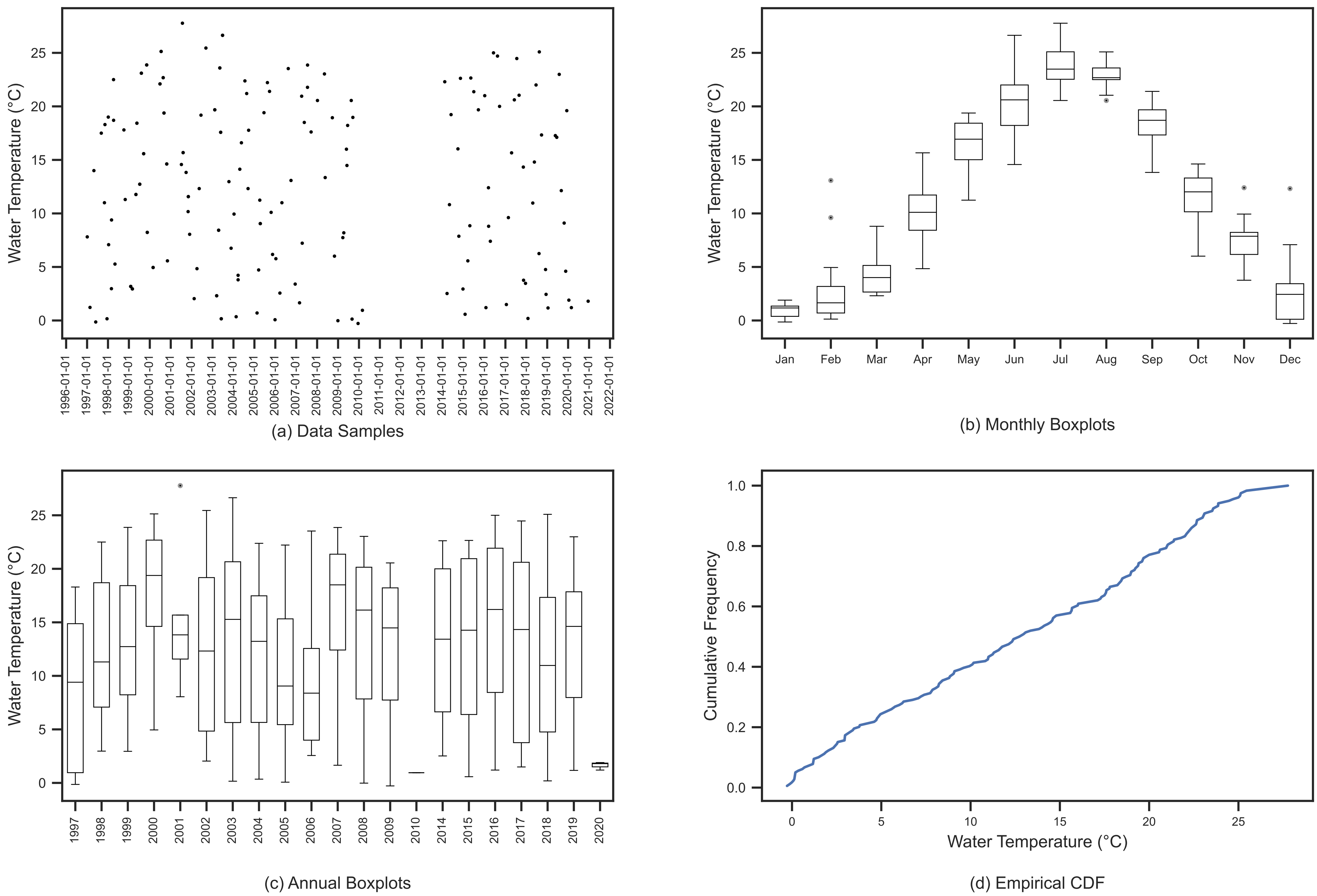


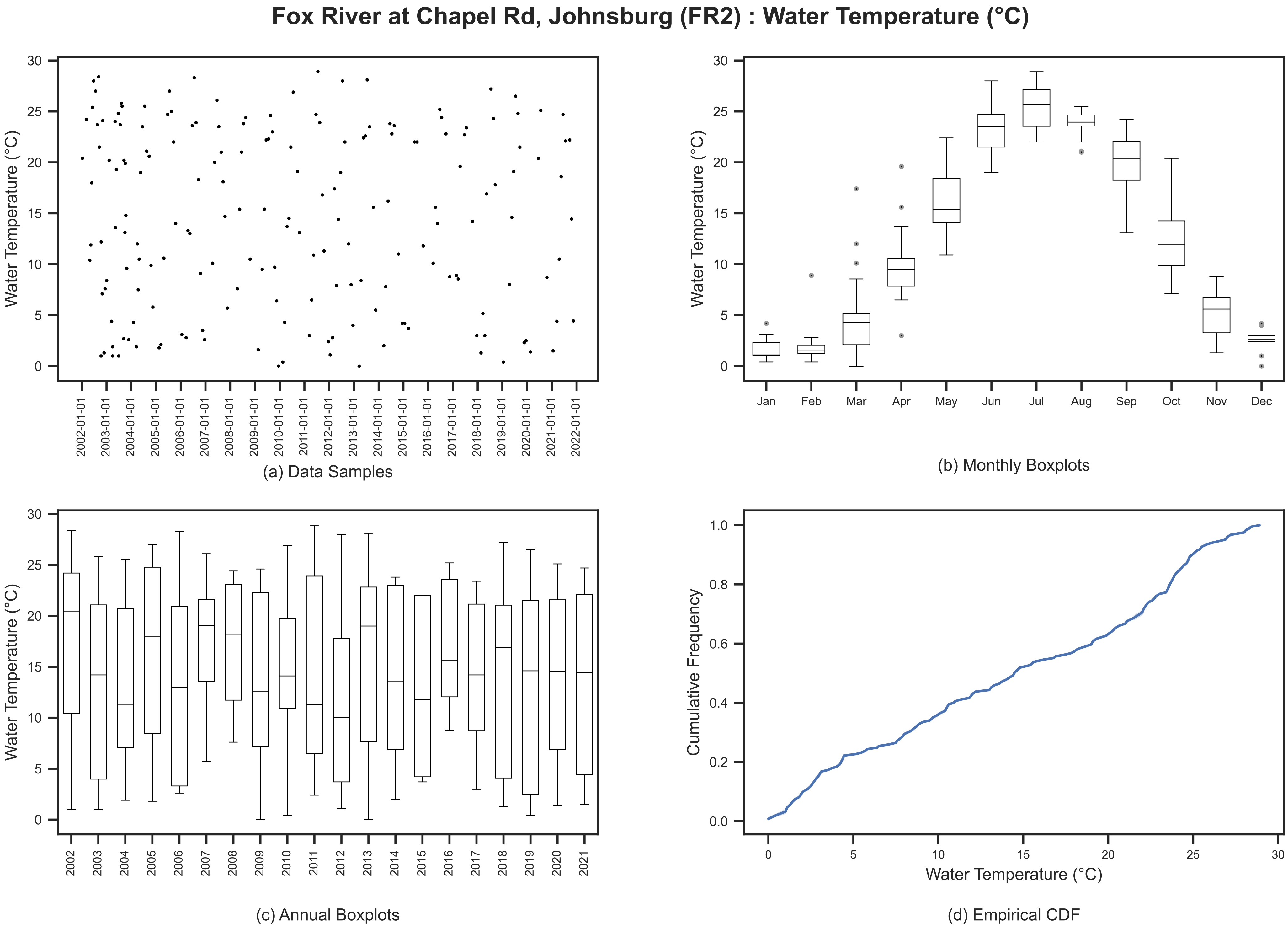
EDA Outputs for Water Temperature (^0C)

Fox River at Rt. 173 near Channel Lake (FR1) : Water Temperature (°C)

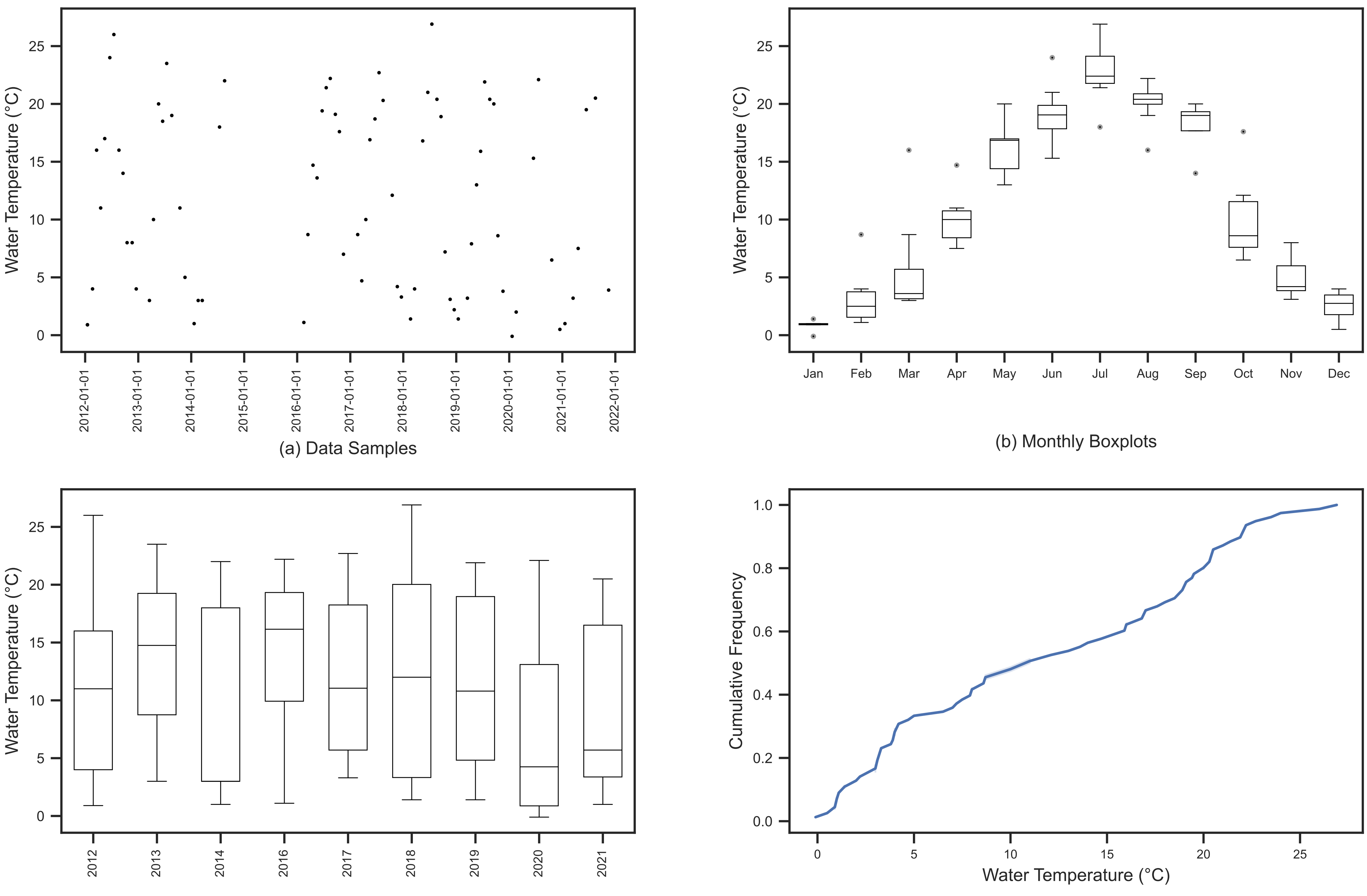


Nippersink Creek near Spring Grove (NC1) : Water Temperature (°C)




Fox River at Chapel Rd, Johnsburg (FR2) : Water Temperature (°C)
Water Temperature (°C)
(a) Data Samples
(b) Monthly Boxplots
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(c) Annual Boxplots
Cumulative Frequency
Water Temperature (°C)
(d) Empirical CDF

Sleepy Hollow Creek at Stilling Ln. (SH1) : Water Temperature (°C)



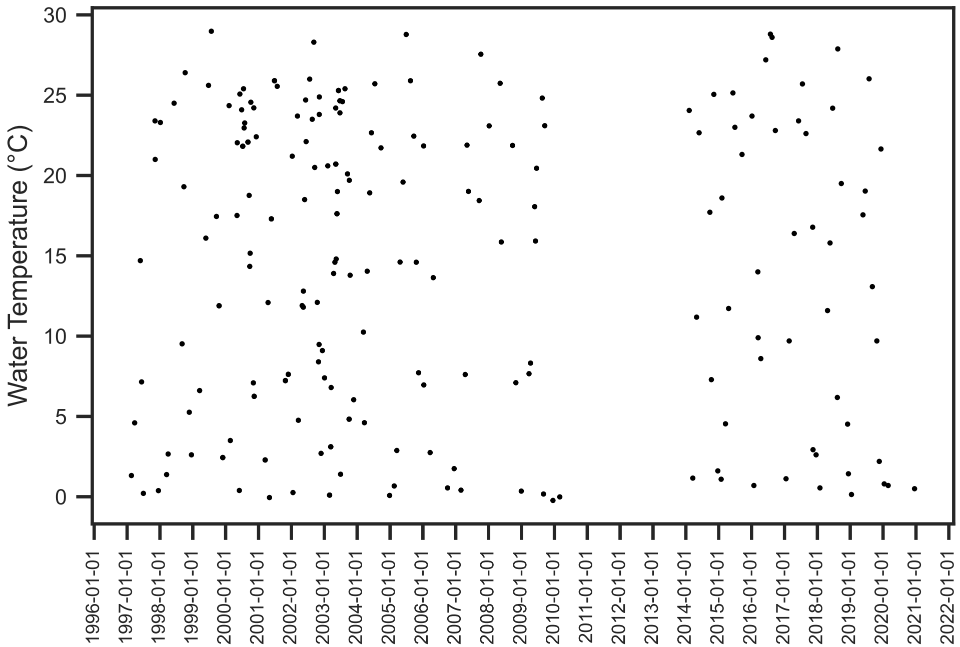
(a) Data Samples

(b) Monthly Boxplots

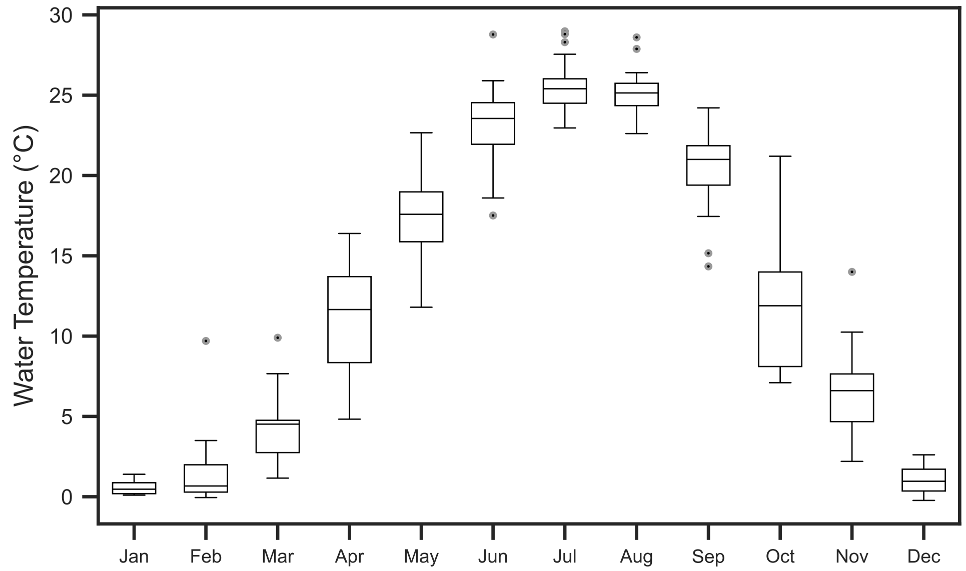
(c) Annual Boxplots

(d) Empirical CDF

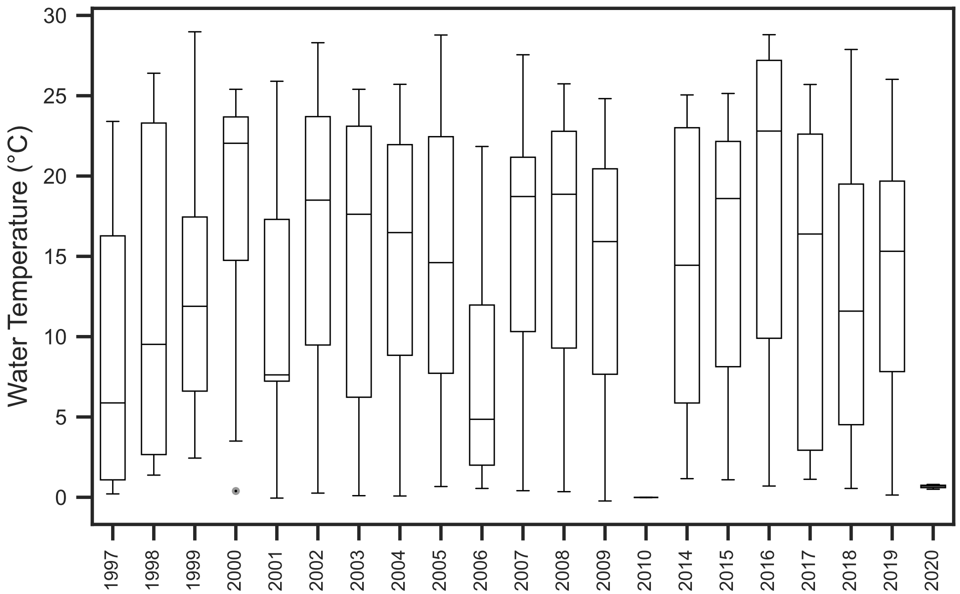
Fox River at Burtons Br. (FR3) : Water Temperature (°C)



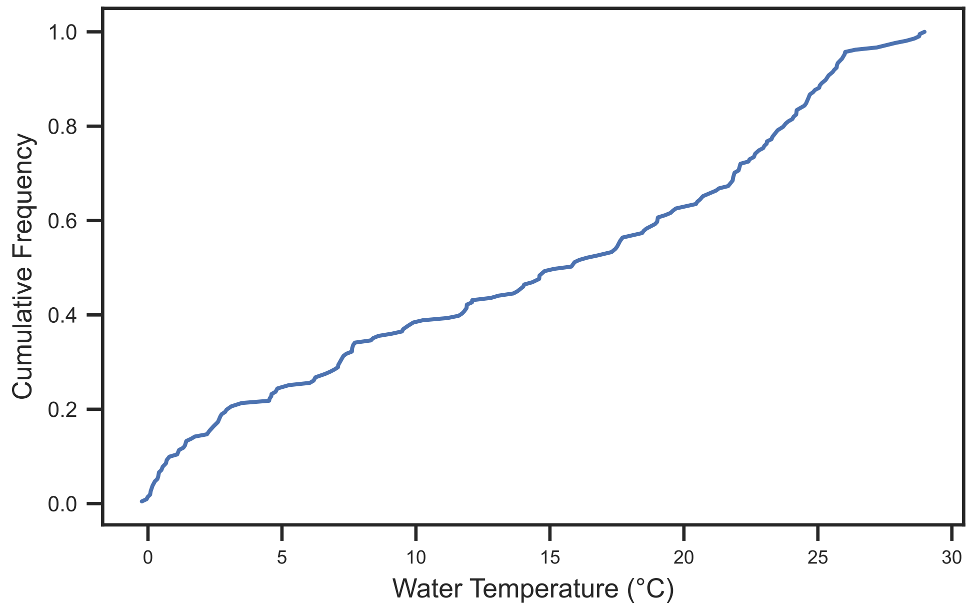
(a) Data Samples



(b) Monthly Boxplots

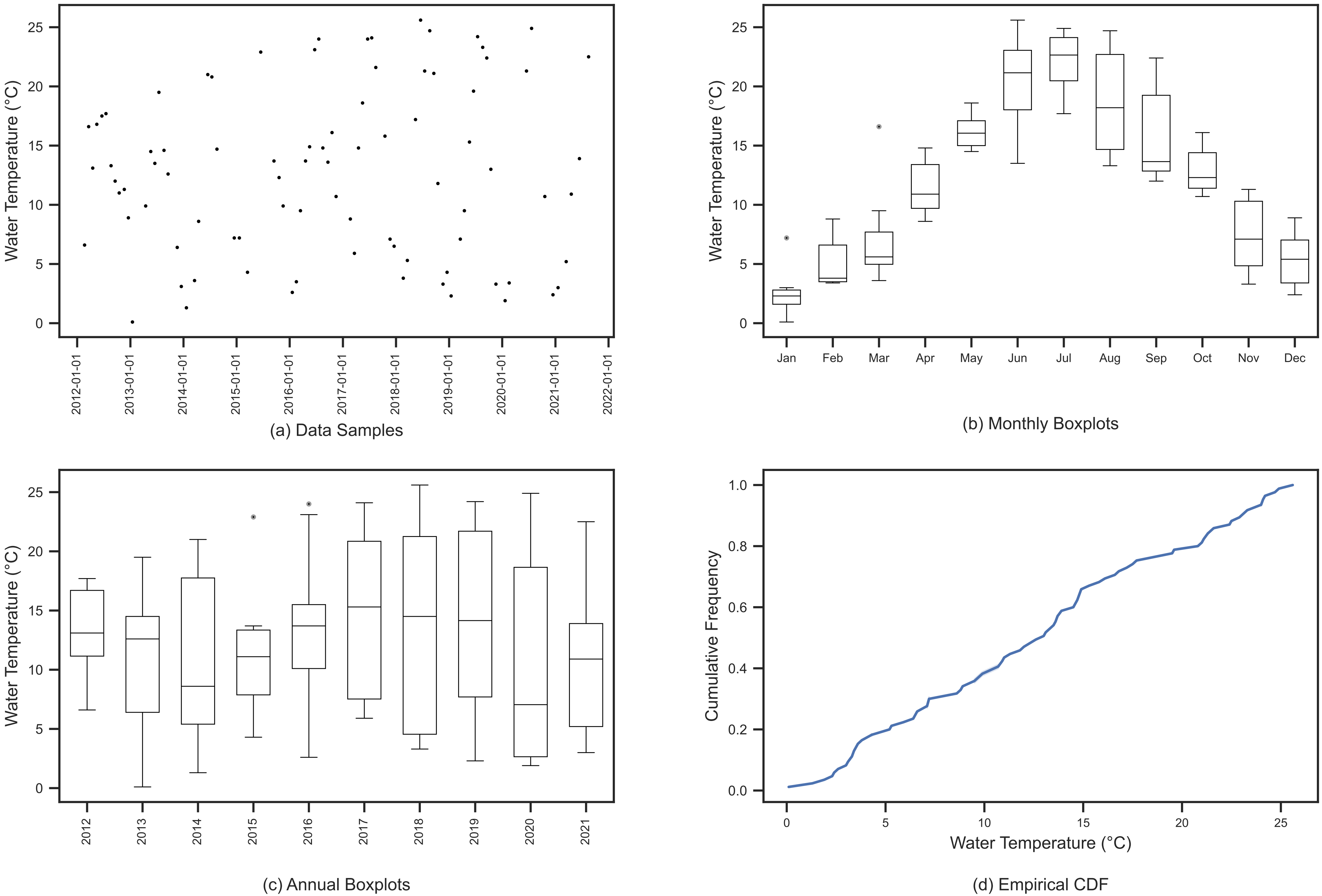


(c) Annual Boxplots

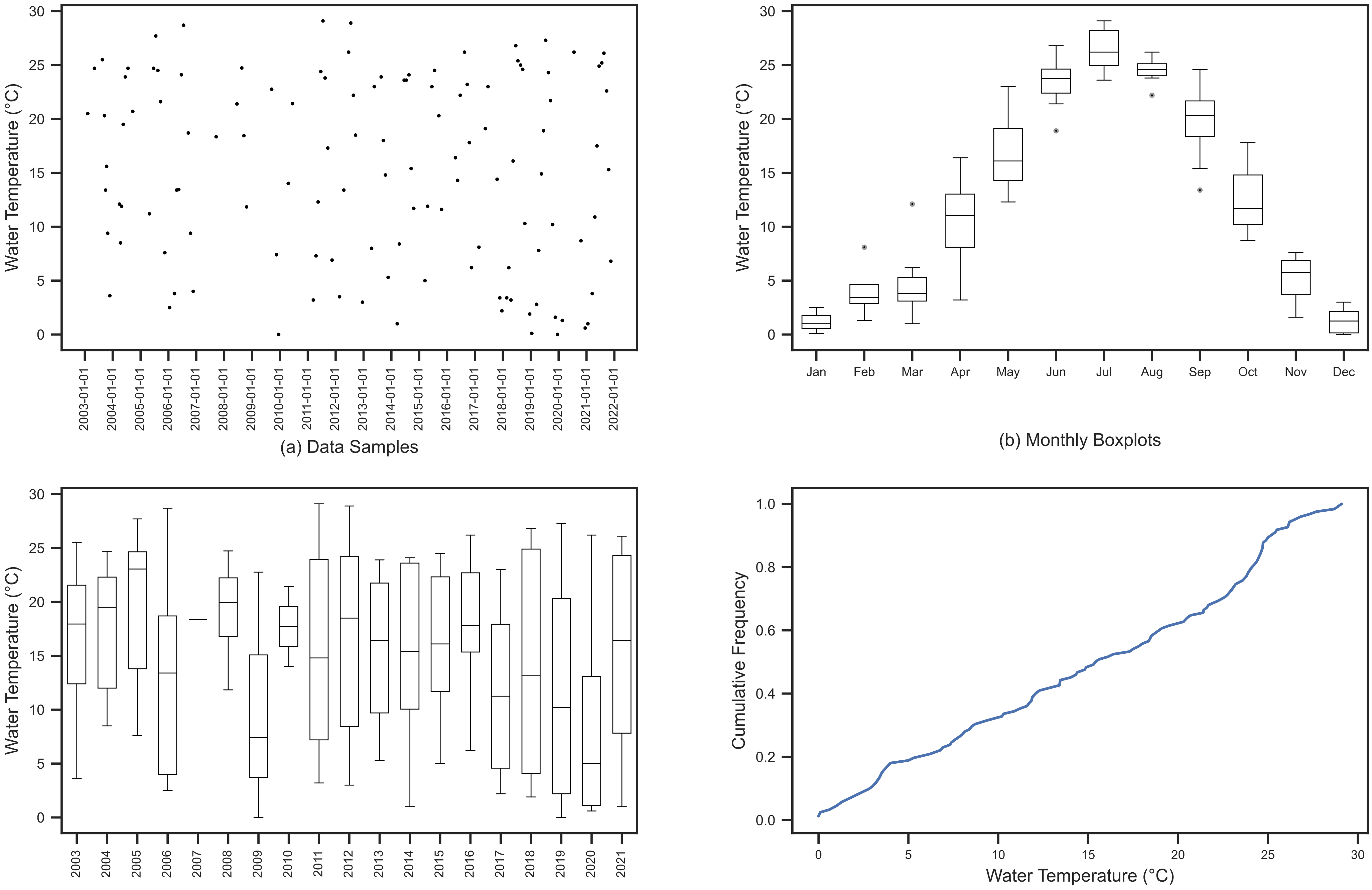


(d) Empirical CDF

Silver Creek at Lk shore Dr. & E. Park Ln. (SC1) : Water Temperature (°C)



Fox River at Rawson Rd., E Oakwood Hills (FR4) : Water Temperature (°C)



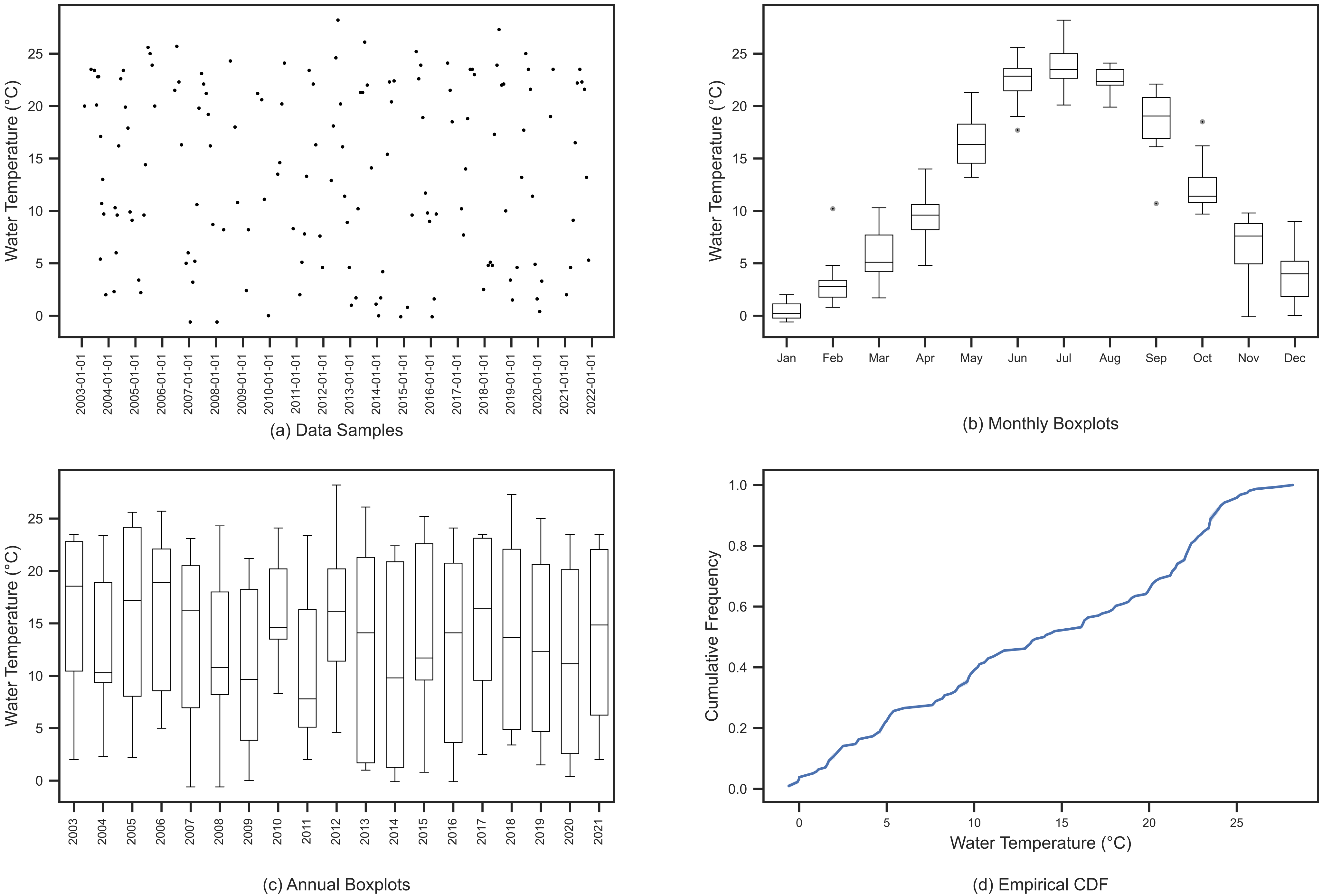
(a) Data Samples

(b) Monthly Boxplots

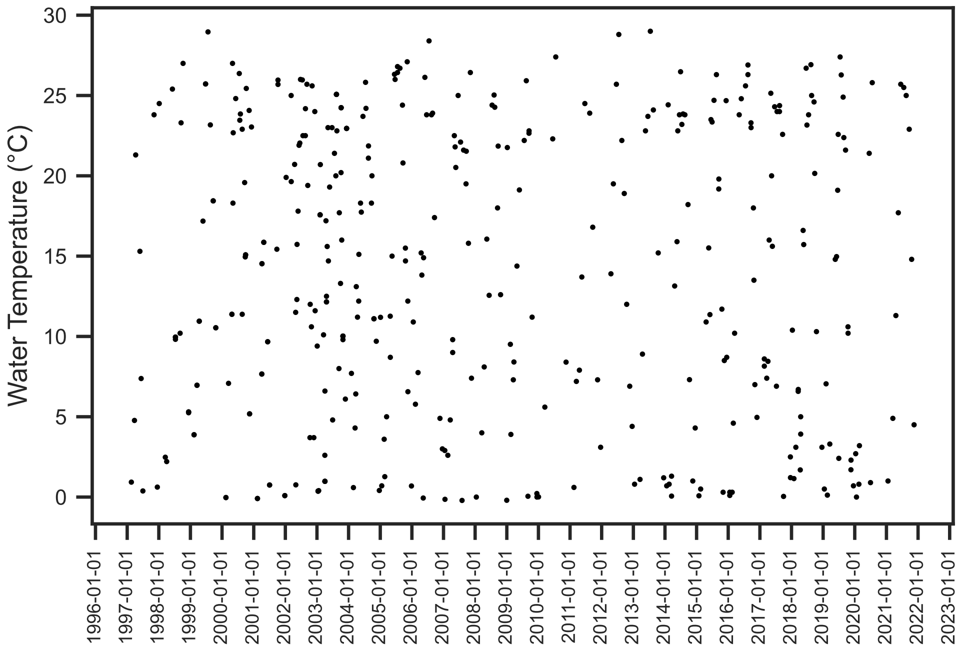
(c) Annual Boxplots

(d) Empirical CDF

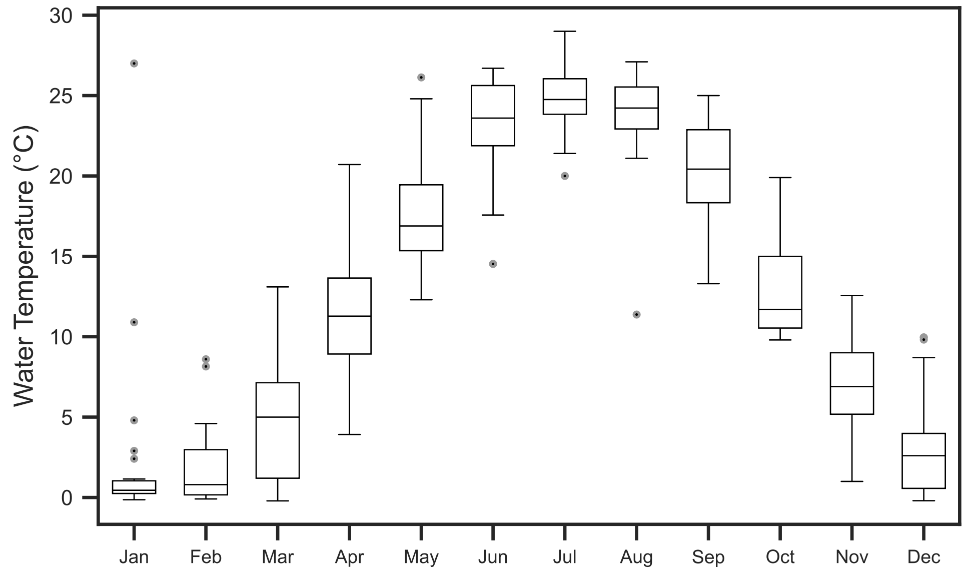
Crystal Lk Outlet-Rt 31, Algonquin (CL1) : Water Temperature (°C)



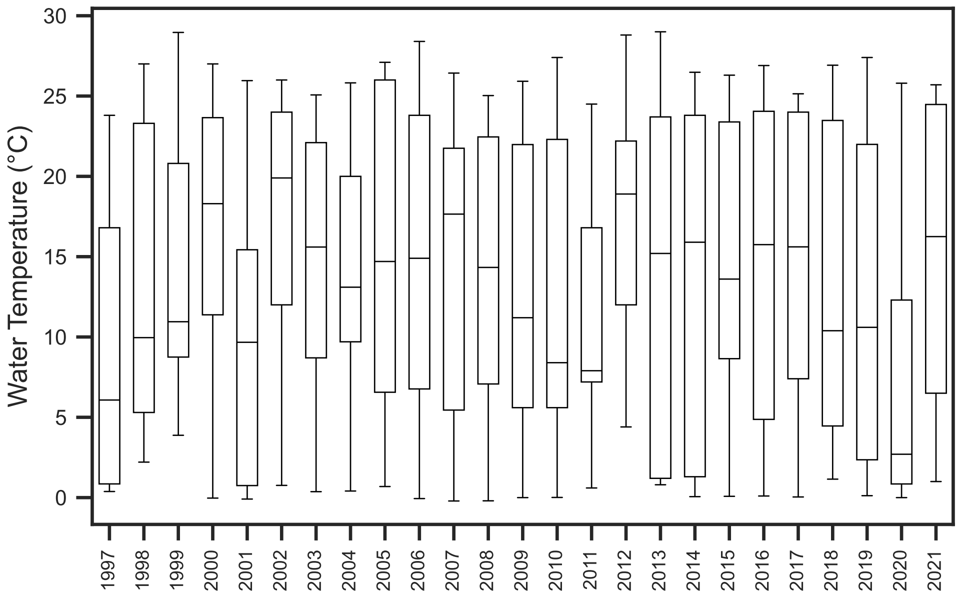
Fox River at Algonquin (FR5) : Water Temperature (°C)



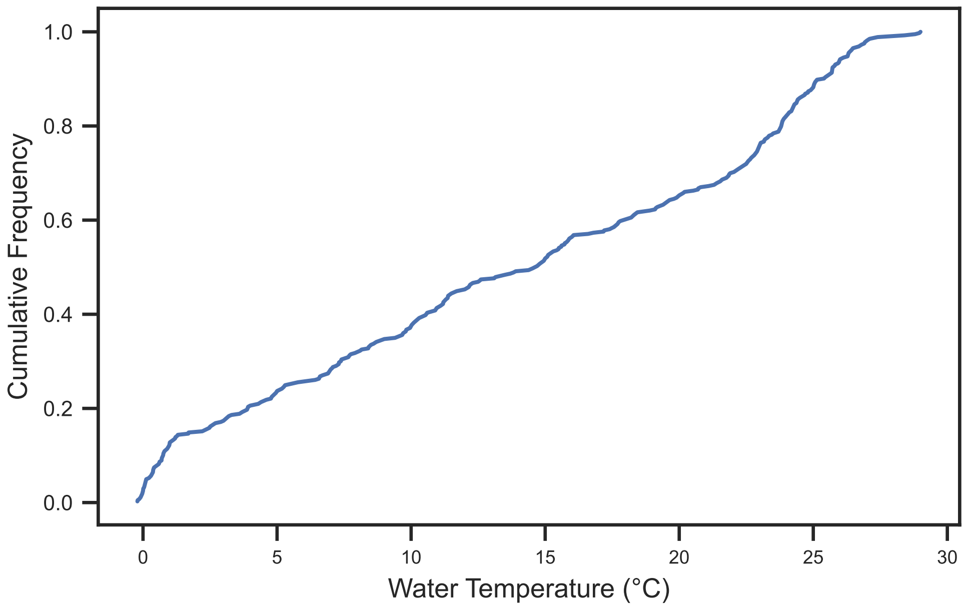
(a) Data Samples



(b) Monthly Boxplots

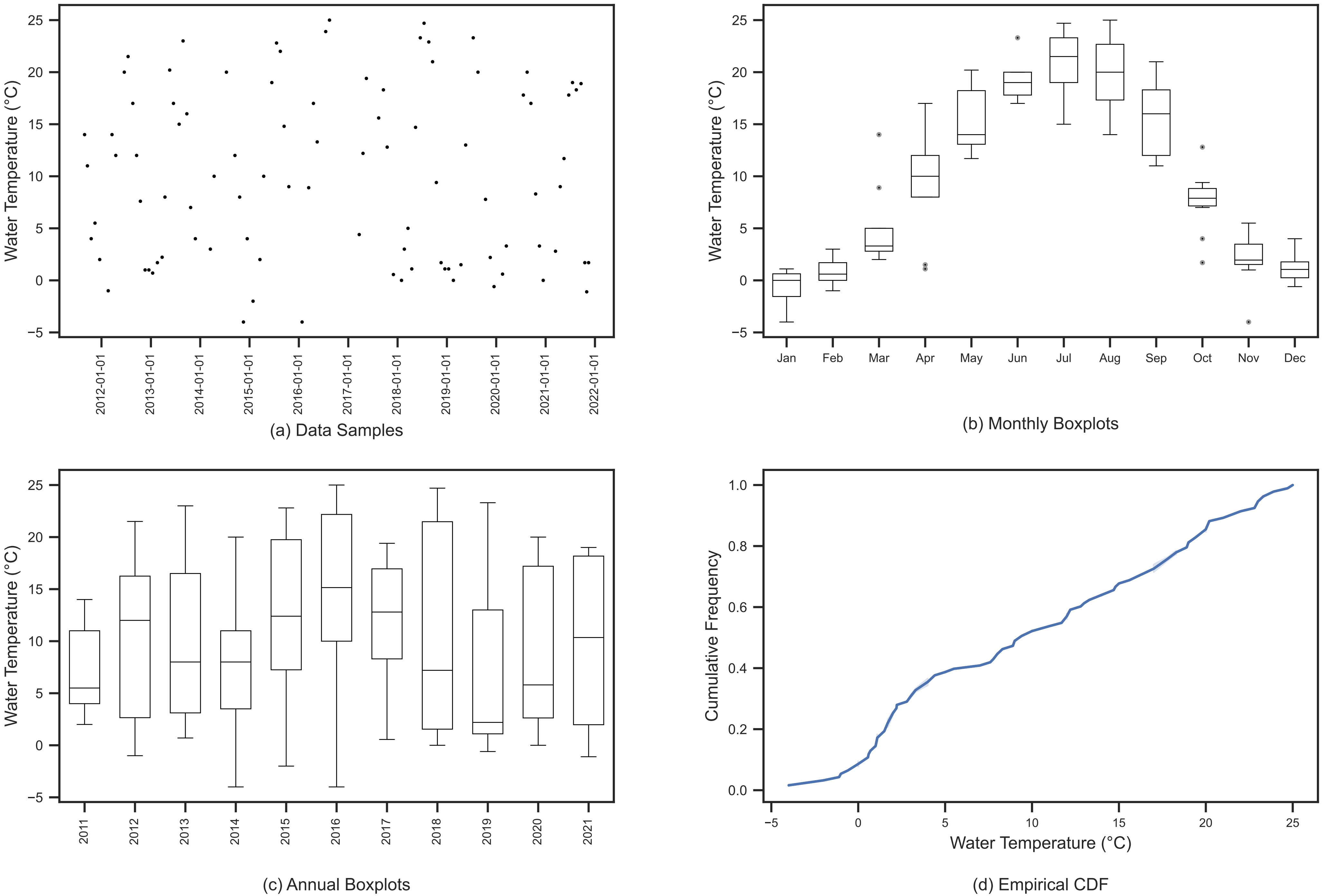


(c) Annual Boxplots

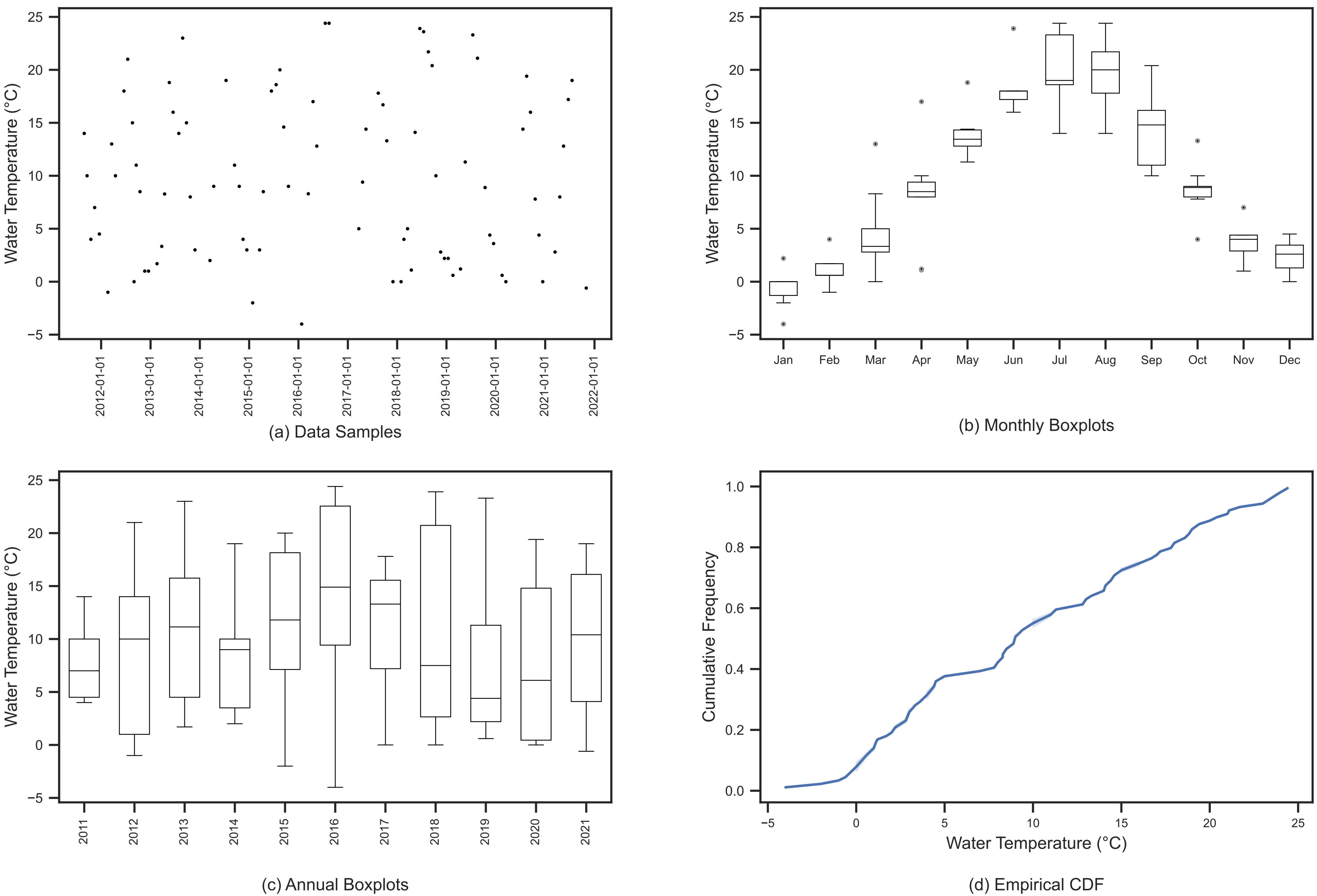


(d) Empirical CDF

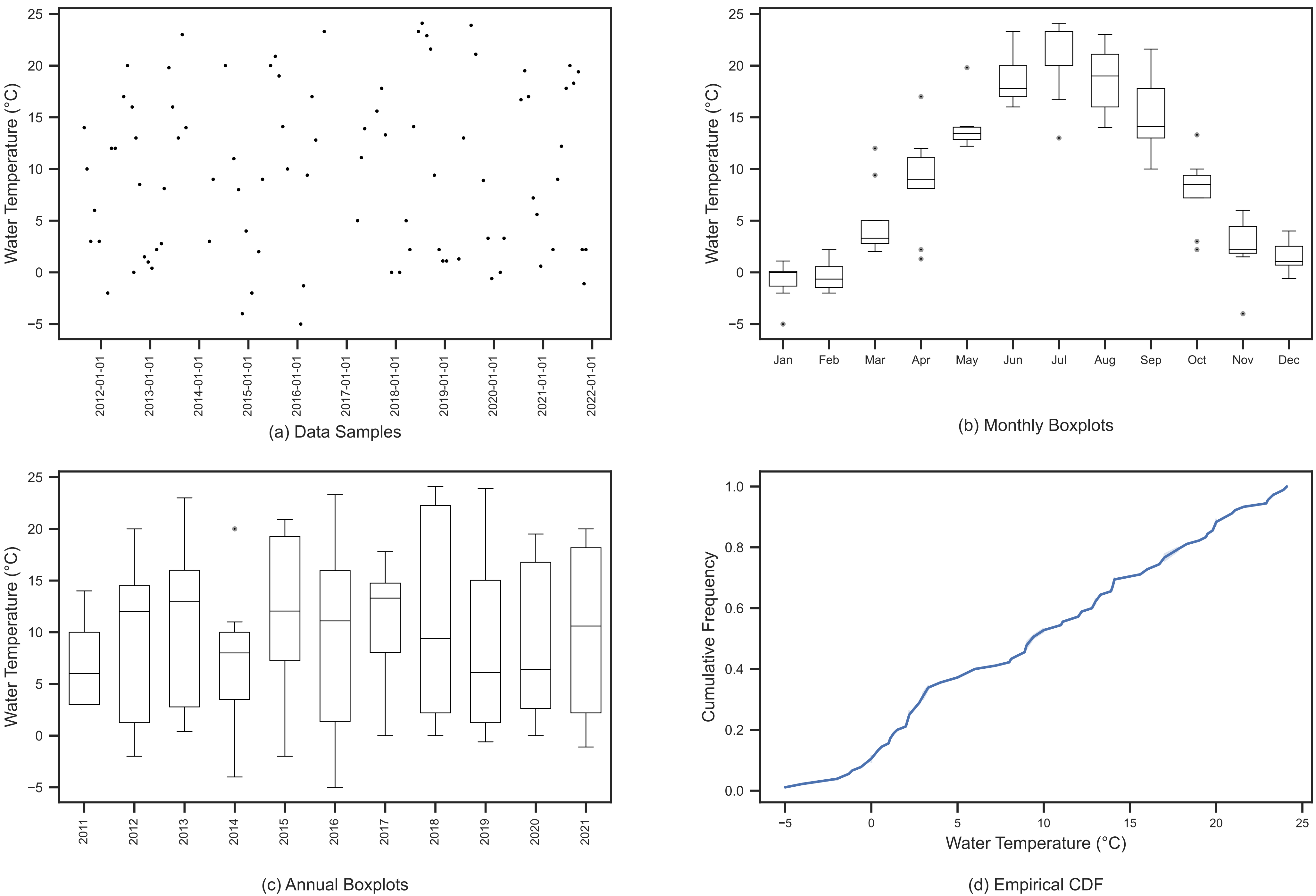
Tyler Creek at Damisch (TC1) : Water Temperature (°C)



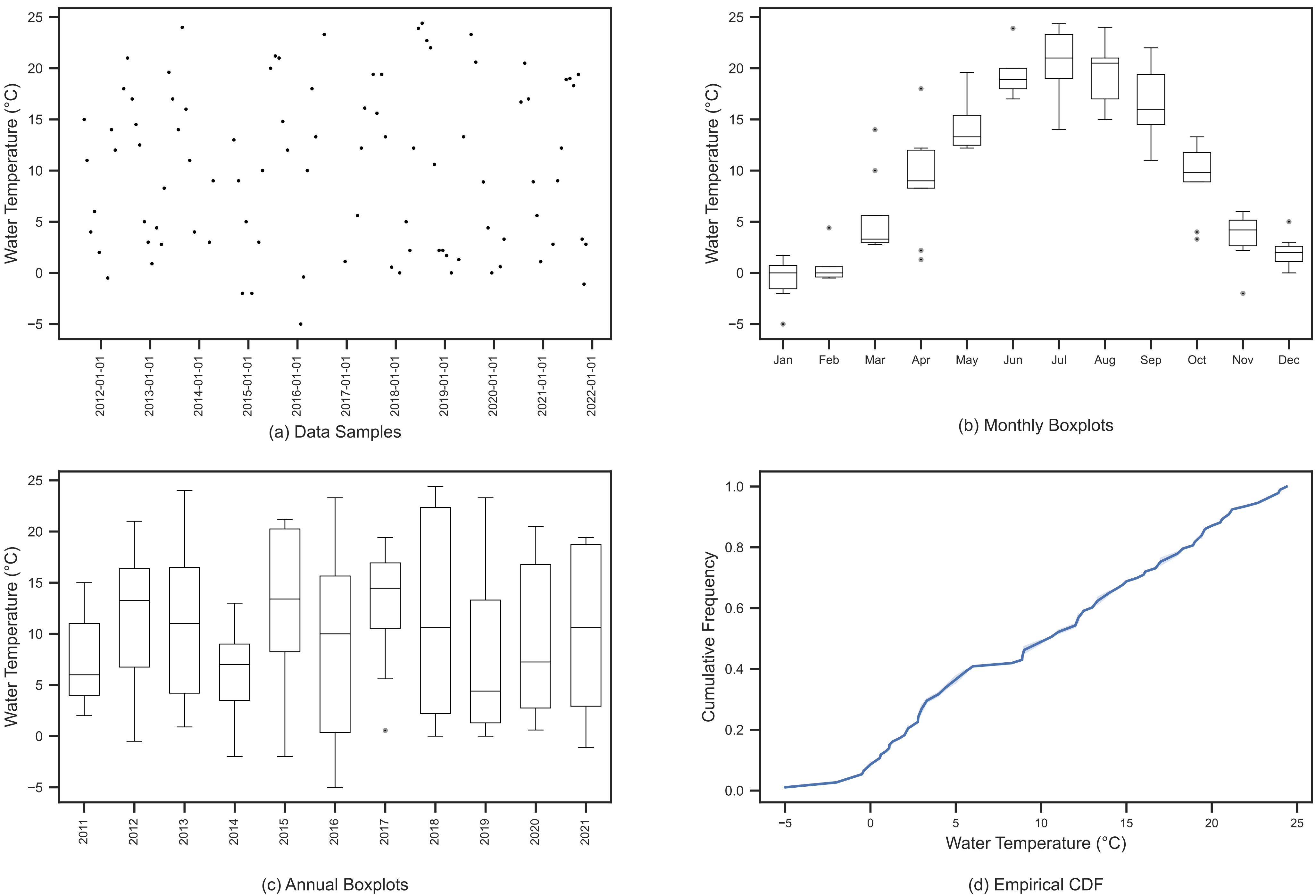
Tyler Creek at Highland (TC2) : Water Temperature (°C)



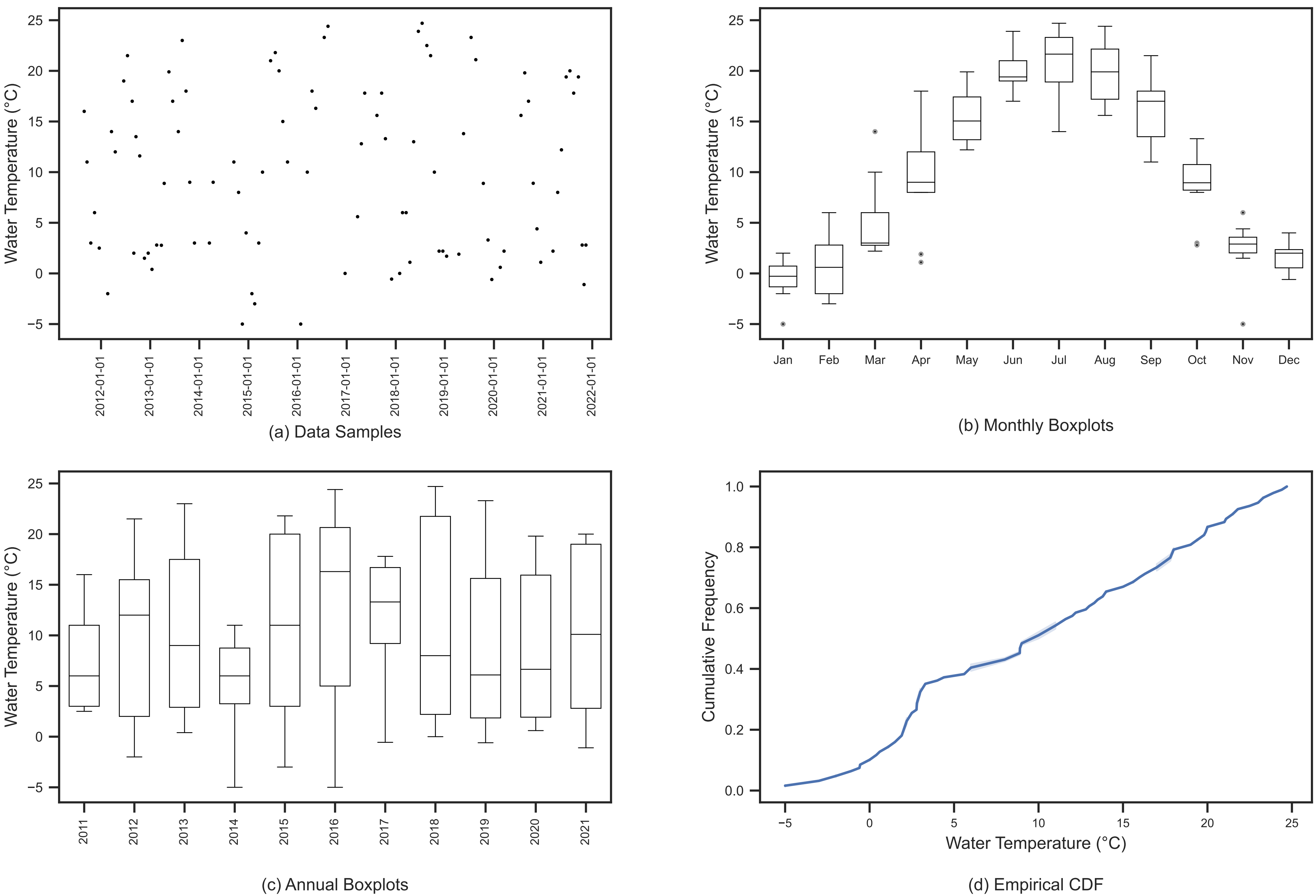
Tyler Creek at McCornack (TC3) : Water Temperature (°C)



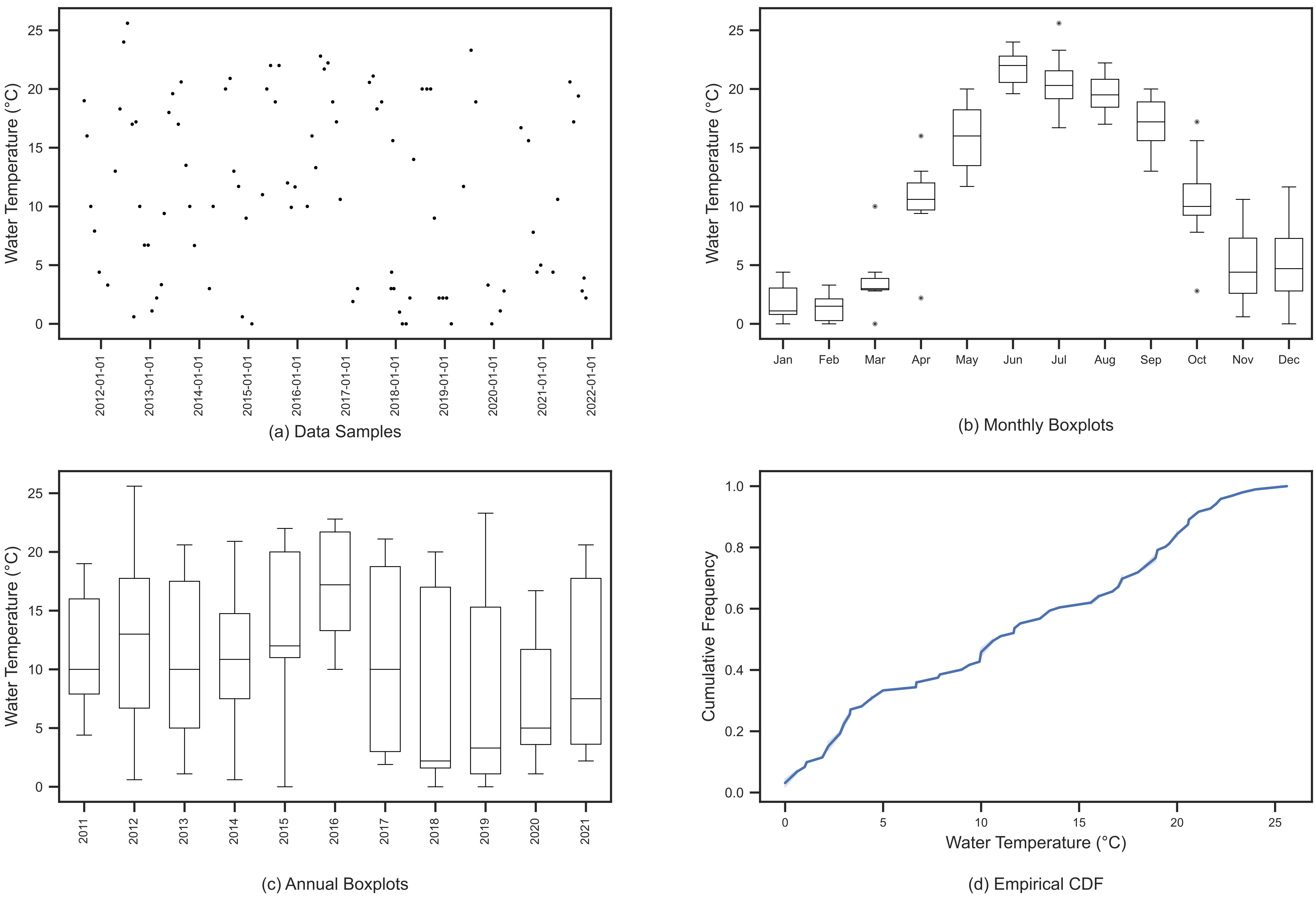
Tyler Creek at Timber Trail (TC4) : Water Temperature (°C)



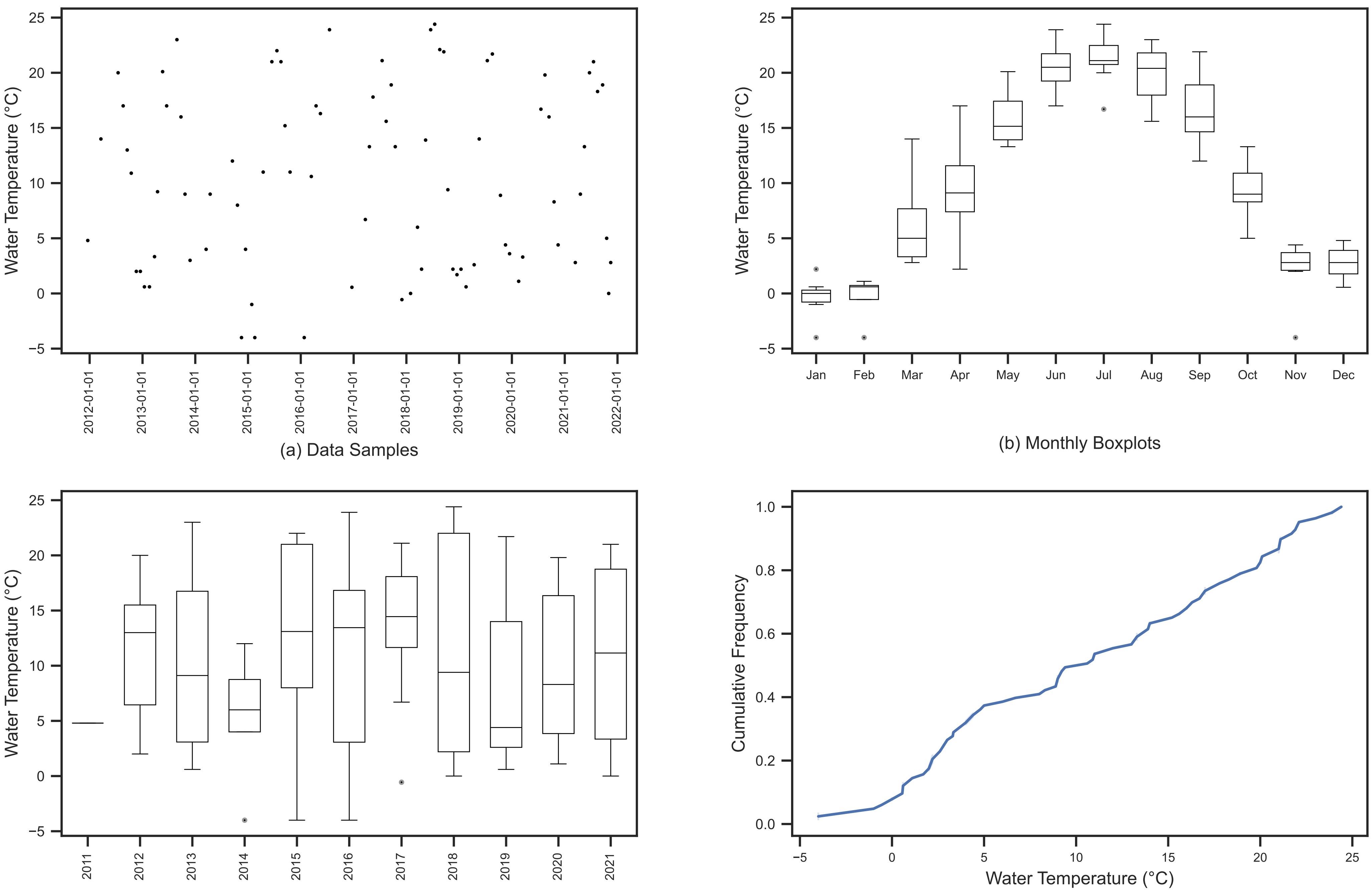
Tyler Creek at Old Randall (TC5) : Water Temperature (°C)



Tyler Creek at Spring Cove (TC6) : Water Temperature (°C)



Tyler Creek at Judson (TC7) : Water Temperature (°C)



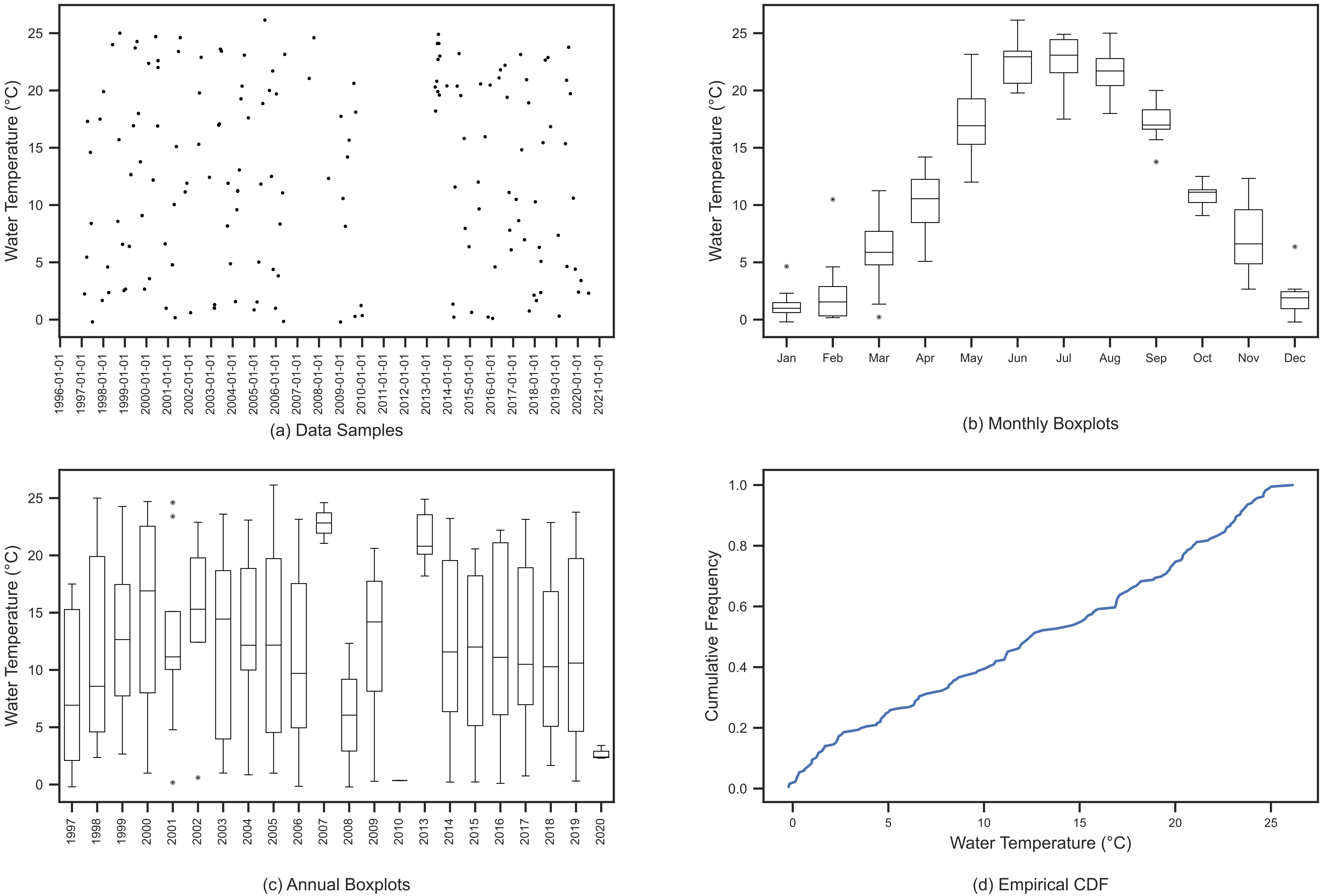
(a) Data Samples

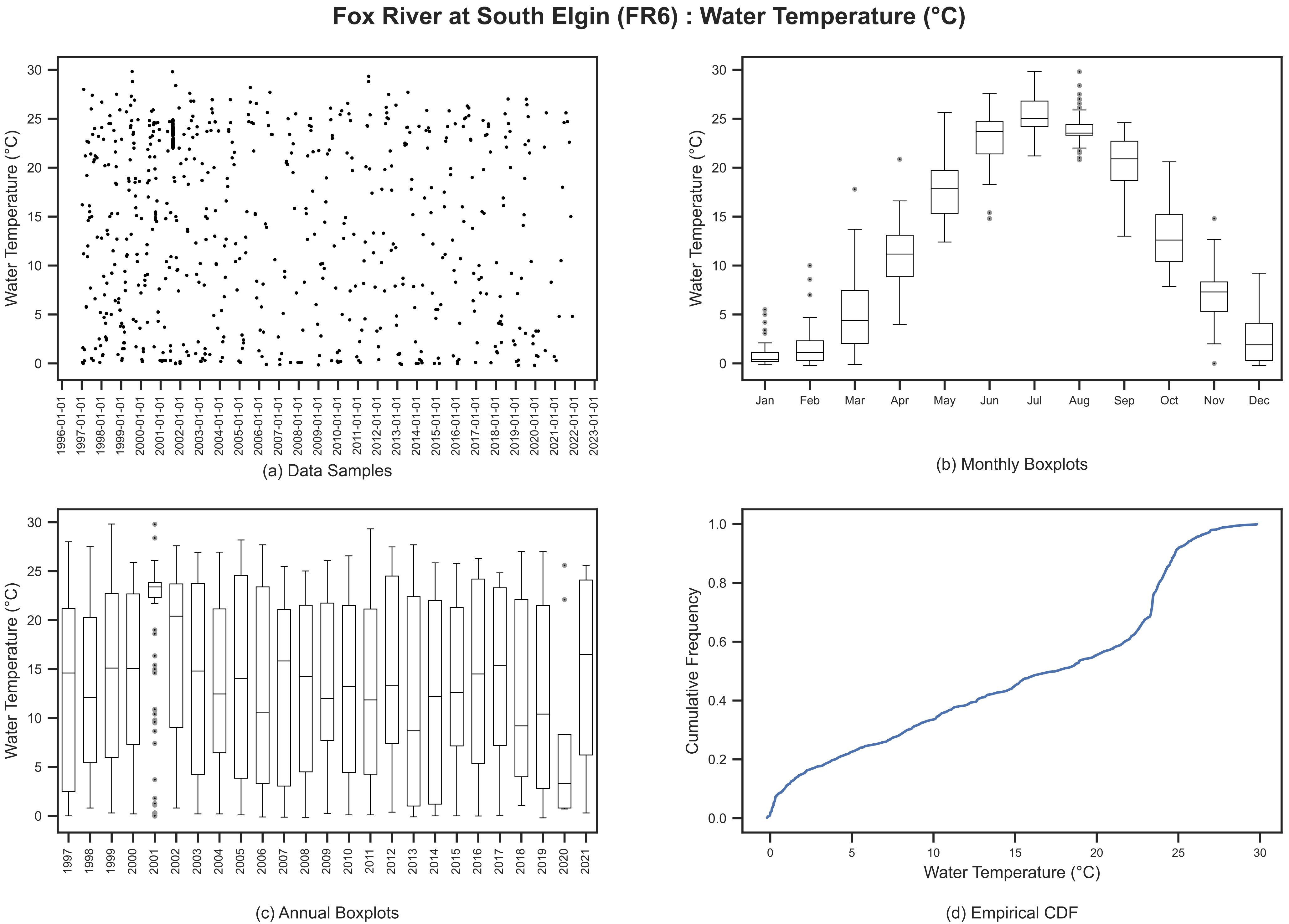
(b) Monthly Boxplots

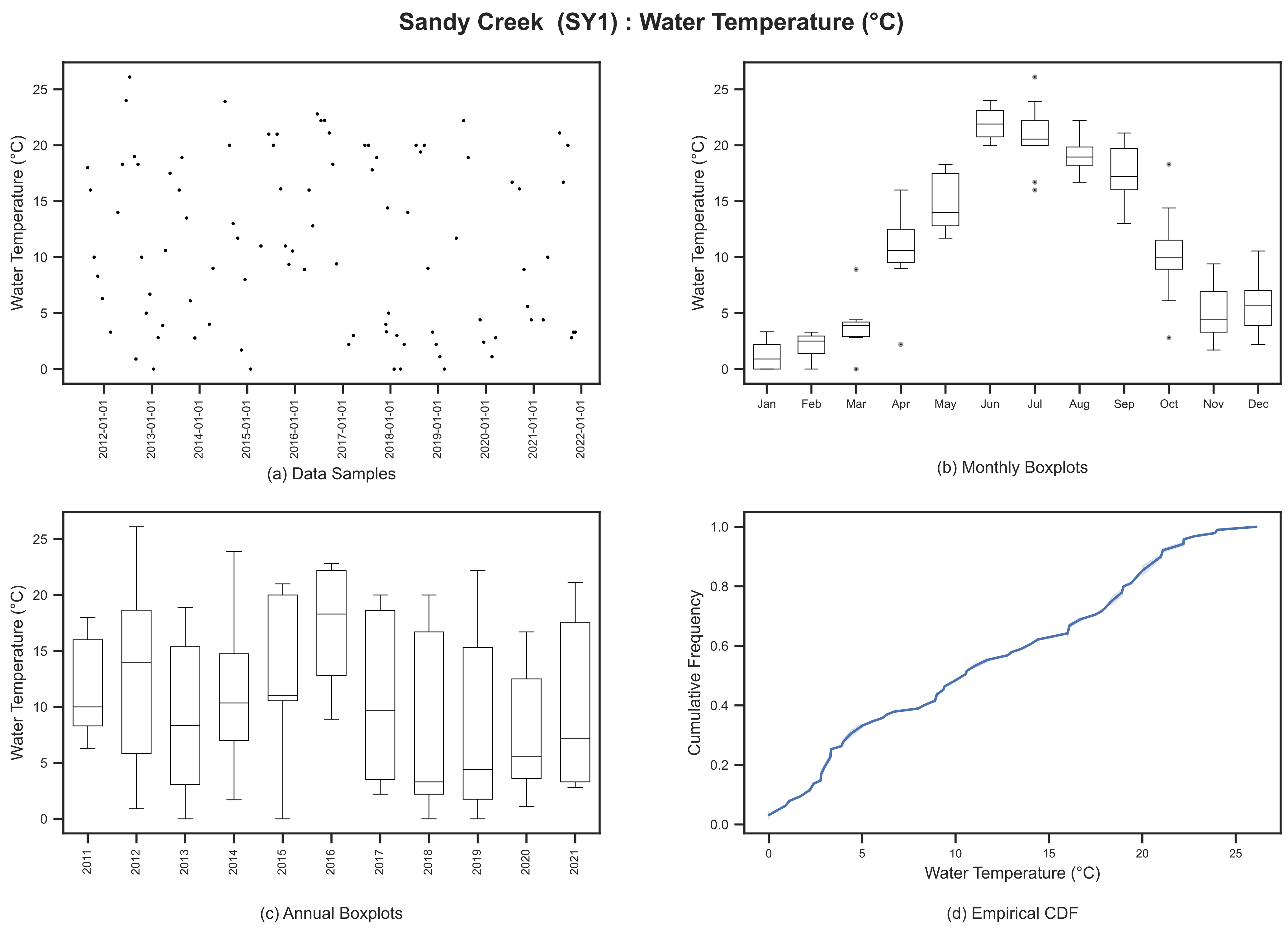
(c) Annual Boxplots

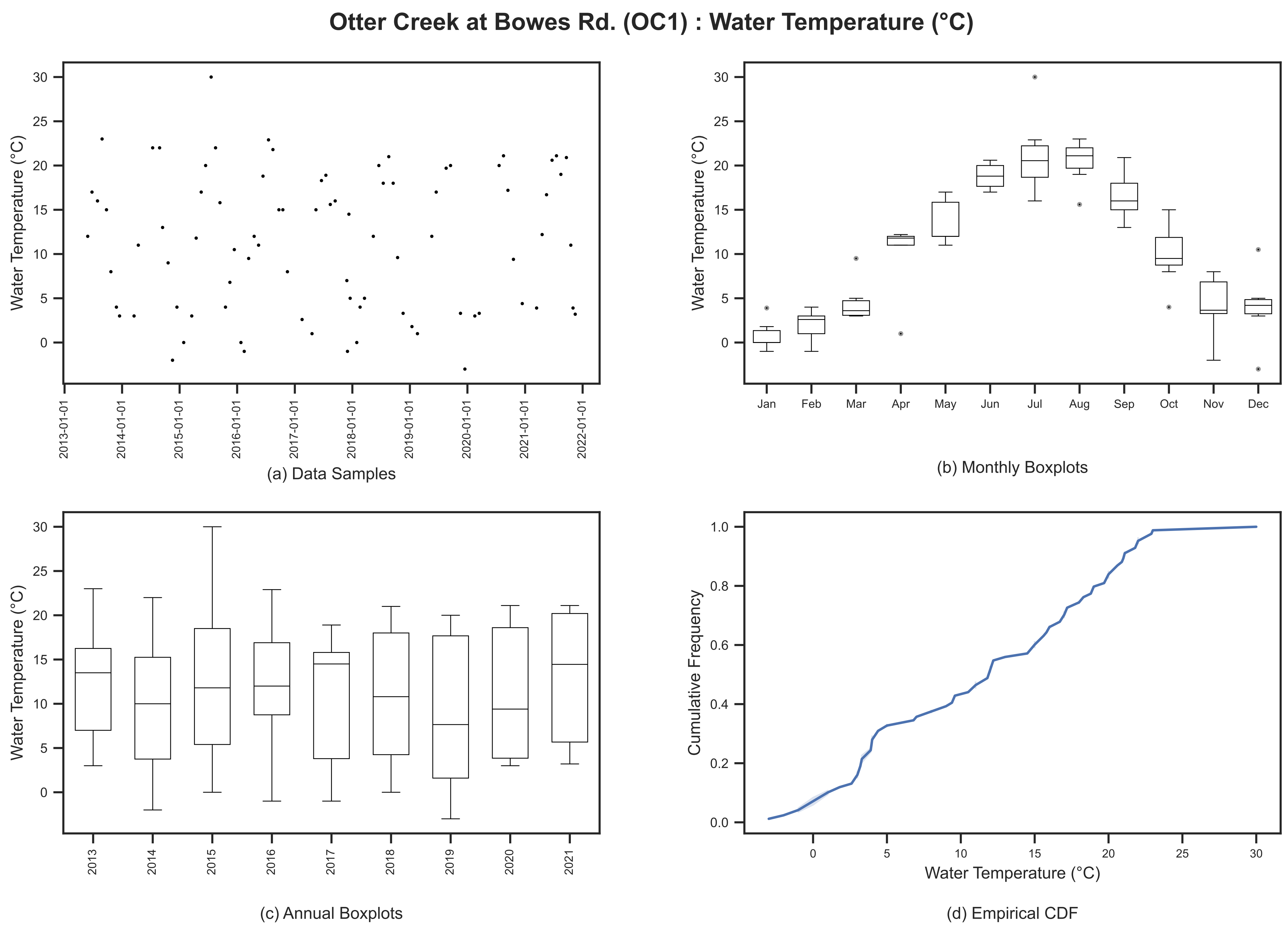
(d) Empirical CDF

Poplar Creek at Elgin (PC1) : Water Temperature (°C)

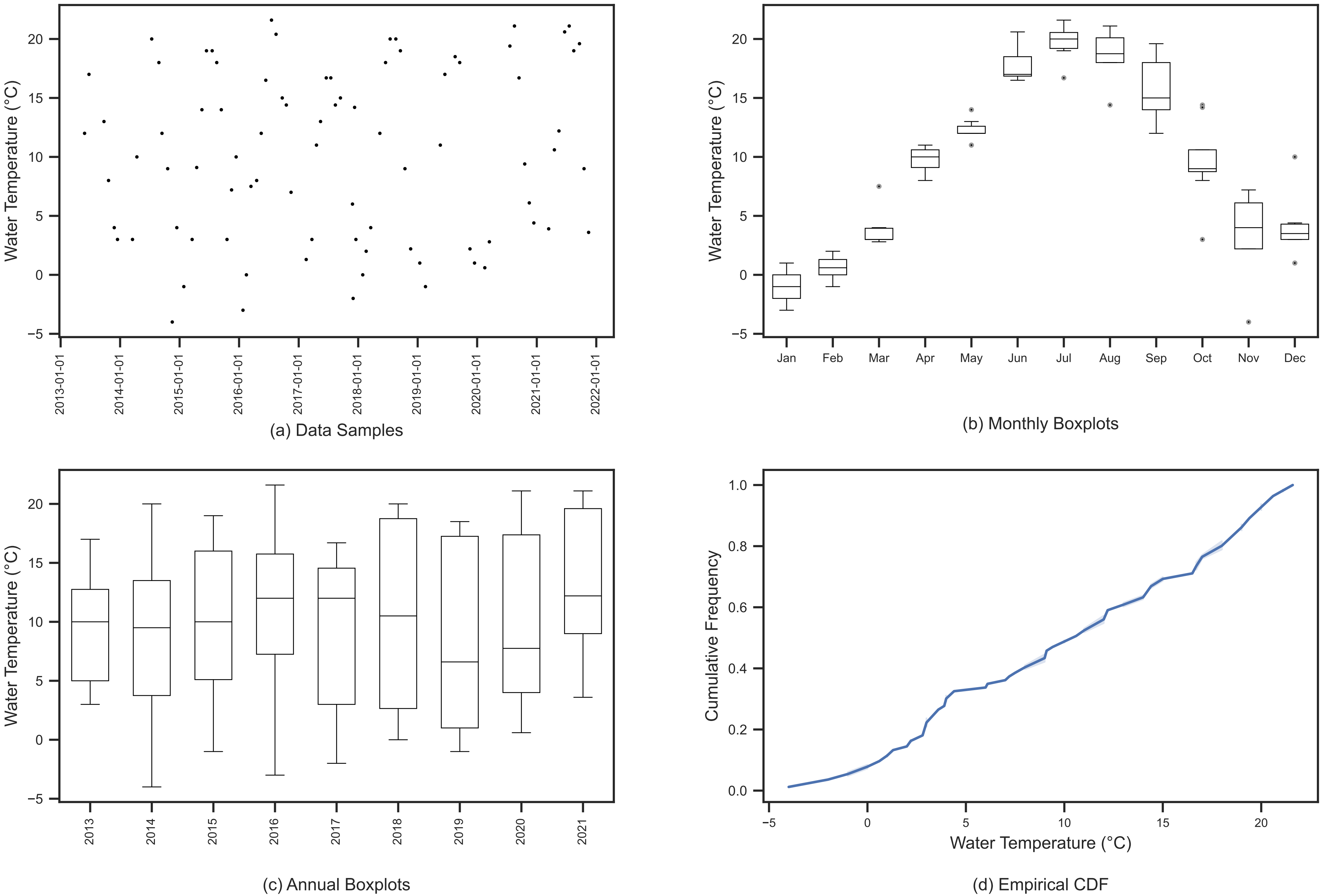



Fox River at South Elgin (FR6) : Water Temperature (°C)
Water Temperature (°C)
(a) Data Samples
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(b) Monthly Boxplots
(c) Annual Boxplots
Cumulative Frequency
Water Temperature (°C)
(d) Empirical CDF


Sandy Creek (SY1) : Water Temperature (°C)
Water Temperature (°C)
(a) Data Samples
(b) Monthly Boxplots
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(c) Annual Boxplots
Cumulative Frequency
Water Temperature (°C)
(d) Empirical CDF


Otter Creek at Bowes Rd. (OC1) : Water Temperature (°C)
Water Temperature (°C)
(a) Data Samples
(b) Monthly Boxplots
(c) Annual Boxplots
Cumulative Frequency
Water Temperature (°C)
(d) Empirical CDF

Fitchie Creek at Bowes Rd. (FT1) : Water Temperature (°C)



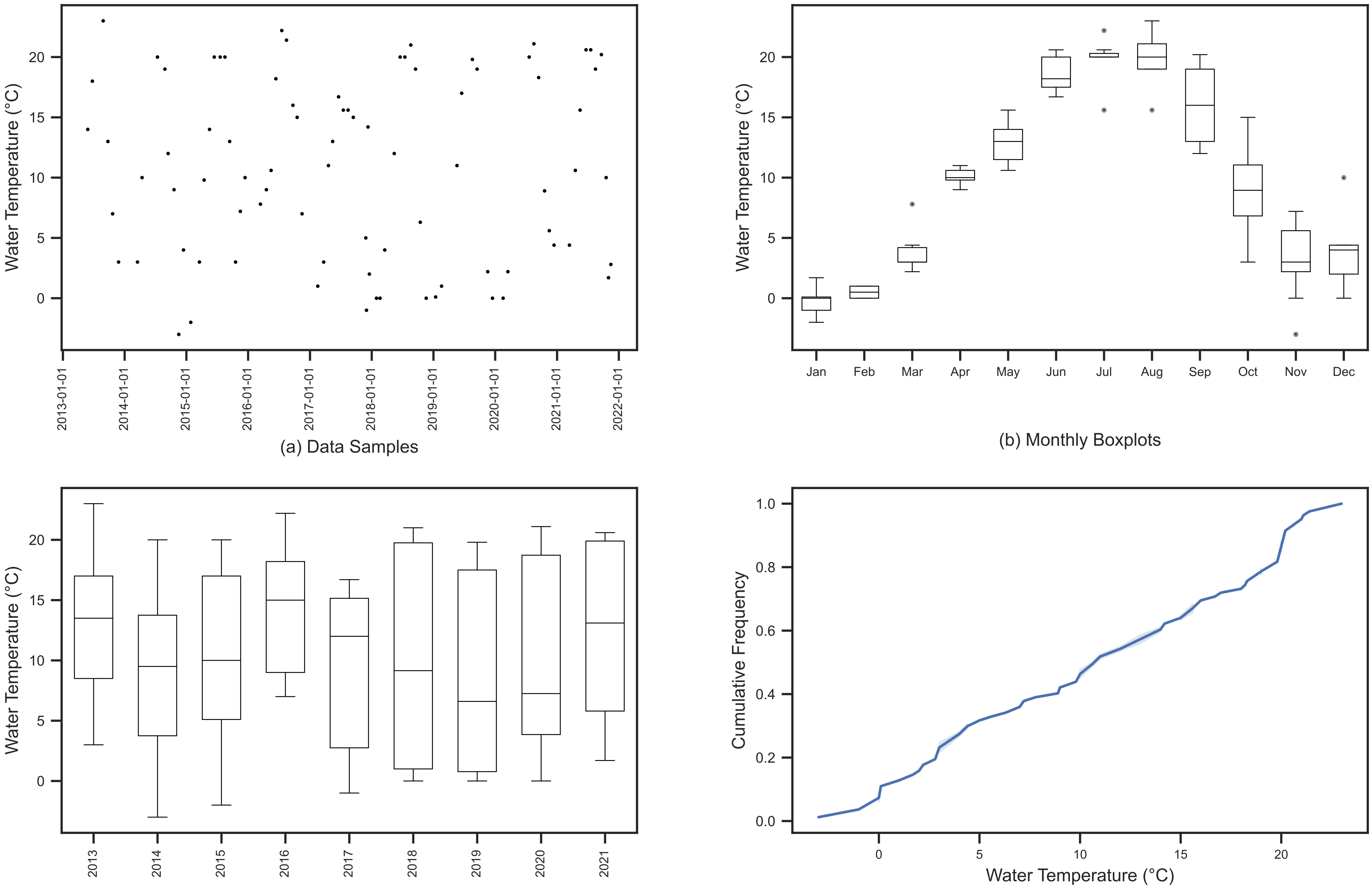
(a) Data Samples

(b) Monthly Boxplots

(c) Annual Boxplots

(d) Empirical CDF

Stoney Creek at Stevens Rd. (ST1) : Water Temperature (°C)



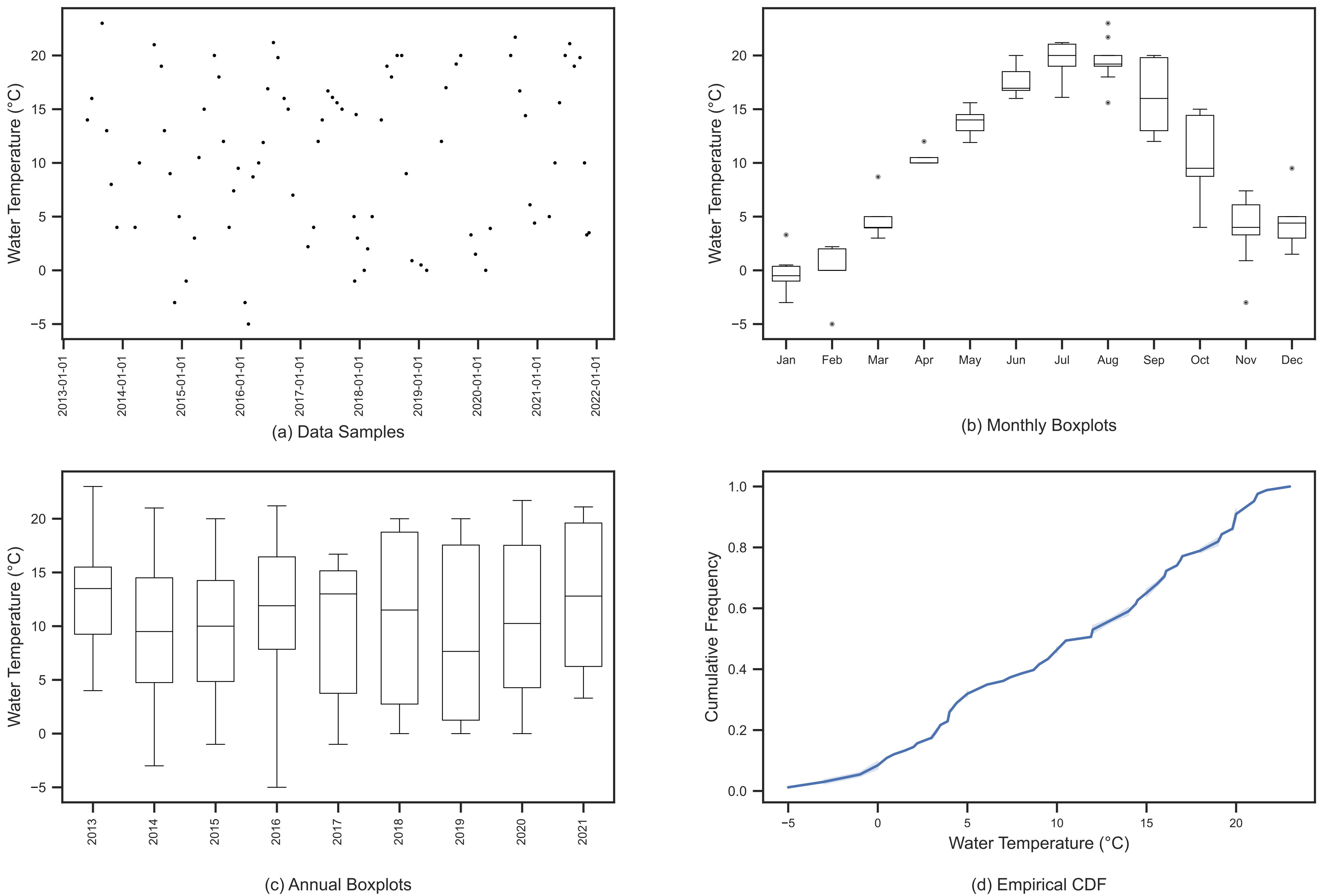
(a) Data Samples

(b) Monthly Boxplots

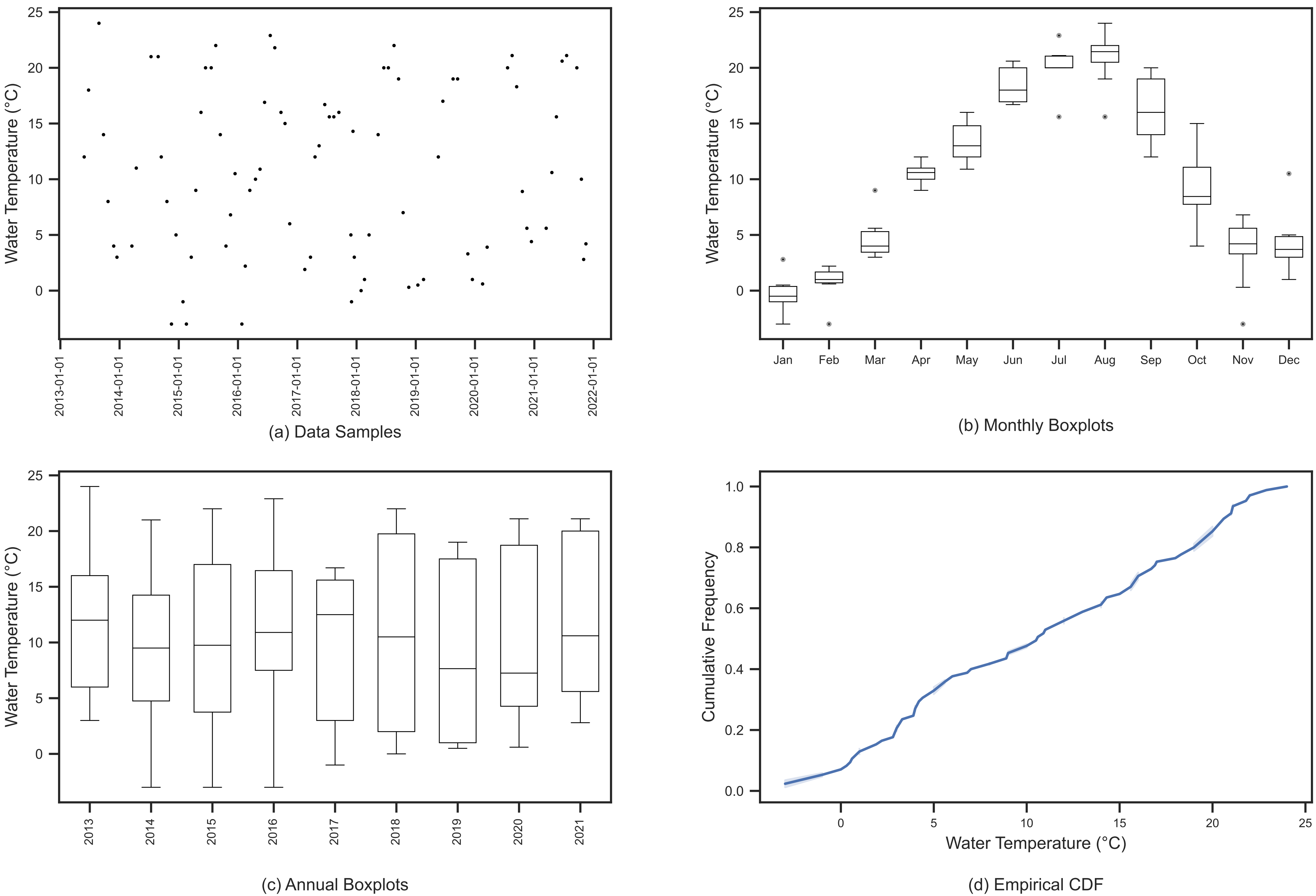
(c) Annual Boxplots

(d) Empirical CDF

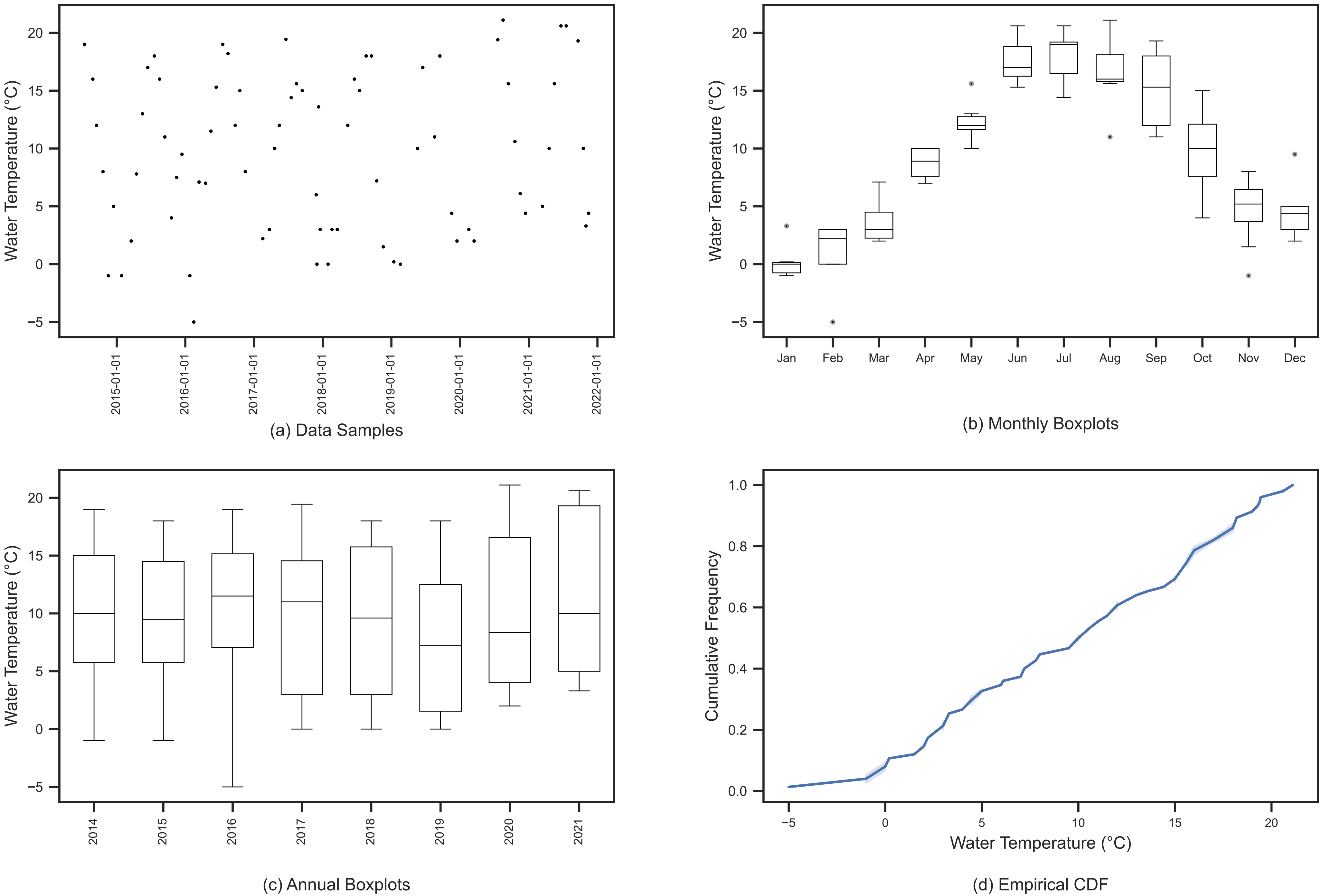
Otter Creek at Burr (OC2) : Water Temperature (°C)

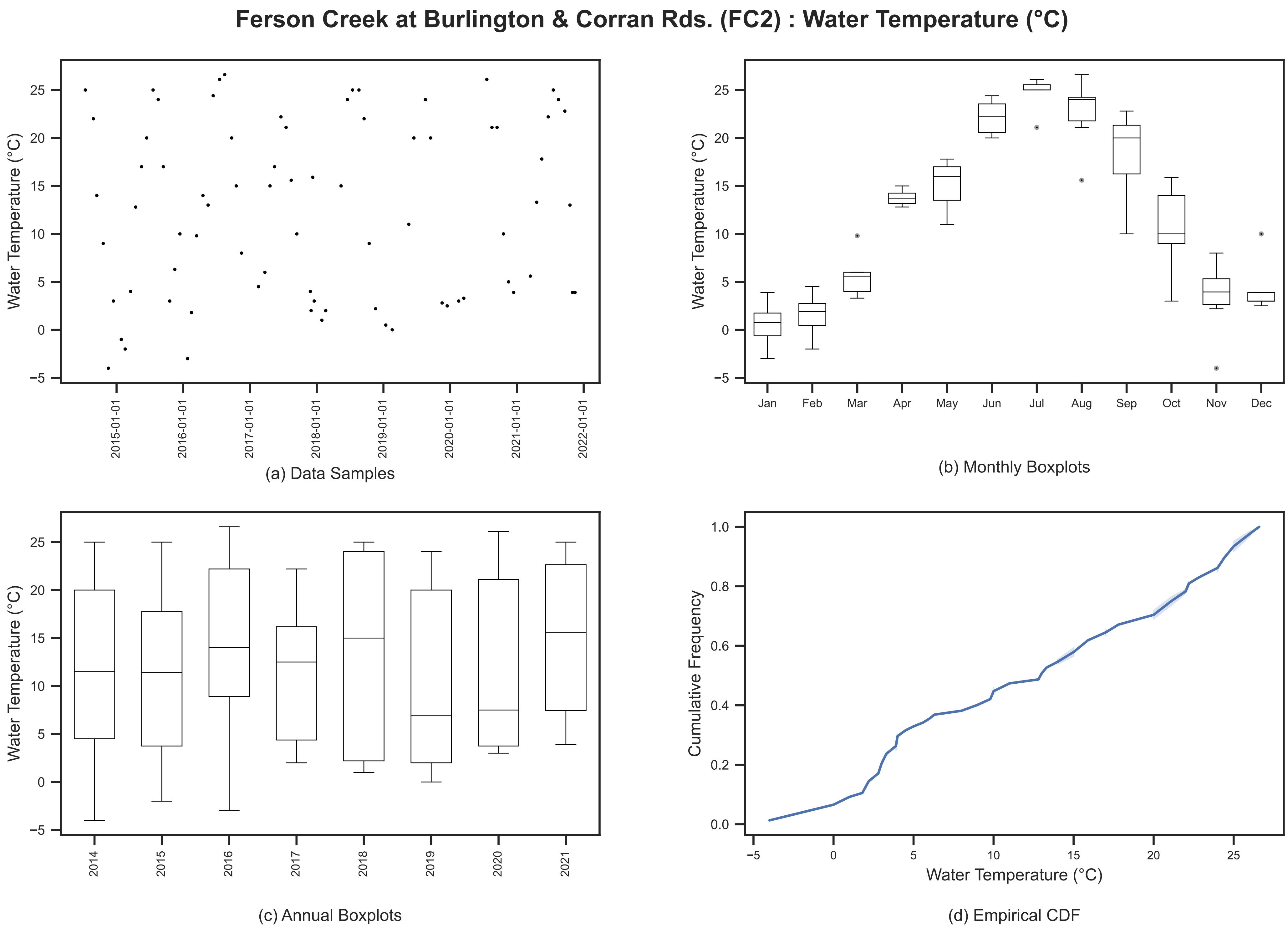


Otter Creek at Silver Glen Rd. (OC3) : Water Temperature (°C)

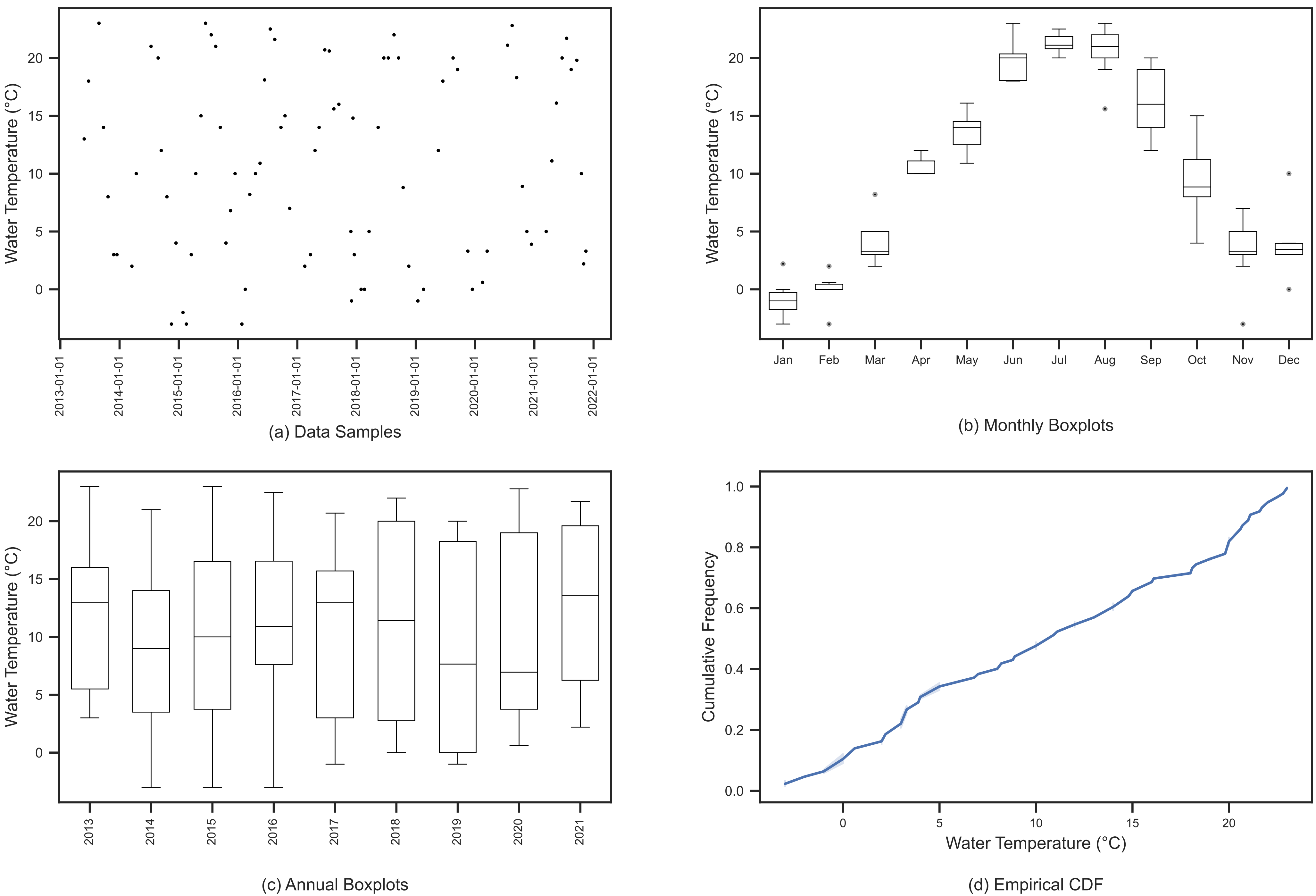


Ferson Creek at Hidden Springs (FC1) : Water Temperature (°C)

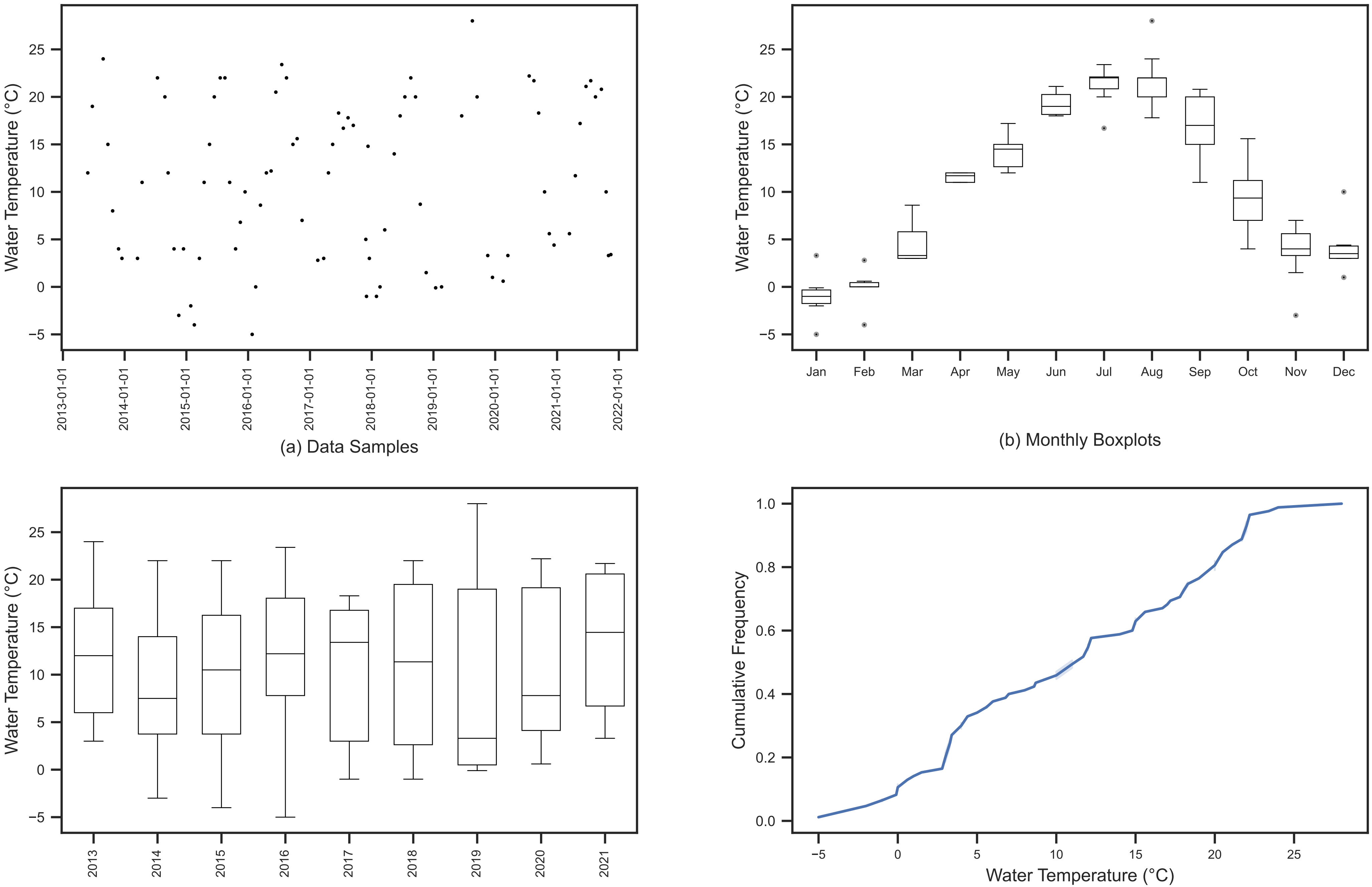



Ferson Creek at Burlington & Corran Rds. (FC2) : Water Temperature (°C)
Water Temperature (°C)
(a) Data Samples
(b) Monthly Boxplots
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(c) Annual Boxplots
Cumulative Frequency
Water Temperature (°C)
(d) Empirical CDF

Ferson Creek at Burr (FC3) : Water Temperature (°C)



Ferson Creek at Randall Rd. (FC4) : Water Temperature (°C)



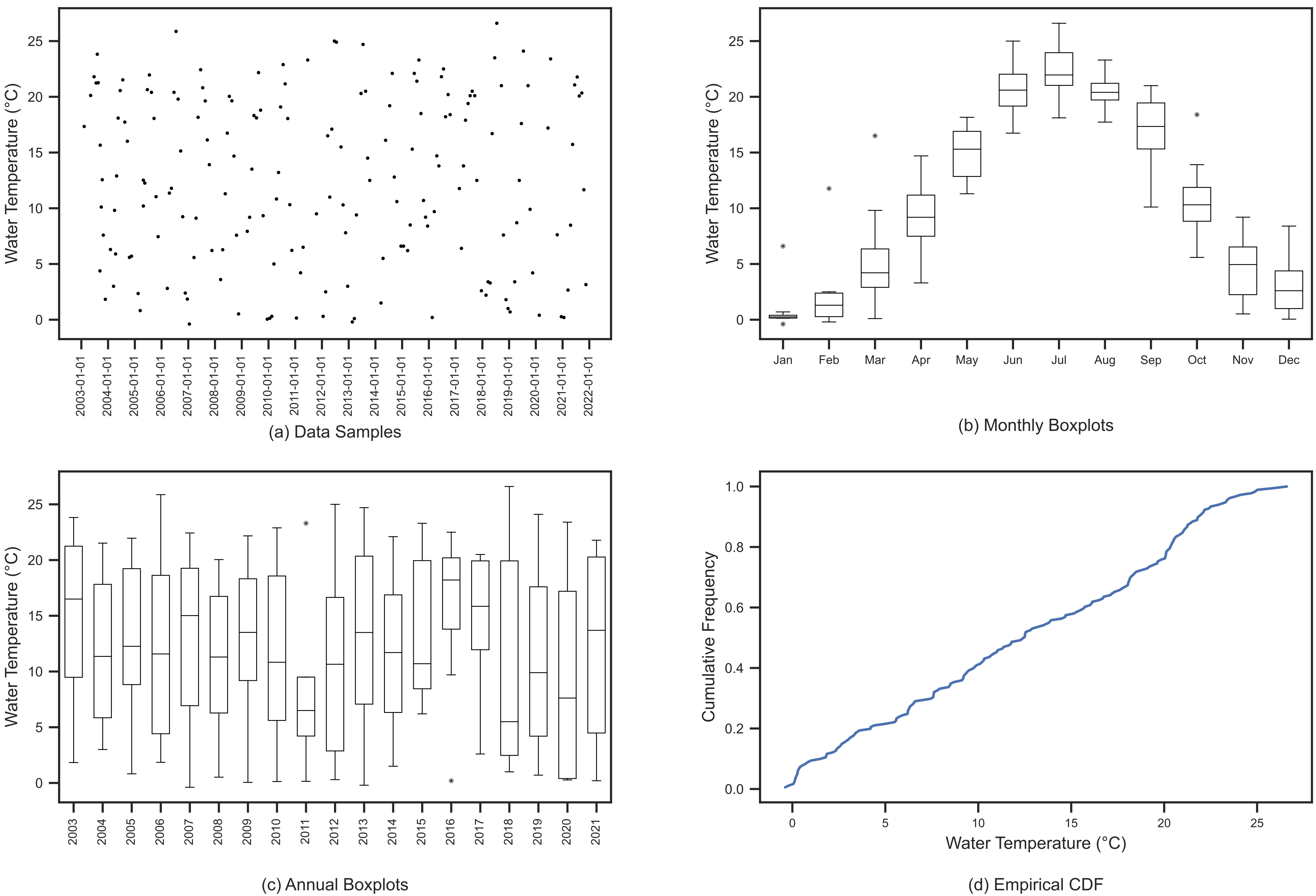
(a) Data Samples

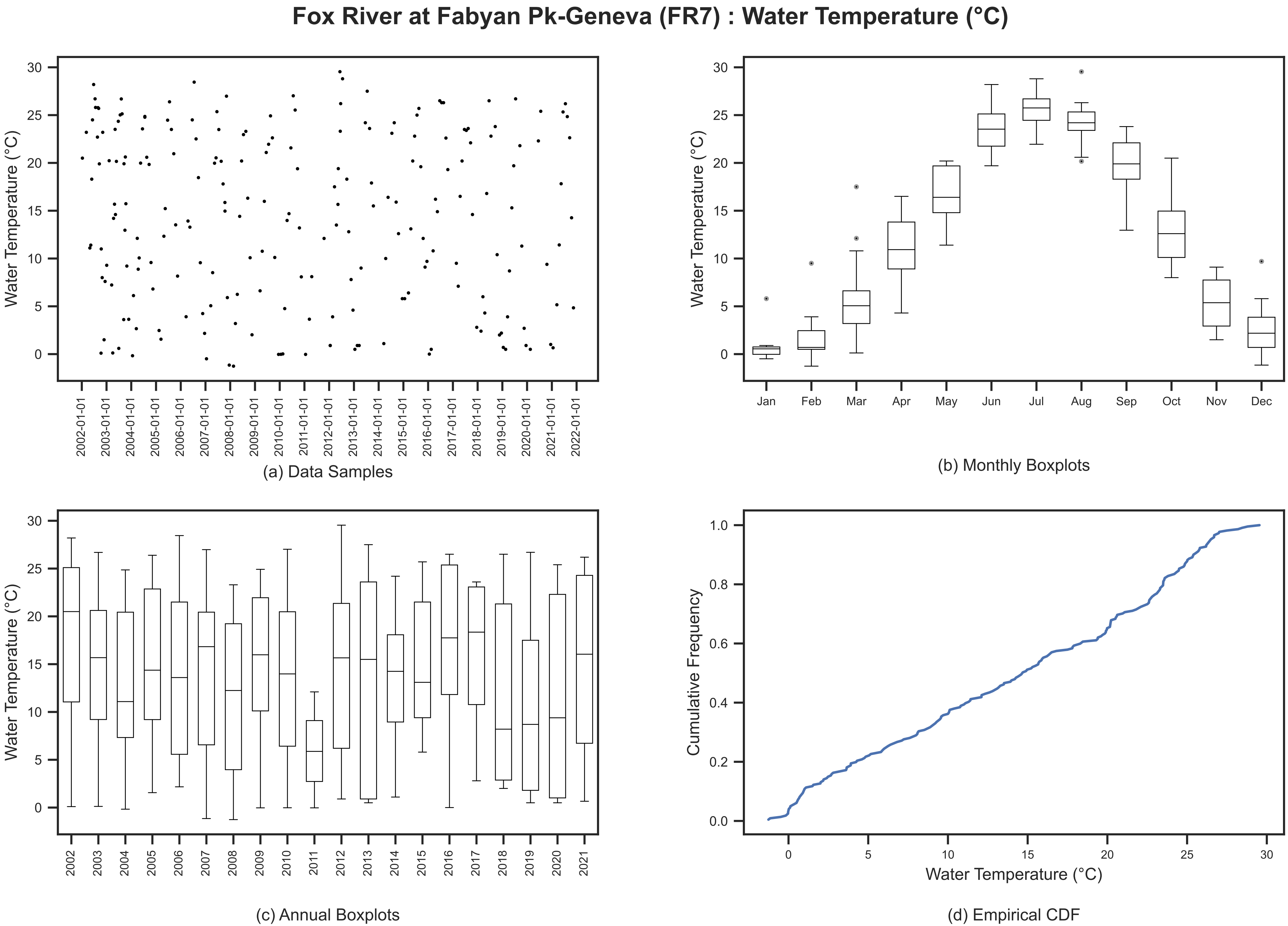
(b) Monthly Boxplots

(c) Annual Boxplots

(d) Empirical CDF

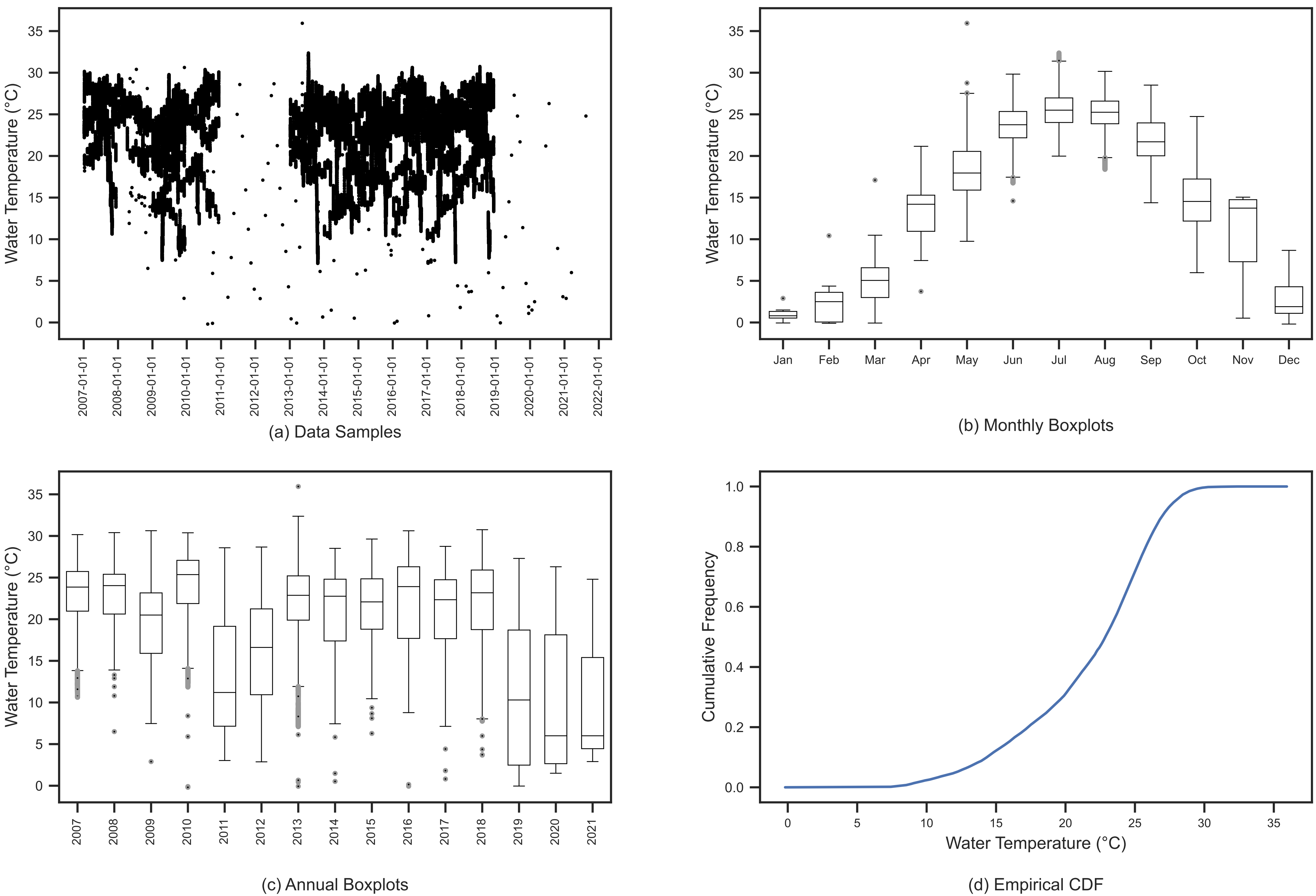
Ferson Creek near St. Charles (FC5) : Water Temperature (°C)



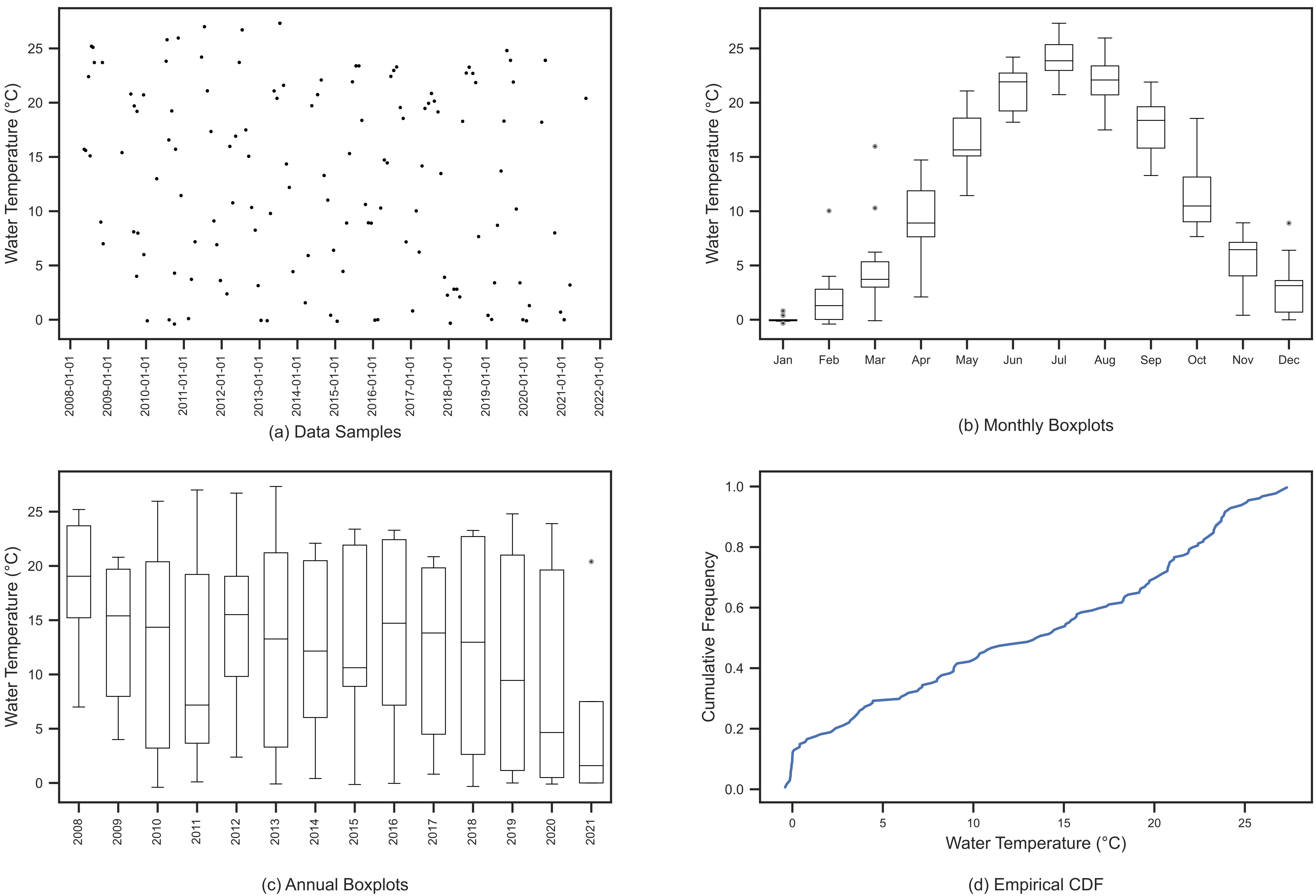


Fox River at Fabyan Pk-Geneva (FR7) : Water Temperature (°C)
Water Temperature (°C)
2002-01-01
2003-01-01
2004-01-01
2005-01-01
2006-01-01
2007-01-01
2008-01-01
2009-01-01
2010-01-01
2011-01-01
2012-01-01
2013-01-01
2014-01-01
2015-01-01
2016-01-01
2017-01-01
2018-01-01
2019-01-01
2020-01-01
2021-01-01
2022-01-01
(a) Data Samples
Water Temperature (°C)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(b) Monthly Boxplots
Water Temperature (°C)
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
(c) Annual Boxplots
Cumulative Frequency
Water Temperature (°C)
(d) Empirical CDF

Fox River at Sullivan Br. (FR8) : Water Temperature (°C)



Indian Creek at Reckinger Rd. (IC1) : Water Temperature (°C)



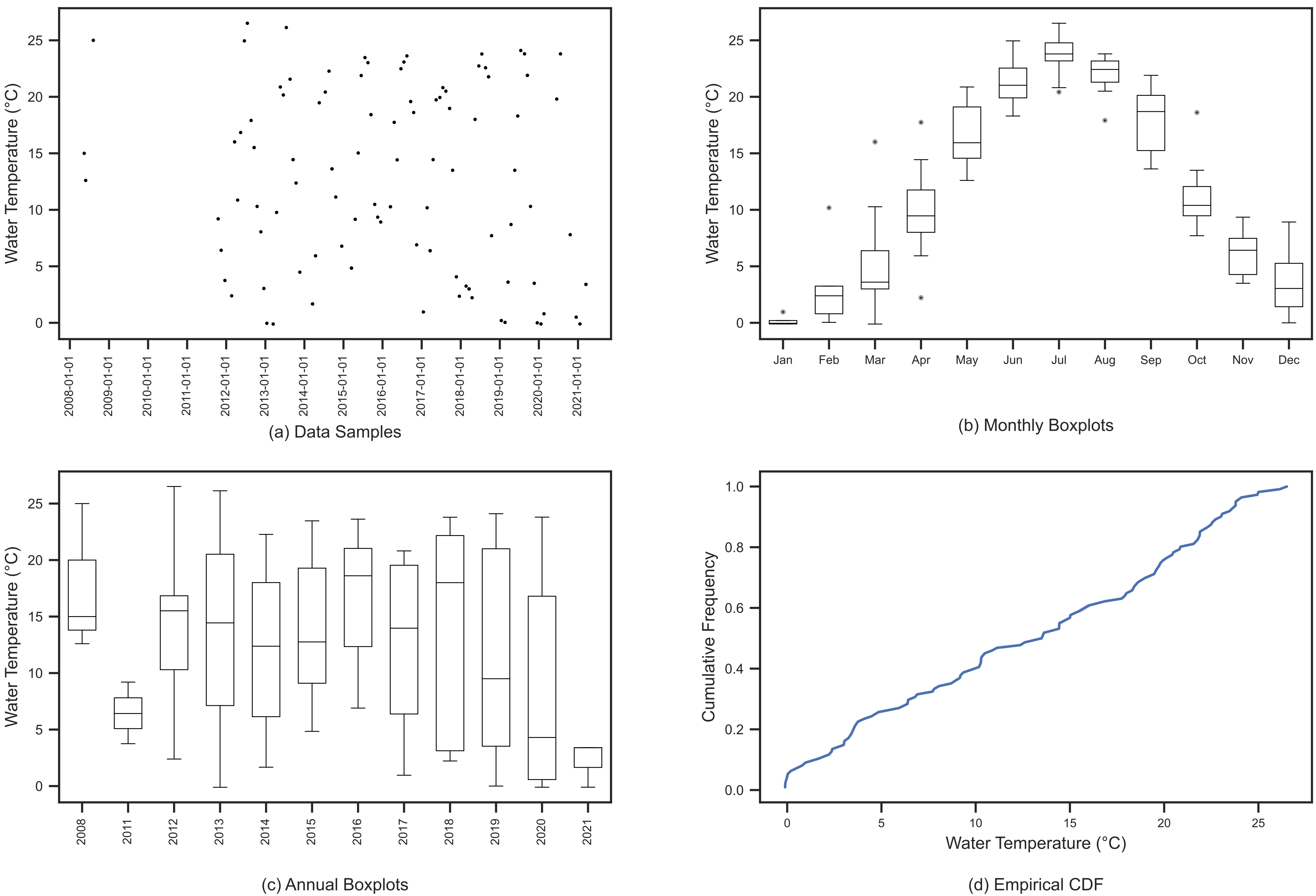
(a) Data Samples

(b) Monthly Boxplots

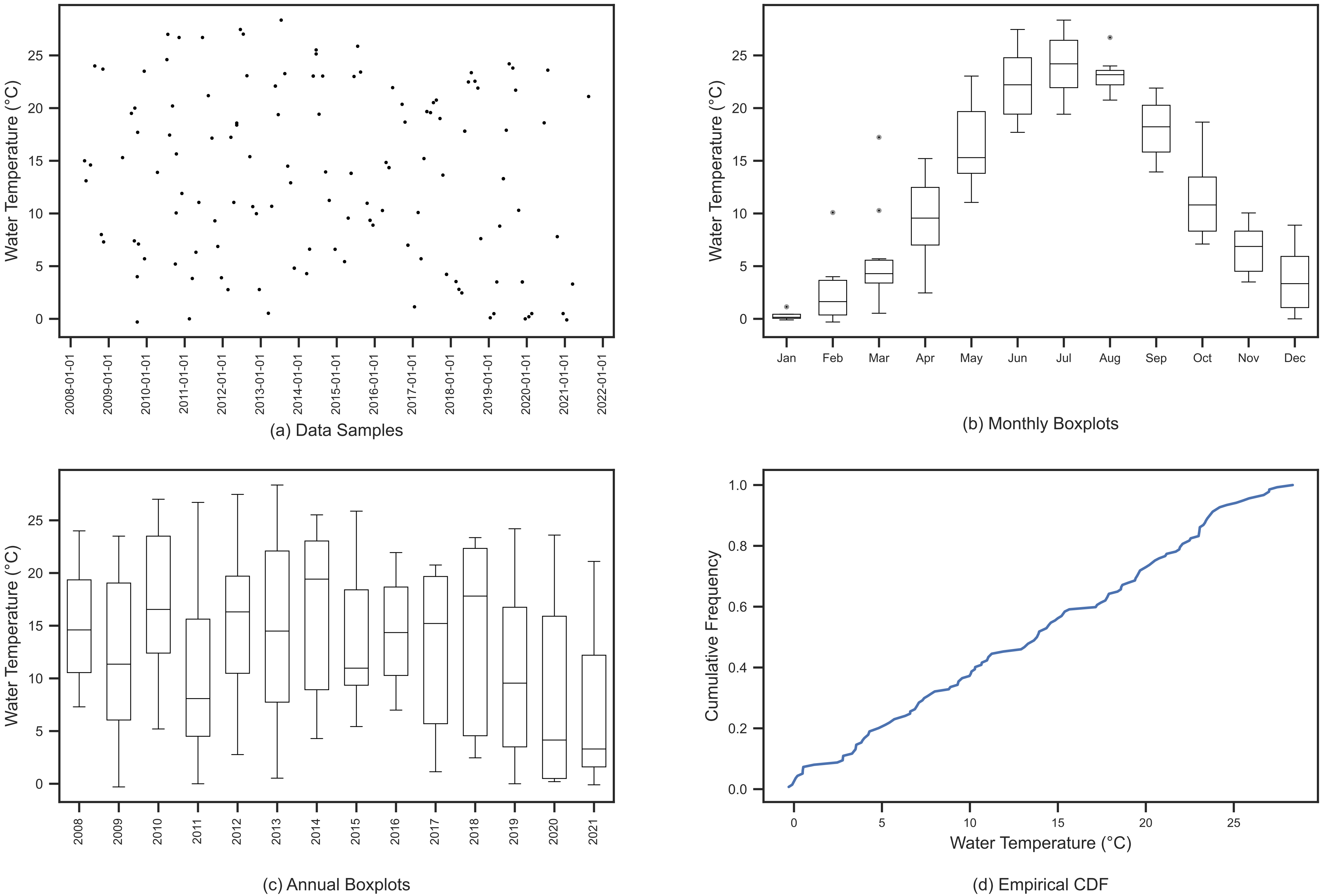
(c) Annual Boxplots

(d) Empirical CDF

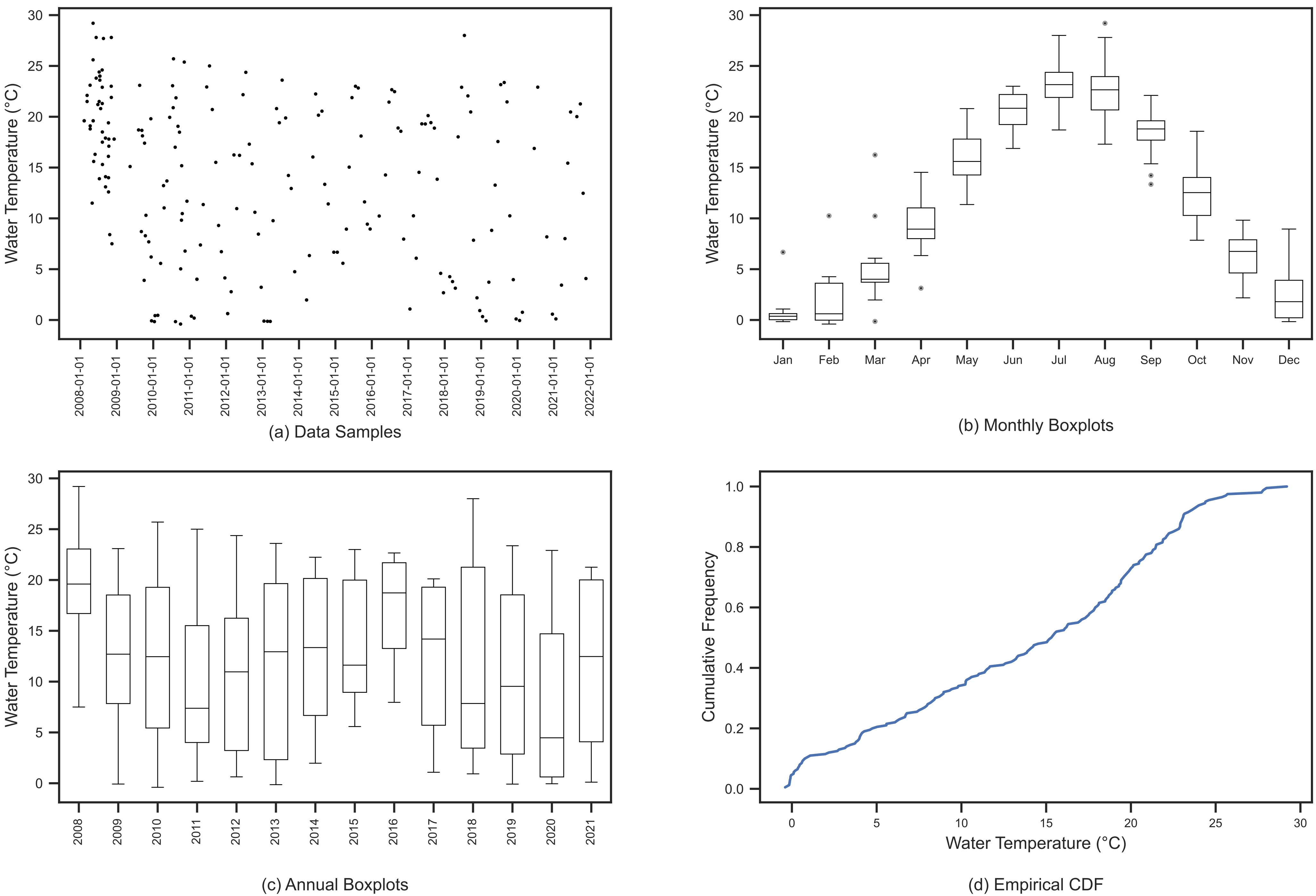
Indian Creek ups Outfall (IC2) : Water Temperature (°C)



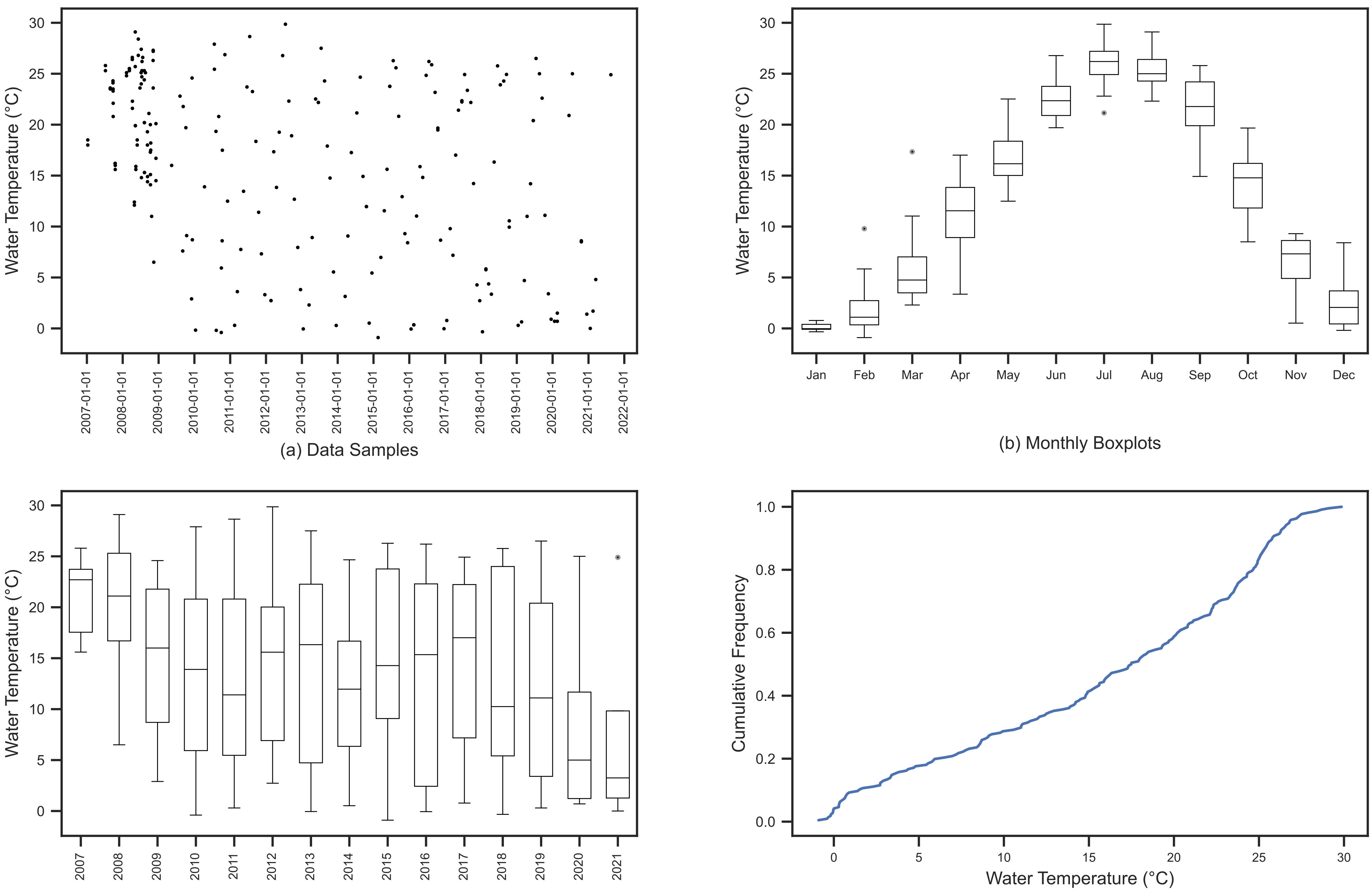
Indian Creek dns Outfall (IC3) : Water Temperature (°C)



Indian Creek u/s Rt. 25 (IC4) : Water Temperature (°C)



Fox River at North Ave. Br. (FR9) : Water Temperature (°C)



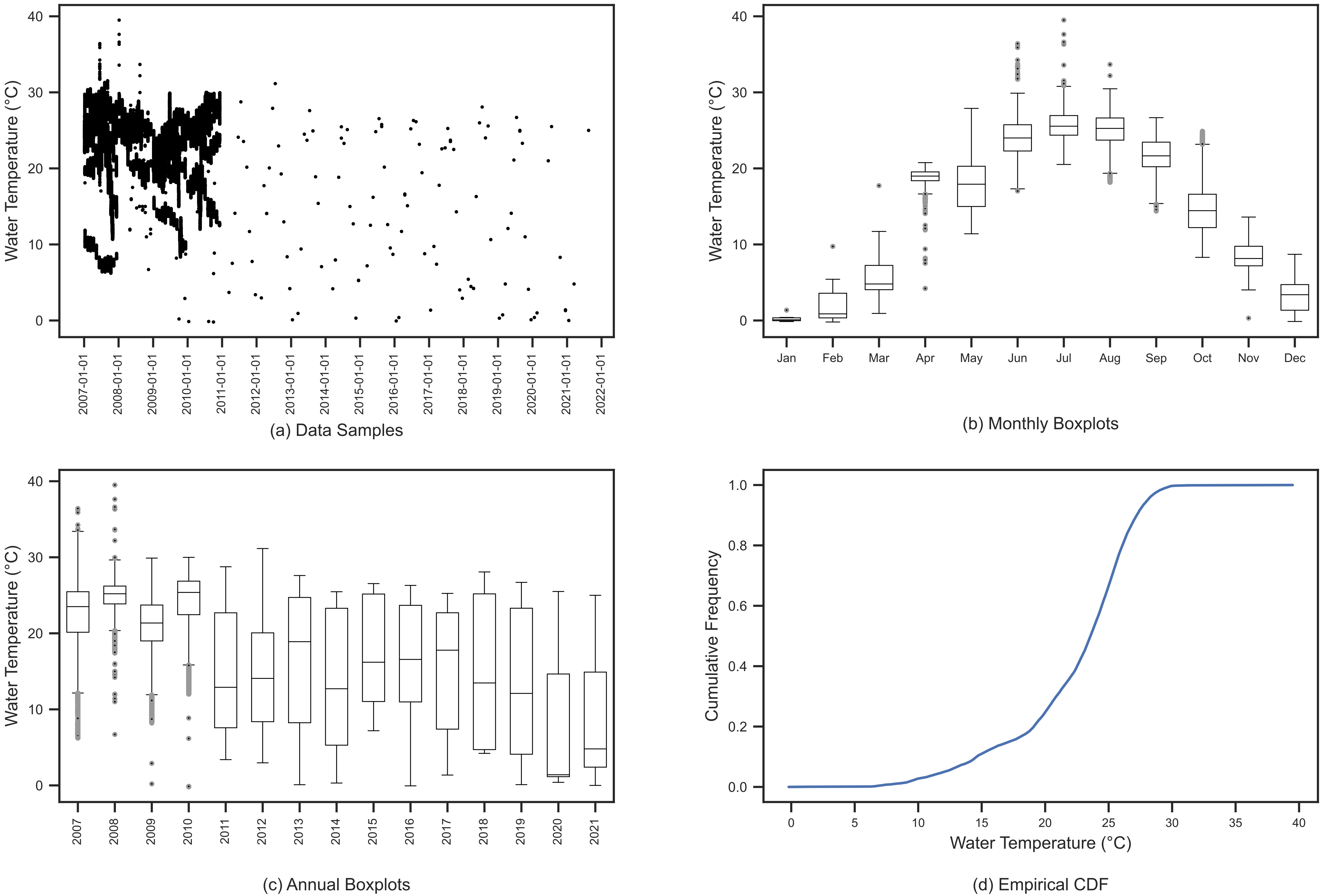
(a) Data Samples

(b) Monthly Boxplots

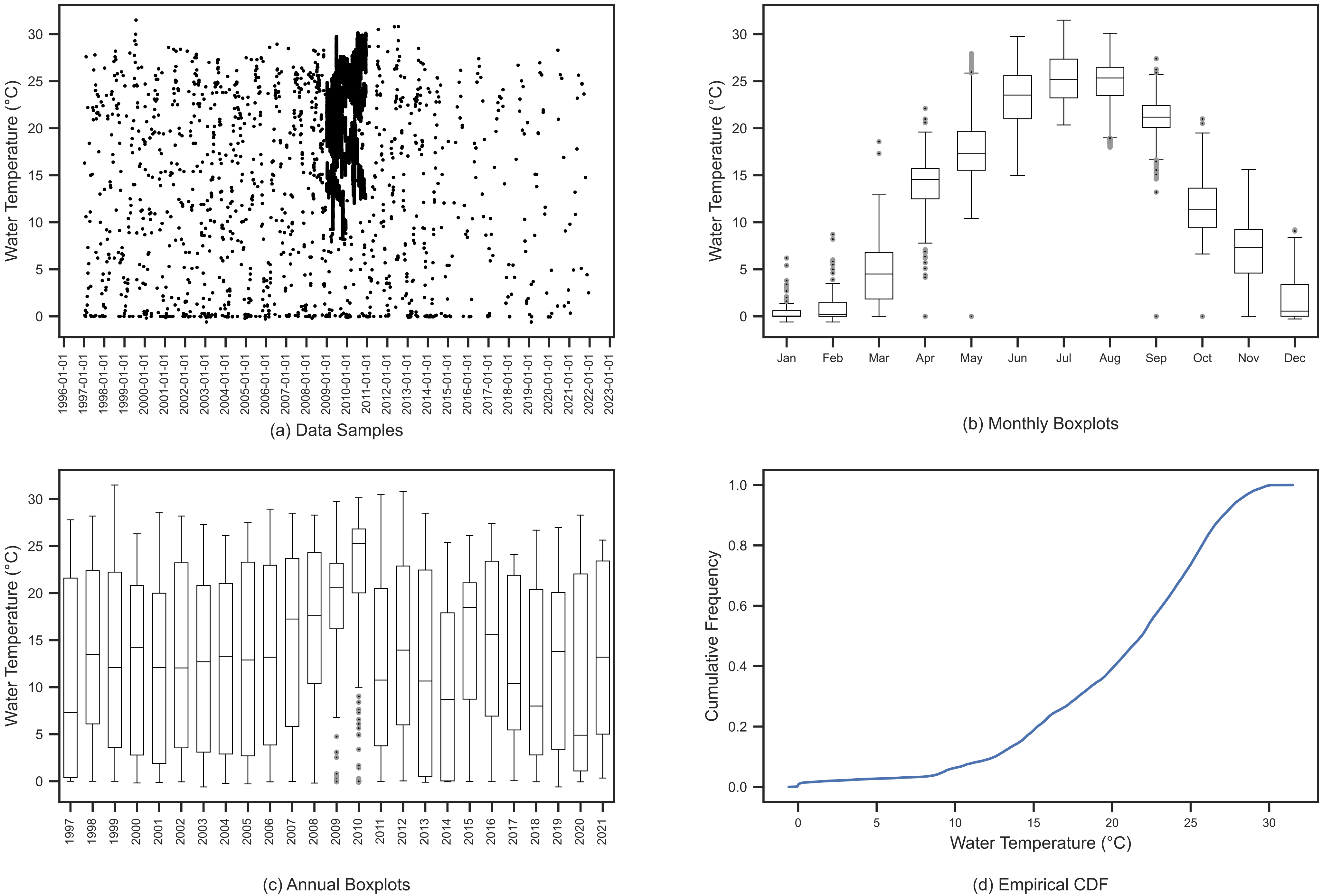
(c) Annual Boxplots

(d) Empirical CDF

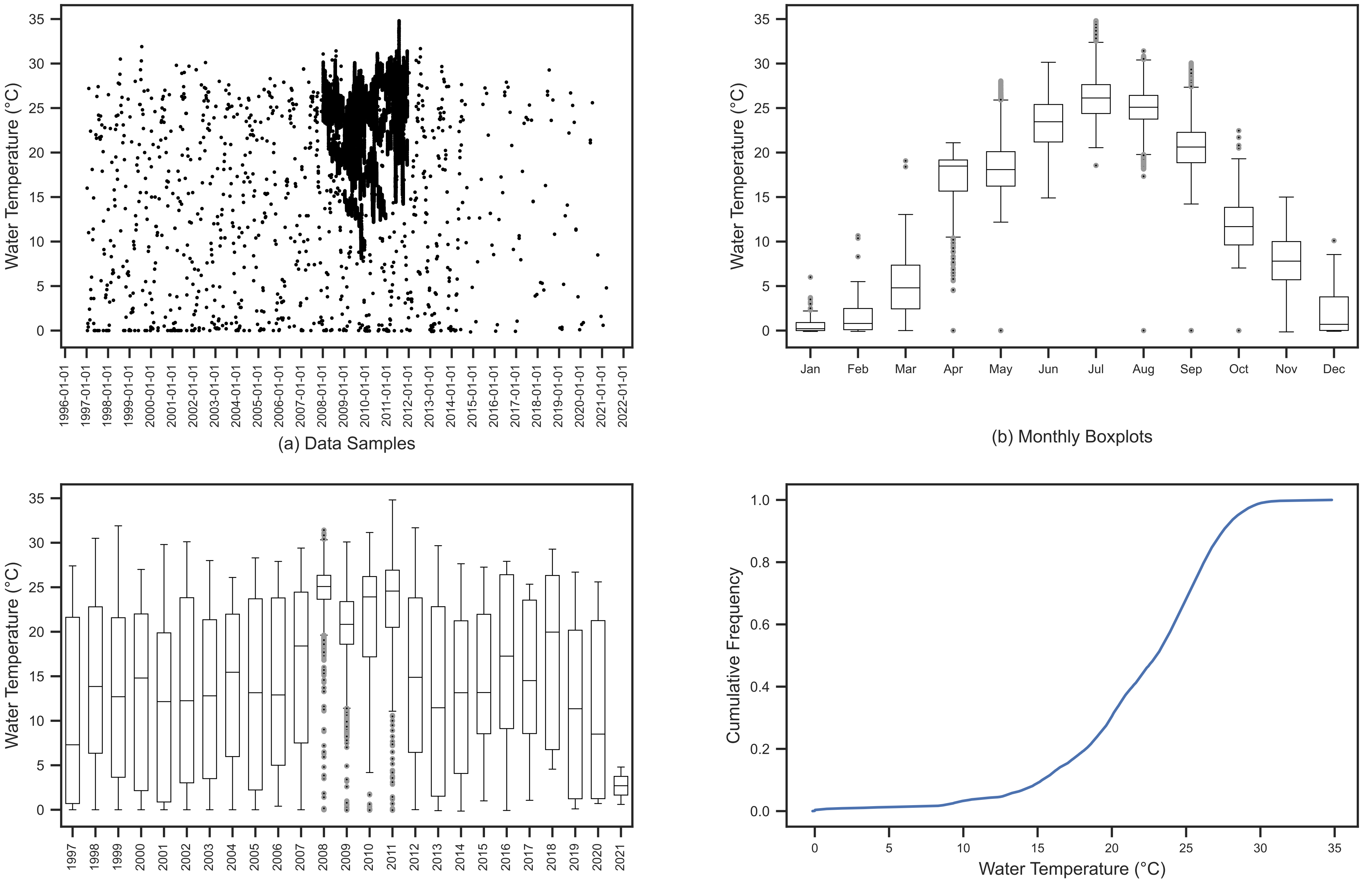
Fox River at Ashland Ave. (FR10) : Water Temperature (°C)



Fox River at Montgomery (FR11) : Water Temperature (°C)



Fox River at Rt. 34, Oswego (FR12) : Water Temperature (°C)

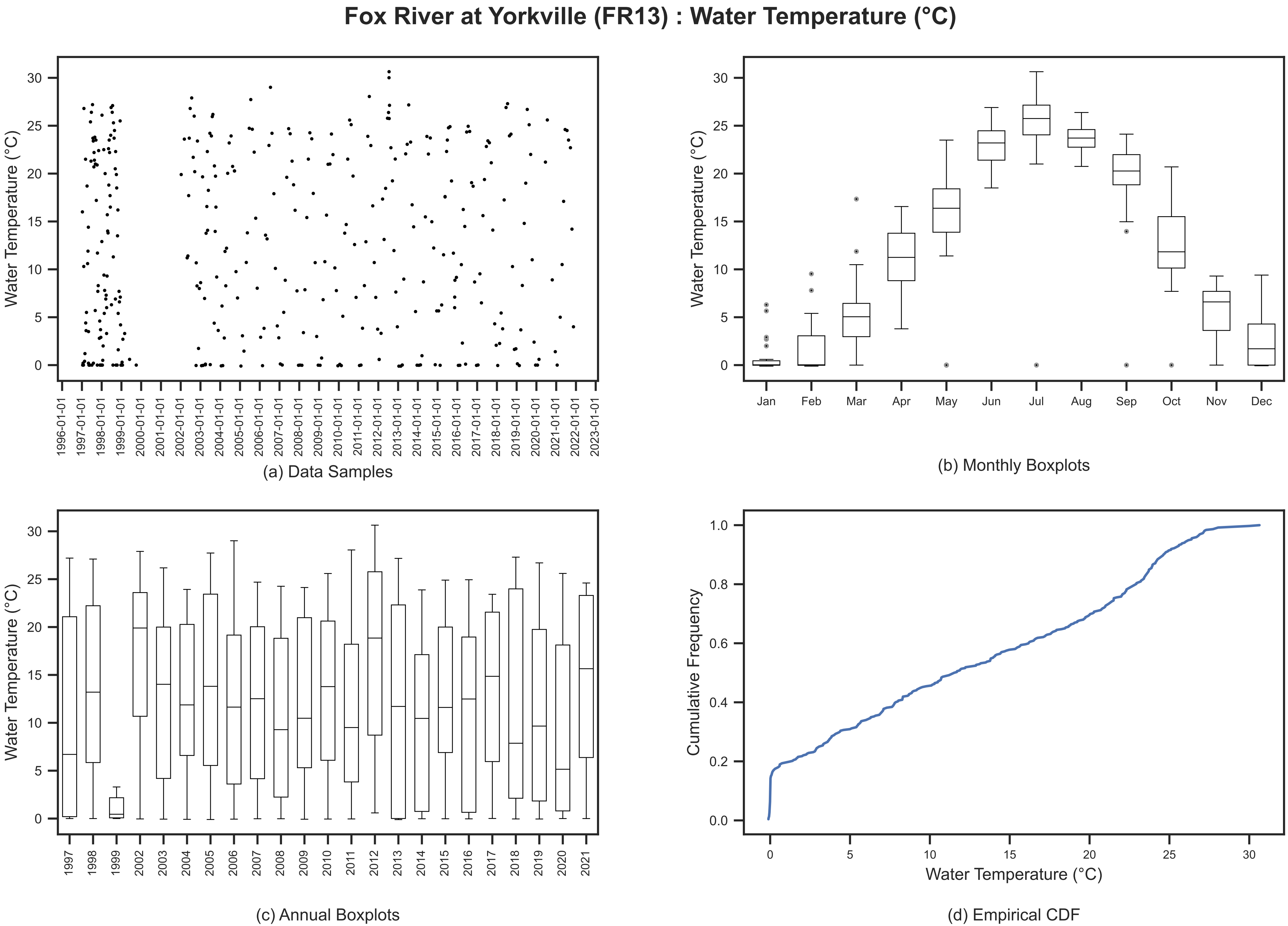


(a) Data Samples

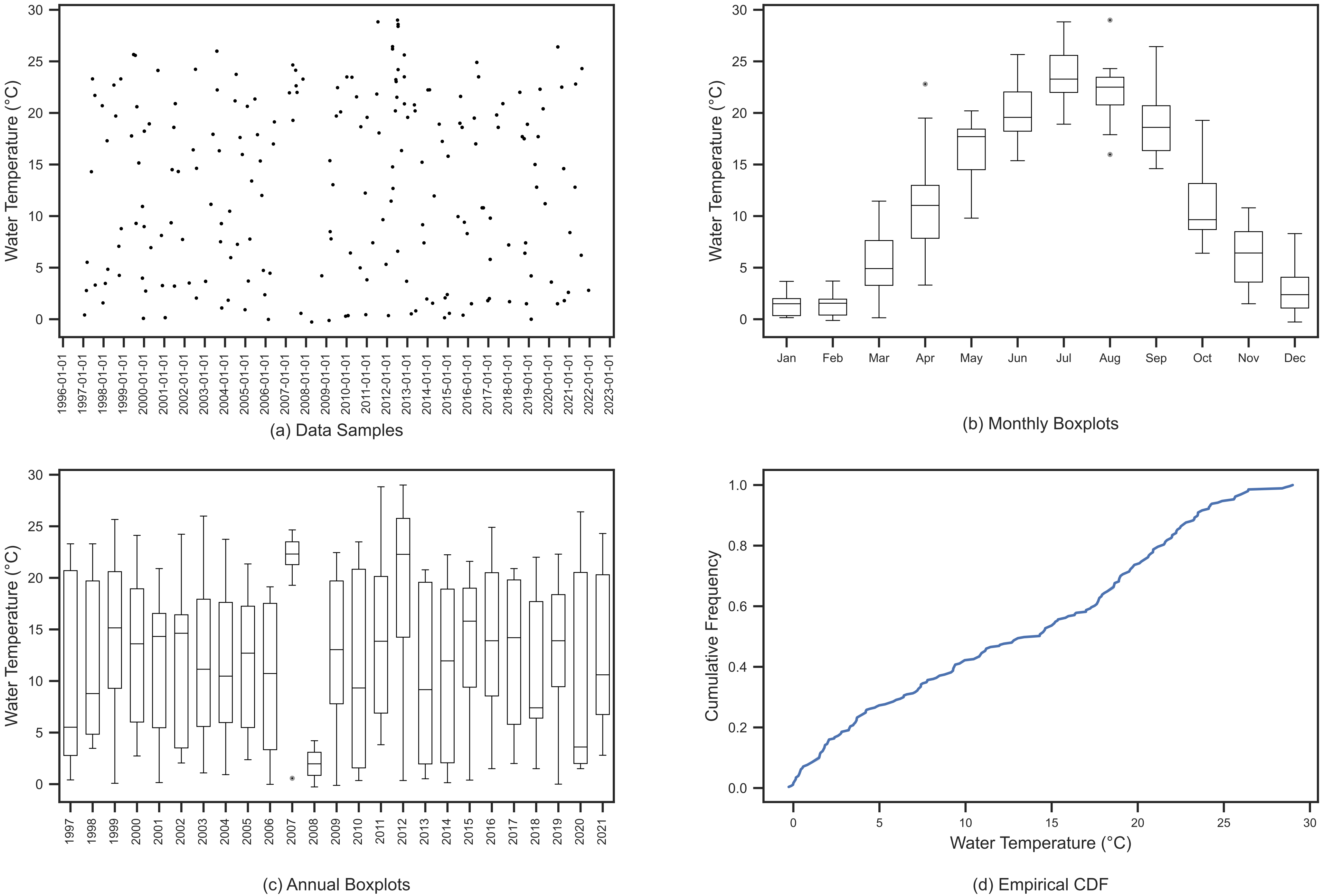
(b) Monthly Boxplots

(c) Annual Boxplots

(d) Empirical CDF


Fox River at Yorkville (FR13) : Water Temperature (°C)
Water Temperature (°C)
(a) Data Samples
(b) Monthly Boxplots
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(c) Annual Boxplots
Cumulative Frequency
Water Temperature (°C)
(d) Empirical CDF

Blackberry Creek near Yorkville (BC1) : Water Temperature (°C)



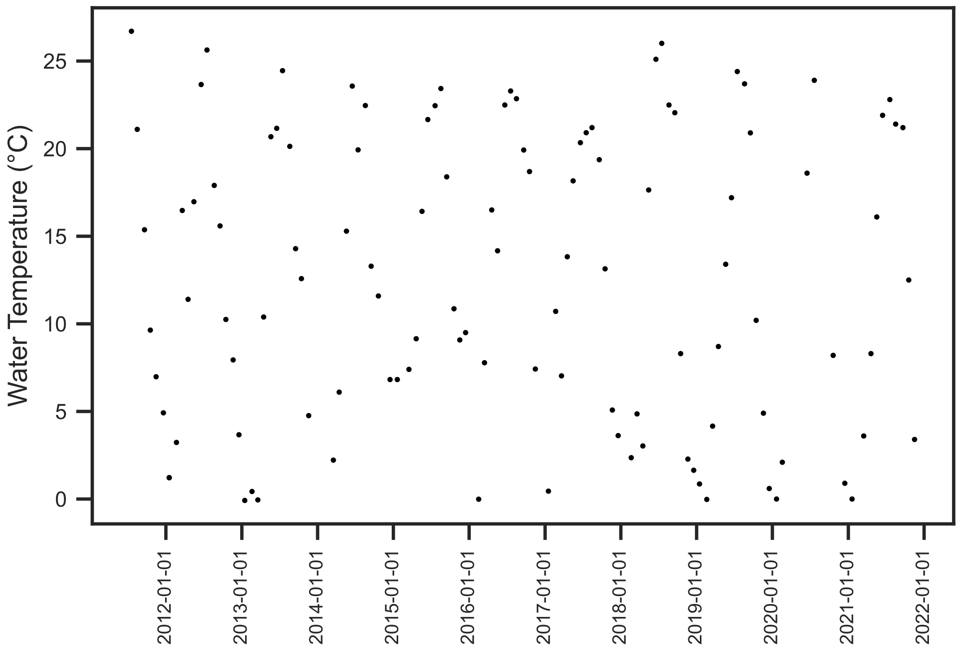
(a) Data Samples

(b) Monthly Boxplots

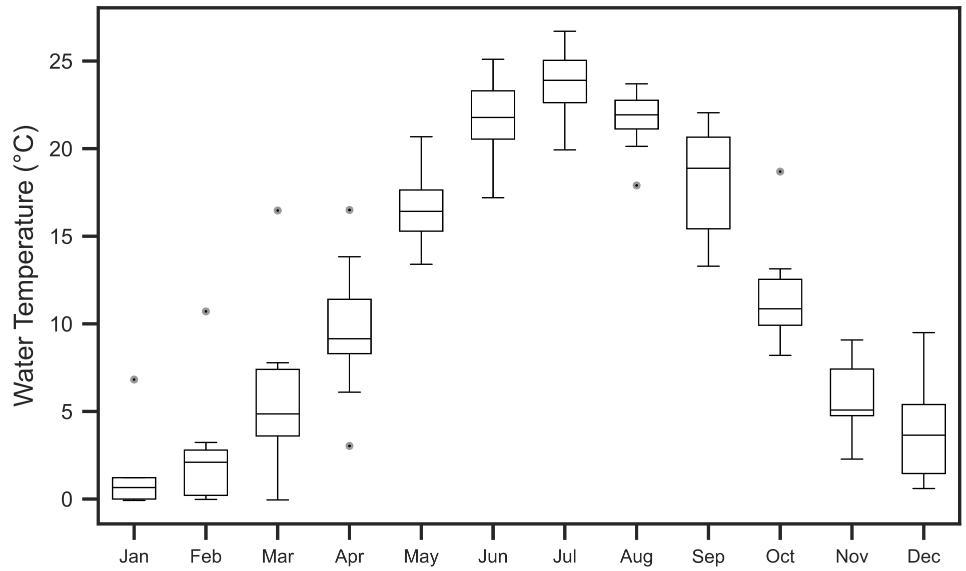
(c) Annual Boxplots

(d) Empirical CDF

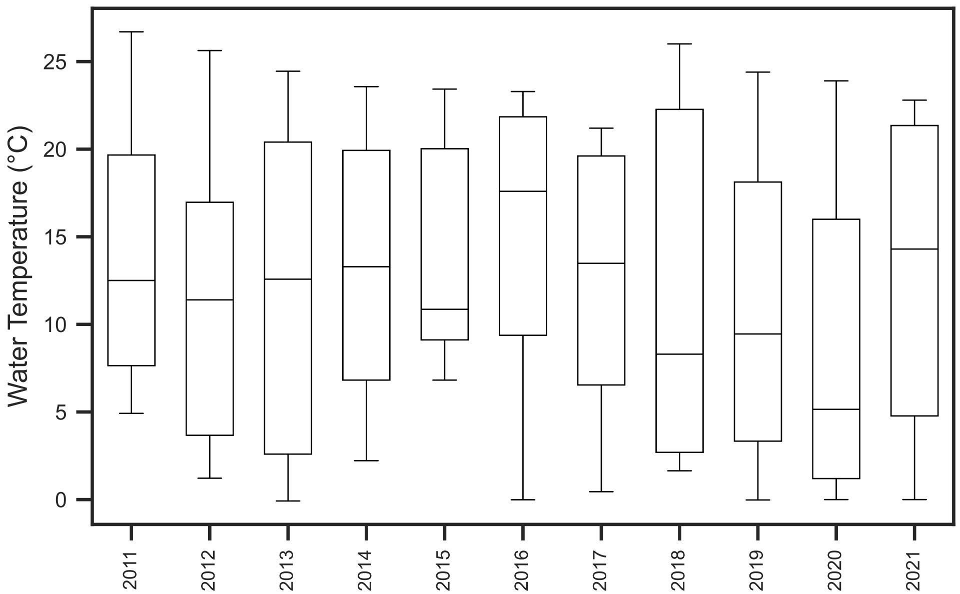
Blackberry Creek near Yorkville Side Rd. (BC2) : Water Temperature (°C)



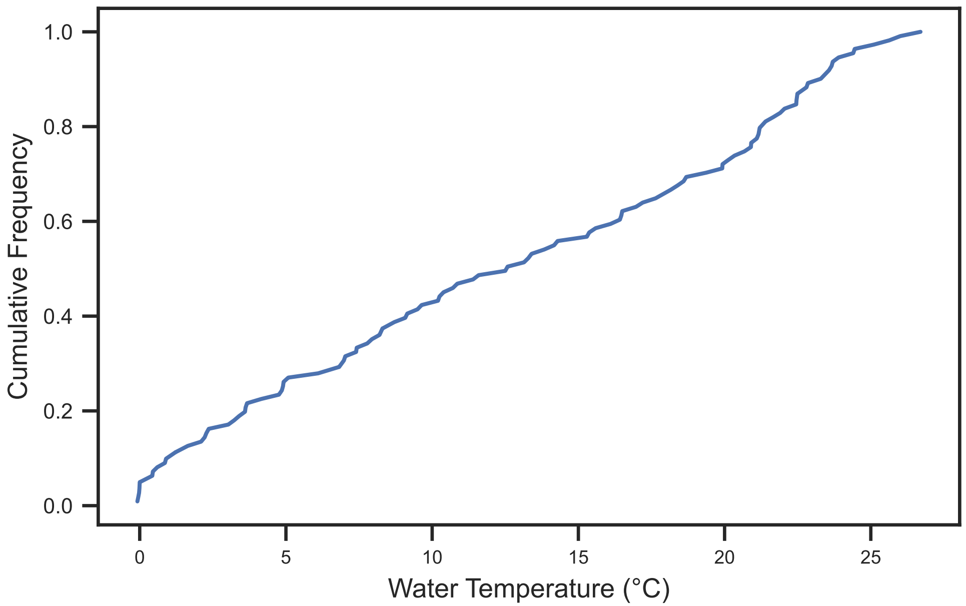
(a) Data Samples



(b) Monthly Boxplots

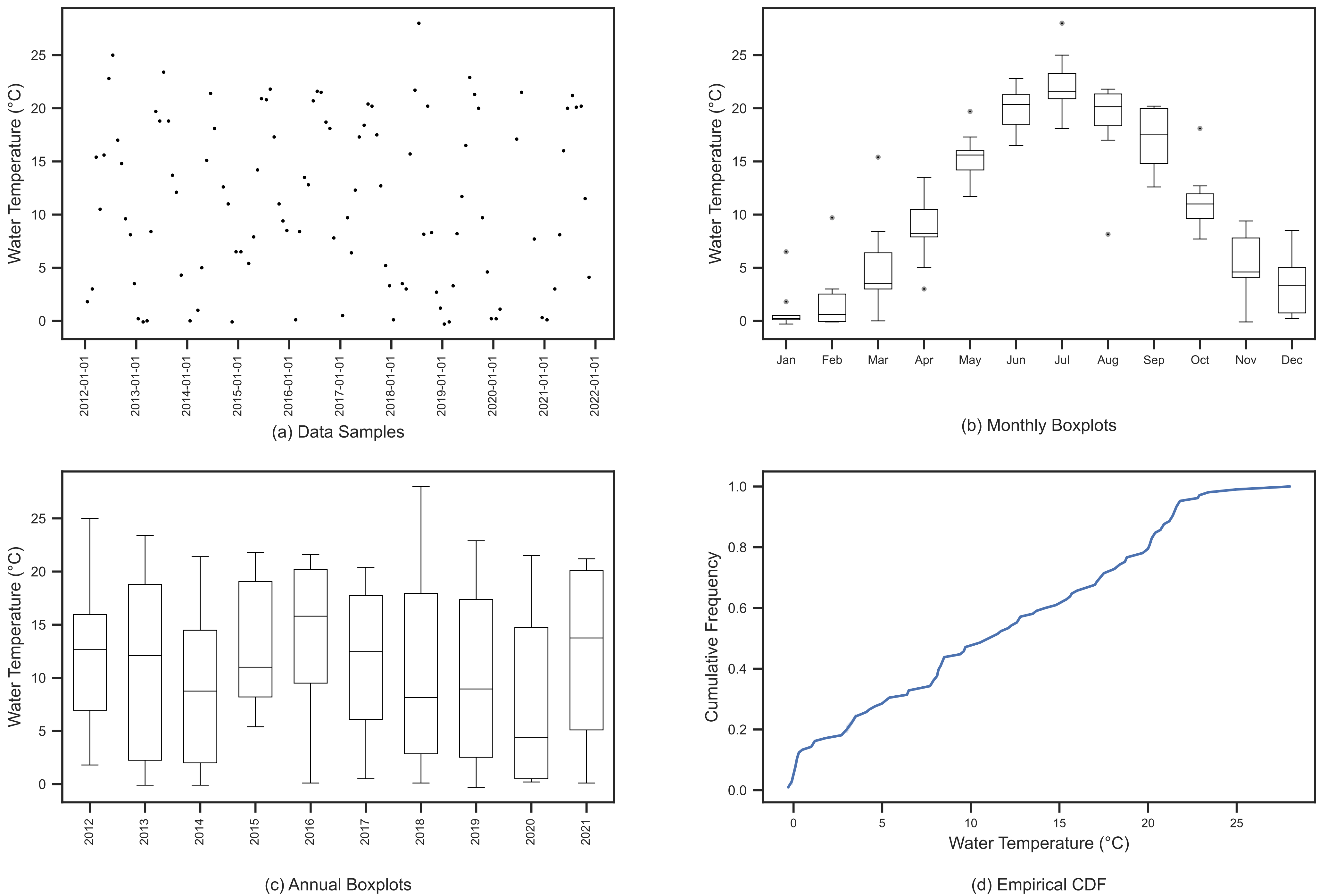


(c) Annual Boxplots

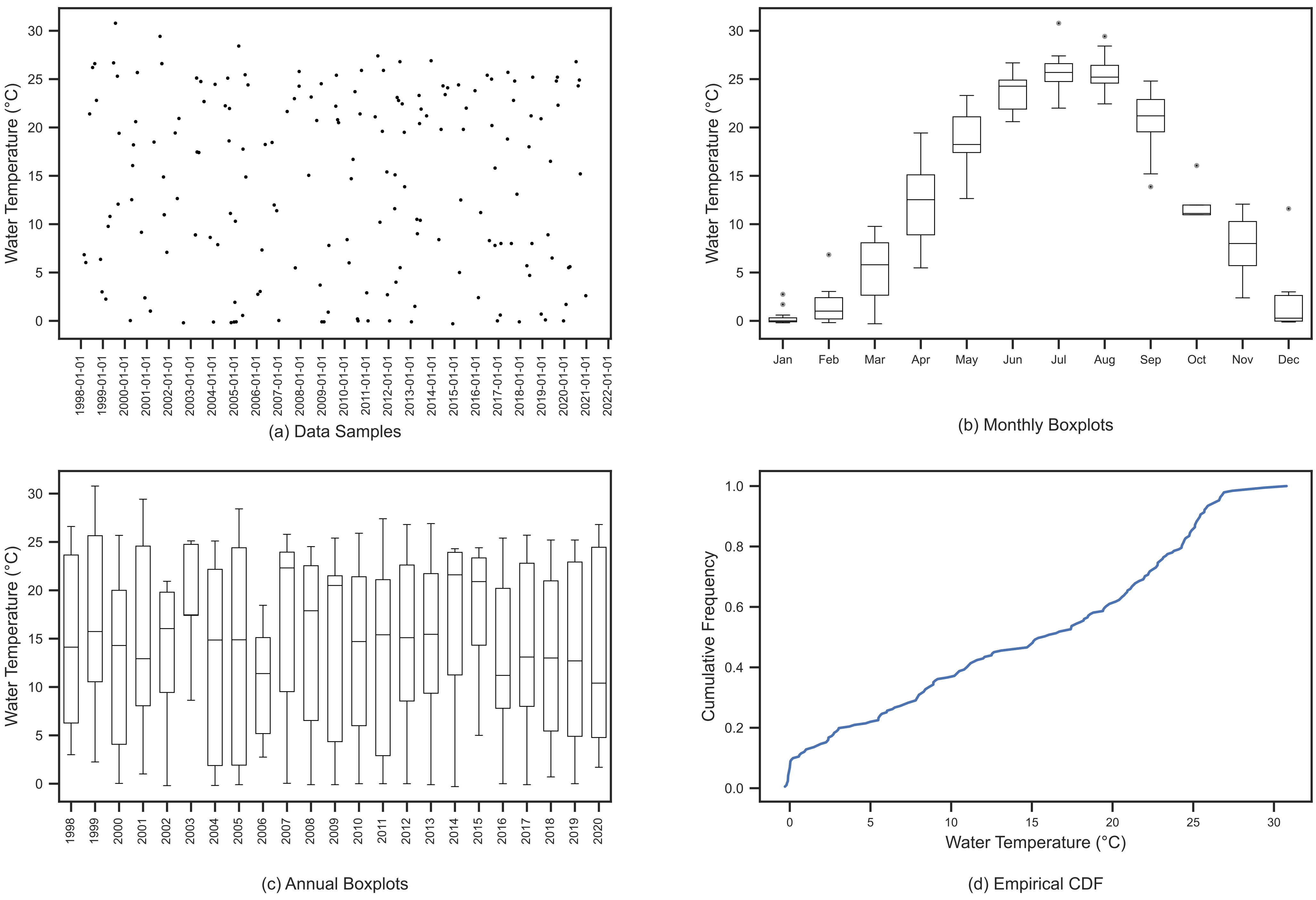


(d) Empirical CDF

Little Indian Creek at dns Unversity Rd. Br. (LC1) : Water Temperature (°C)



Fox River at Rt. 71 (FR14) : Water Temperature (°C)



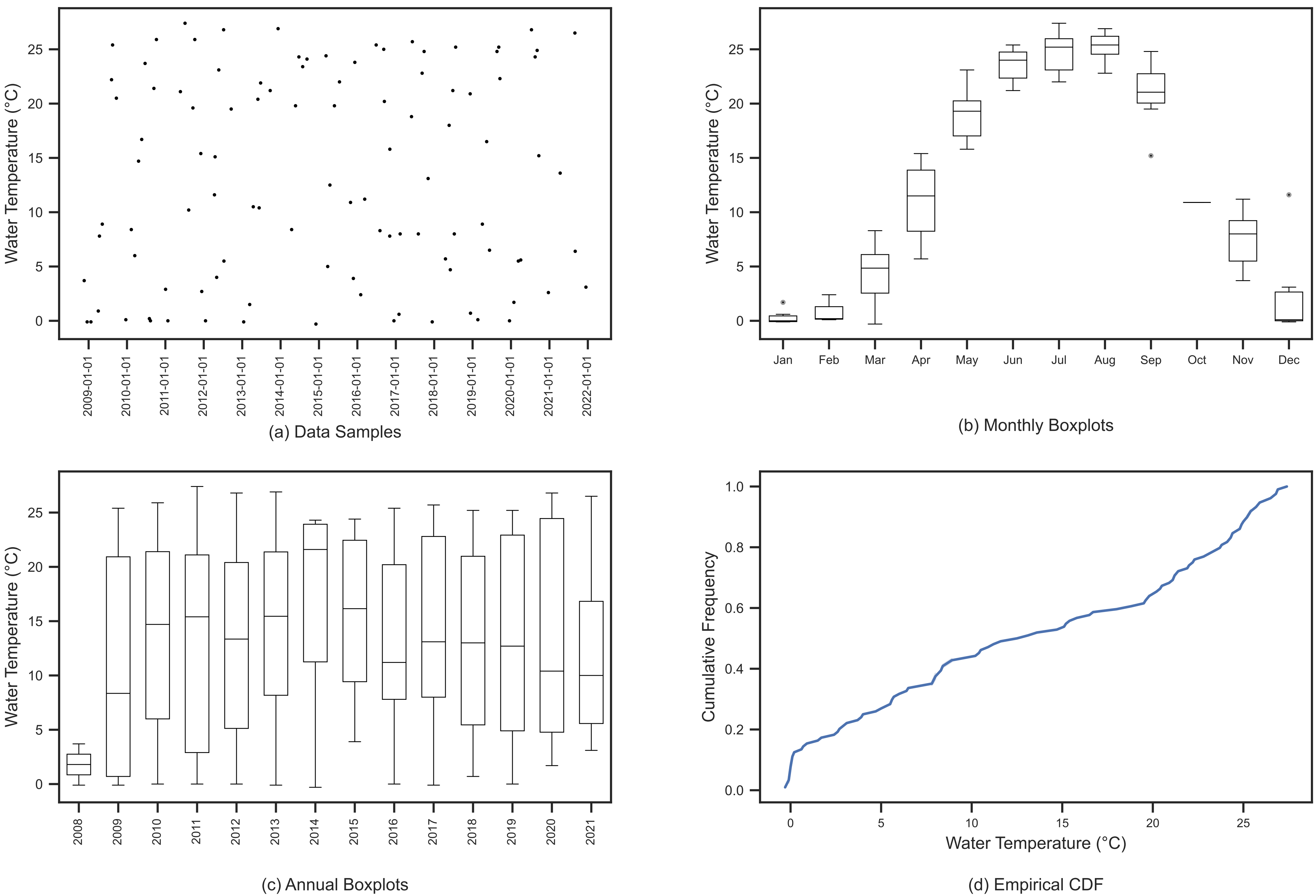
(a) Data Samples

(b) Monthly Boxplots

(c) Annual Boxplots

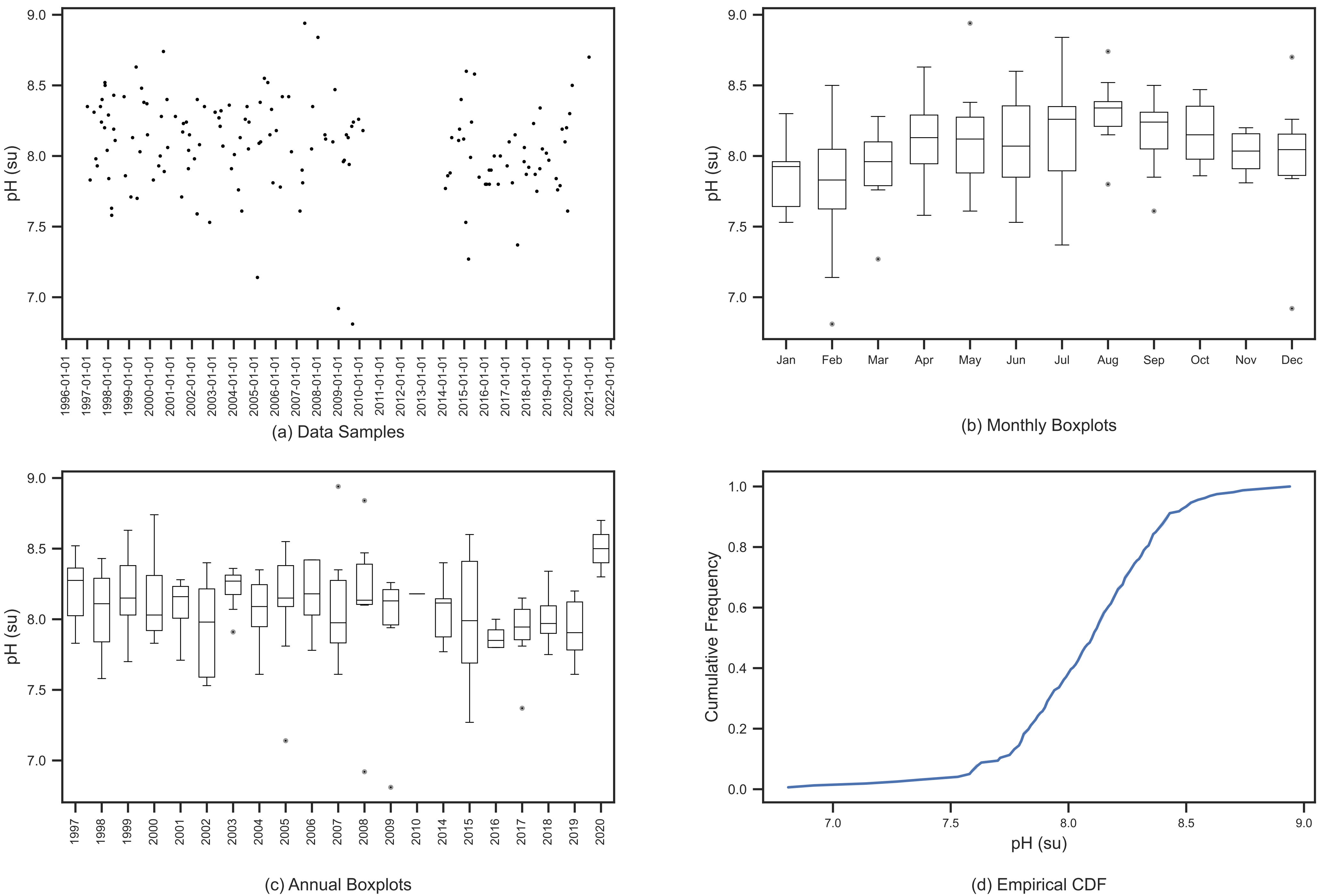
(d) Empirical CDF

Fox River at Ottawa (FR15) : Water Temperature (°C)



EDA Outputs for pH (su)

Fox River at Rt. 173 near Channel Lake (FR1) : pH (su)



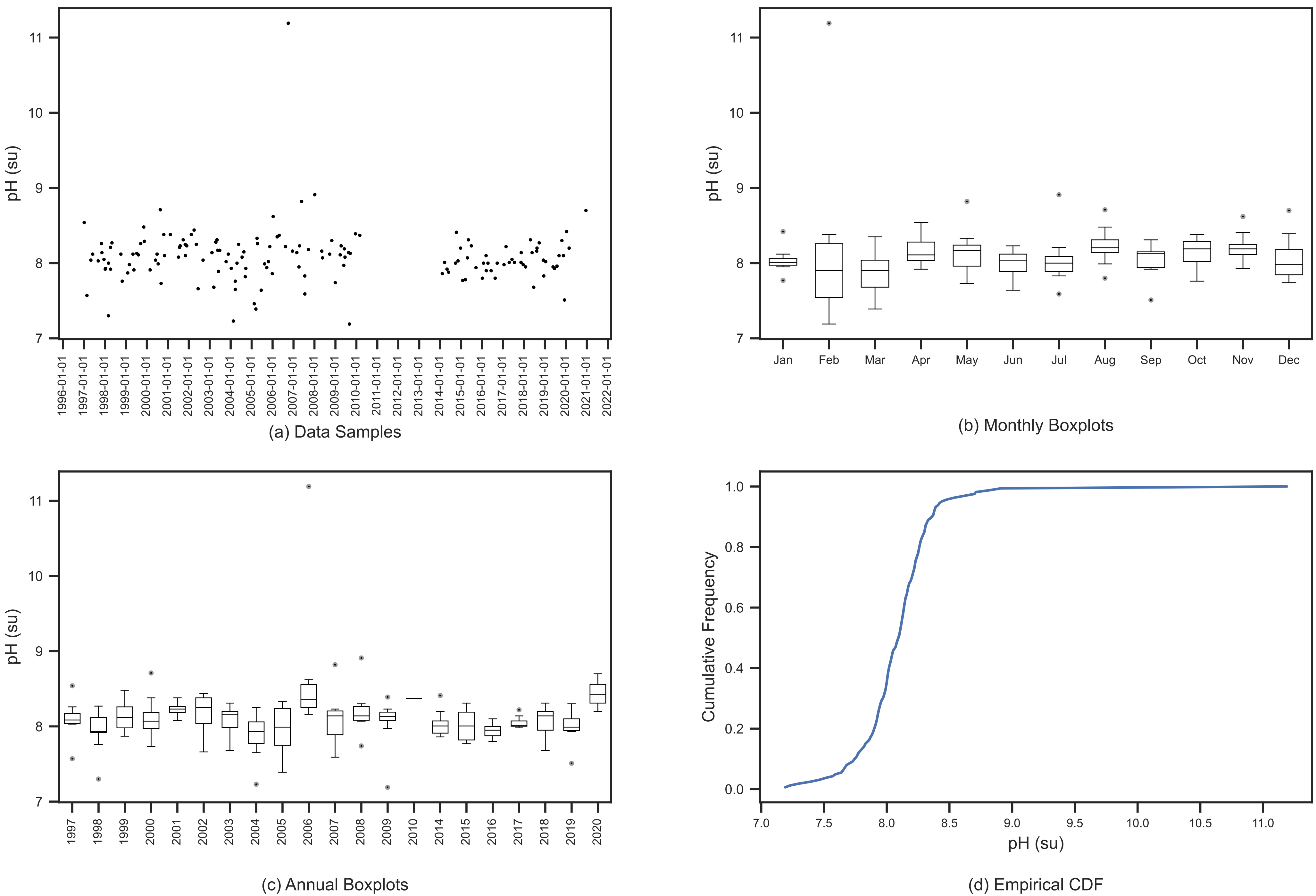
(a) Data Samples

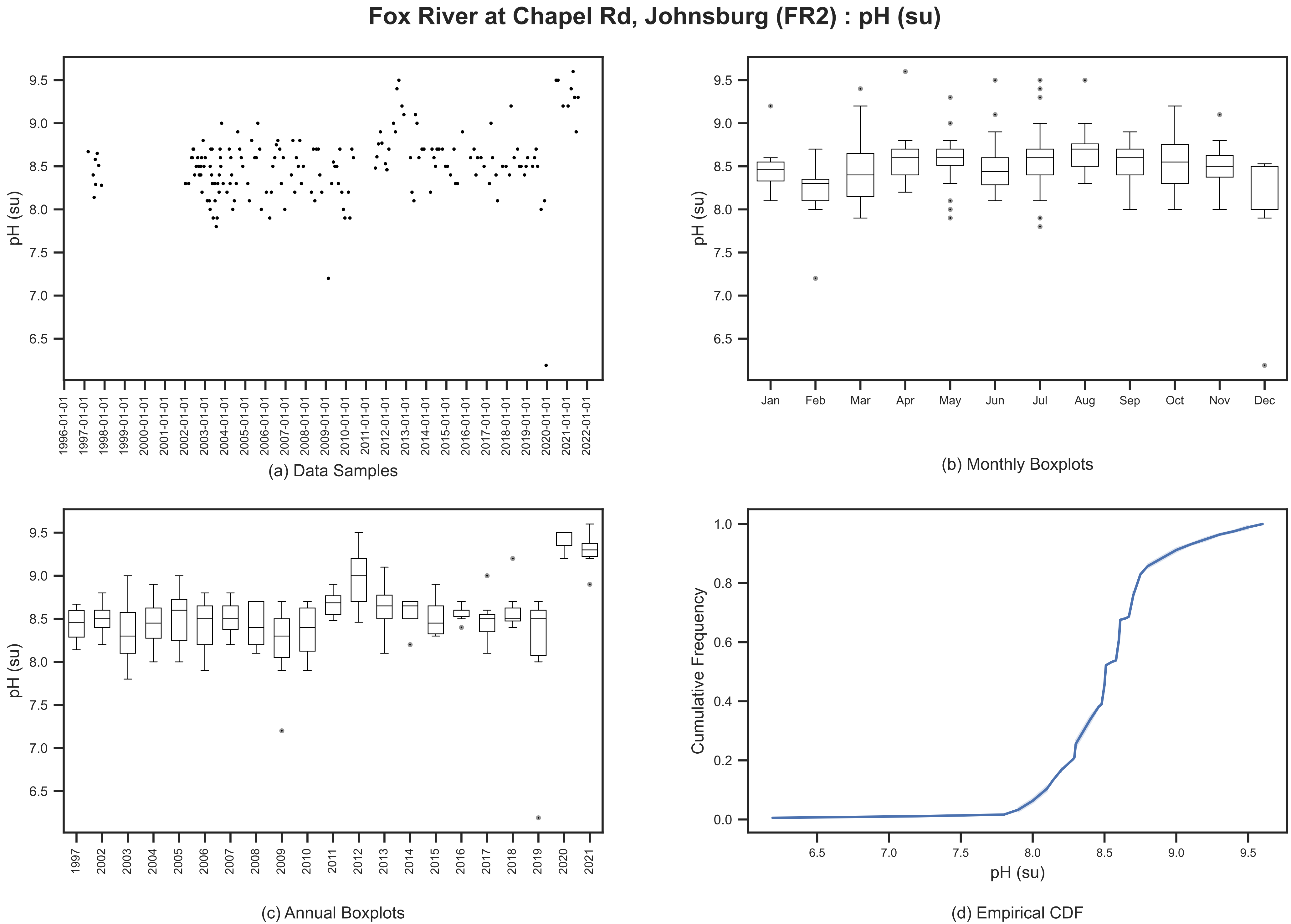
(b) Monthly Boxplots

(c) Annual Boxplots

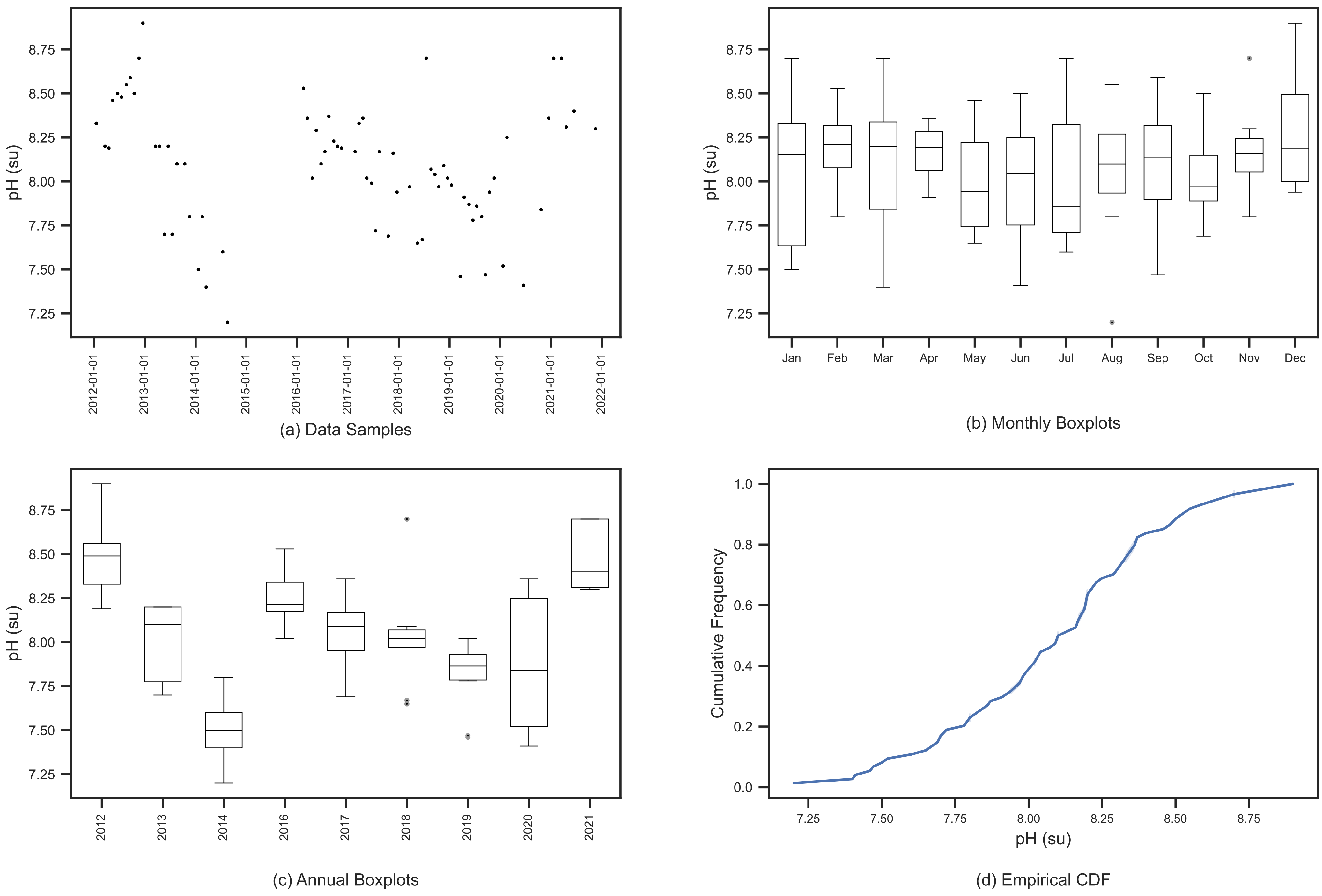
(d) Empirical CDF

Nippersink Creek near Spring Grove (NC1) : pH (su)

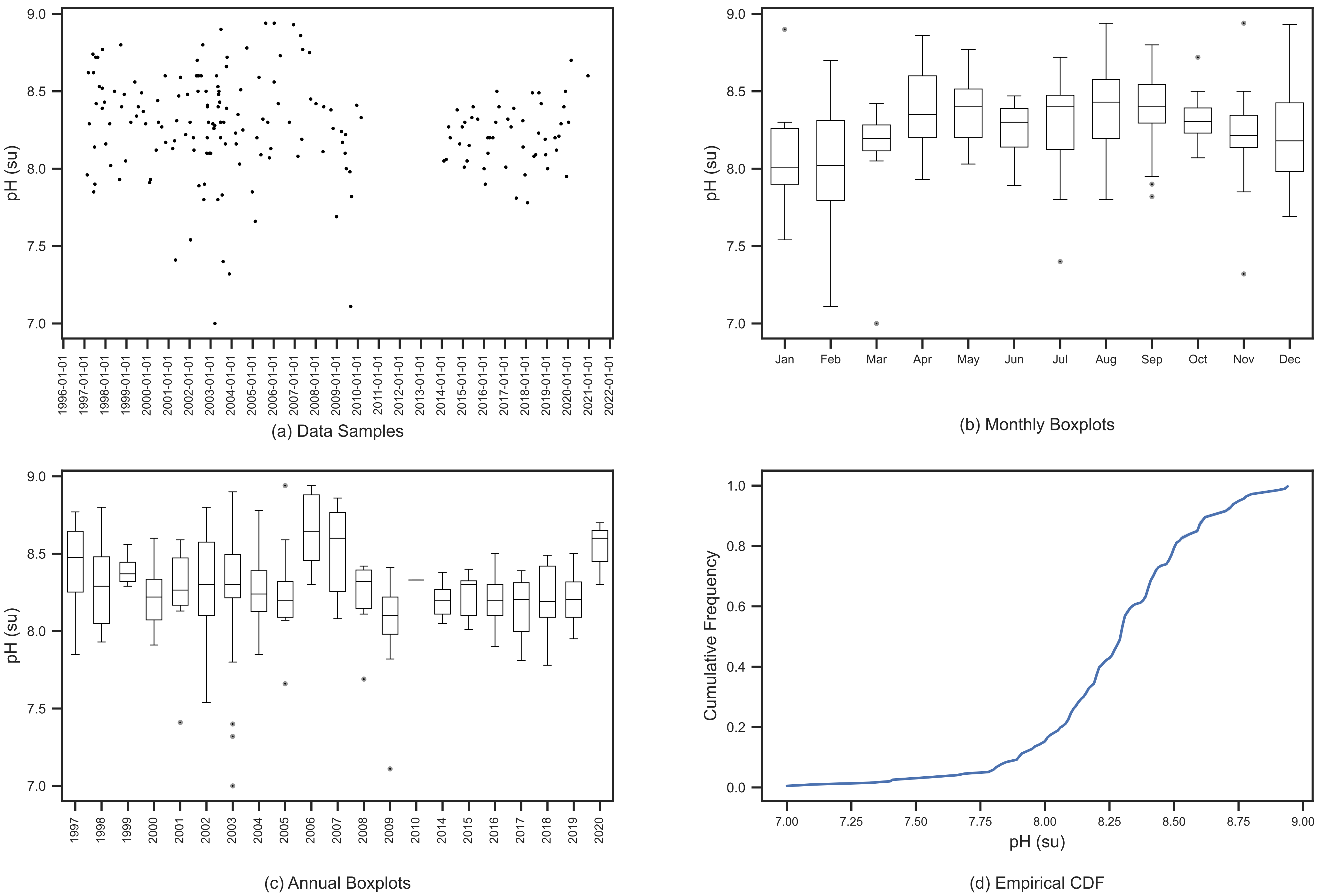



Fox River at Chapel Rd, Johnsburg (FR2) : pH (su)
pH (su)
(a) Data Samples
(b) Monthly Boxplots
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(c) Annual Boxplots
Cumulative Frequency
(d) Empirical CDF

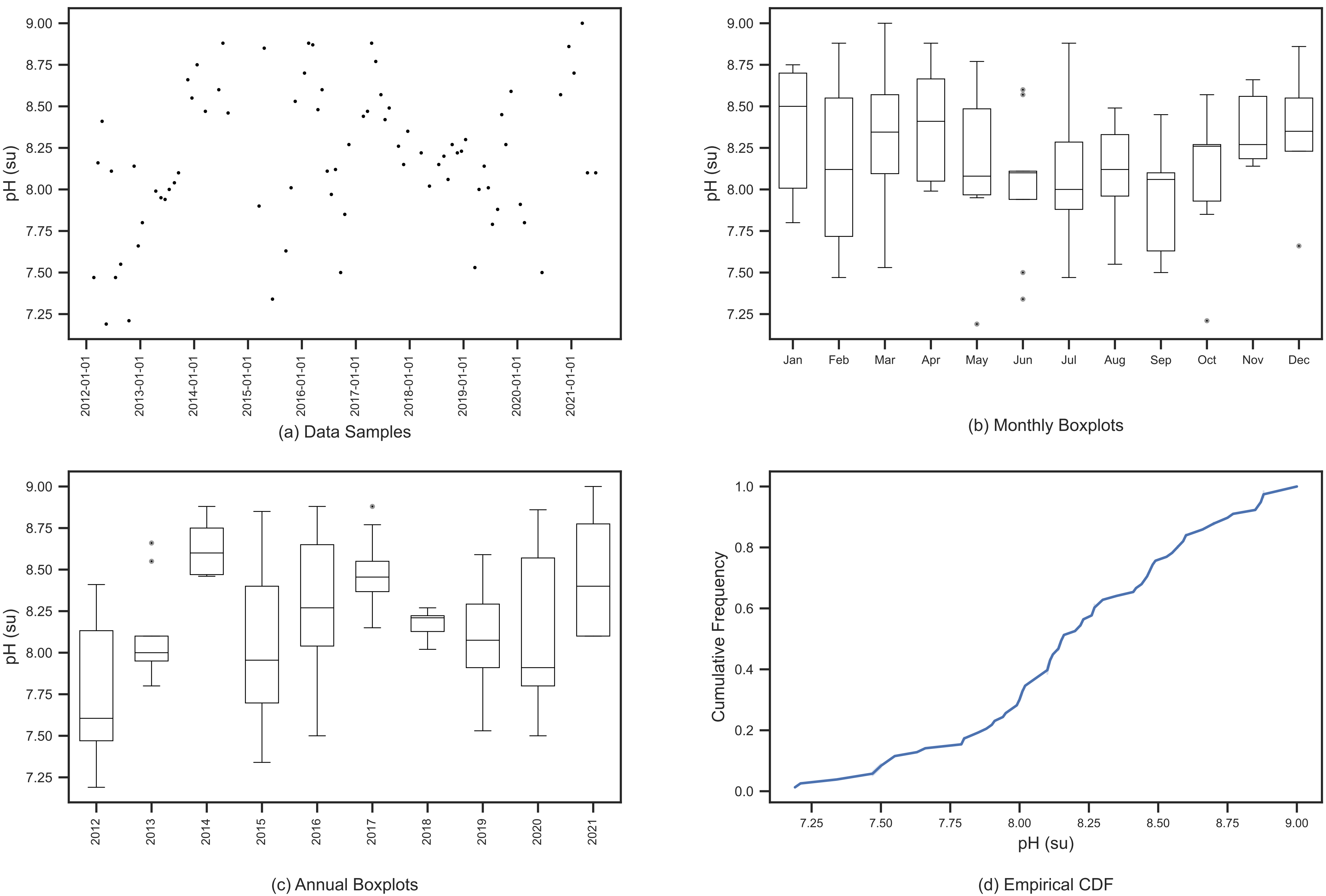
Sleepy Hollow Creek at Stilling Ln. (SH1) : pH (su)



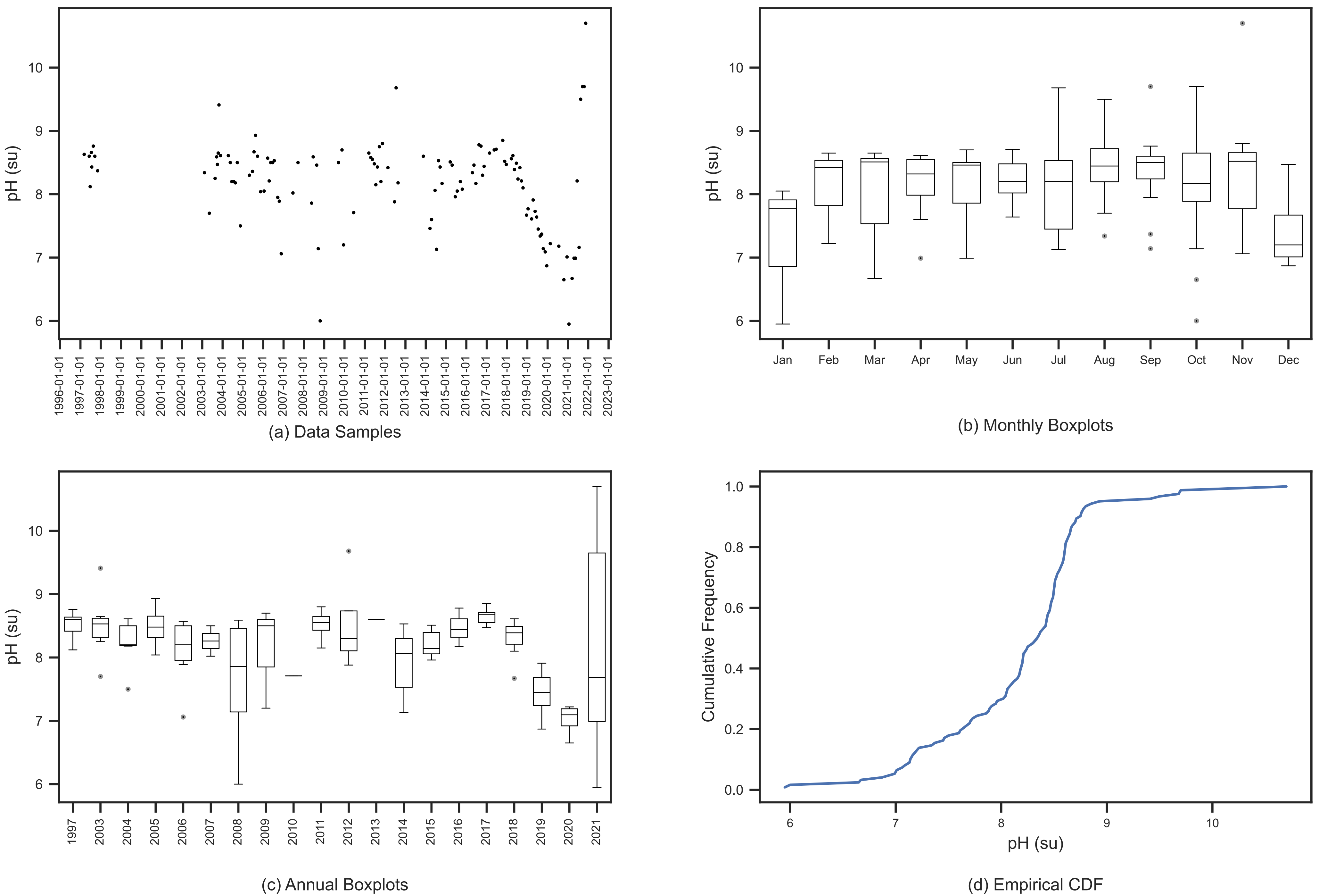
Fox River at Burtons Br. (FR3) : pH (su)



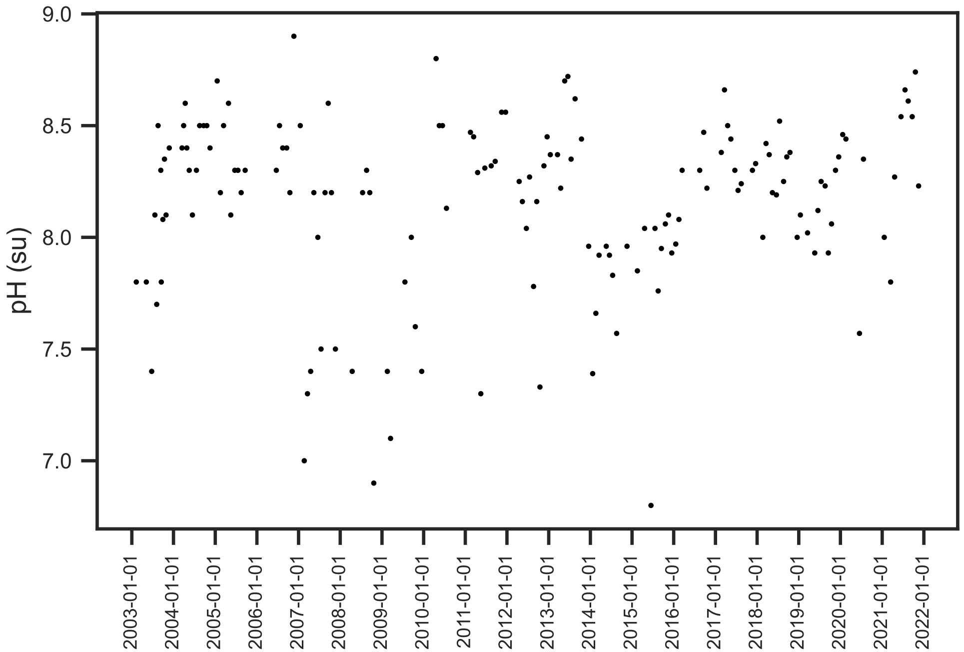
Silver Creek at Lk shore Dr. & E. Park Ln. (SC1) : pH (su)



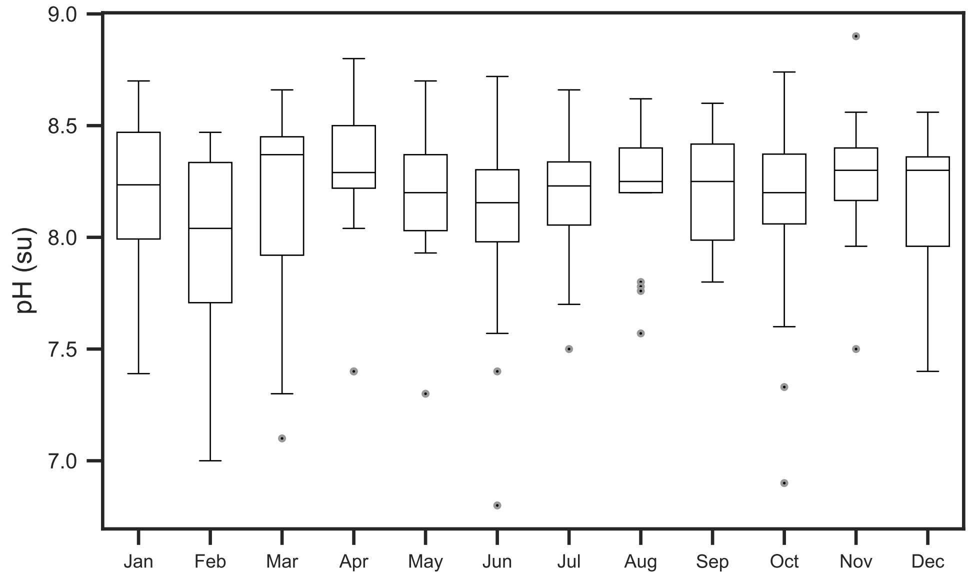
Fox River at Rawson Rd., E Oakwood Hills (FR4) : pH (su)



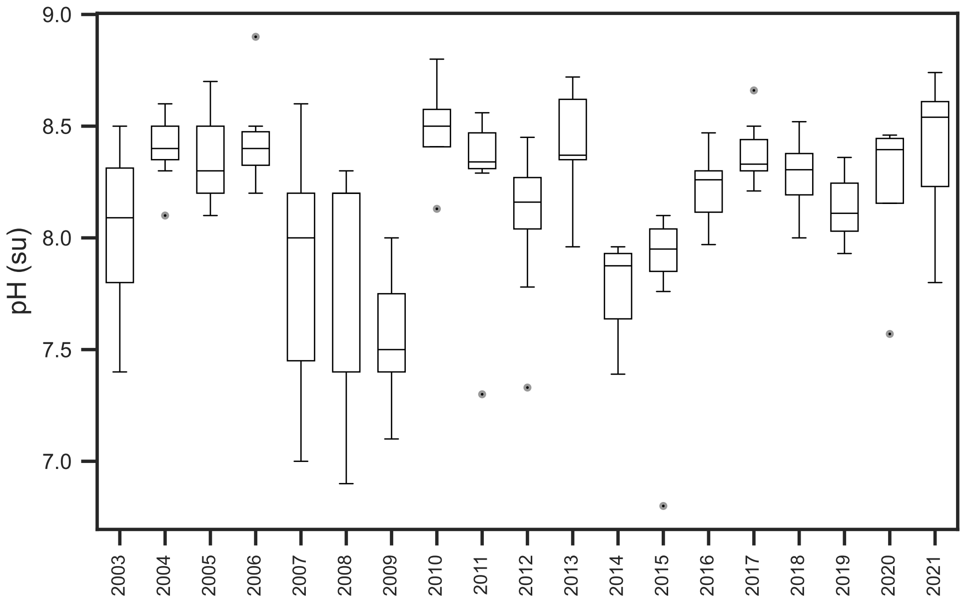
Crystal Lk Outlet-Rt 31, Algonquin (CL1) : pH (su)



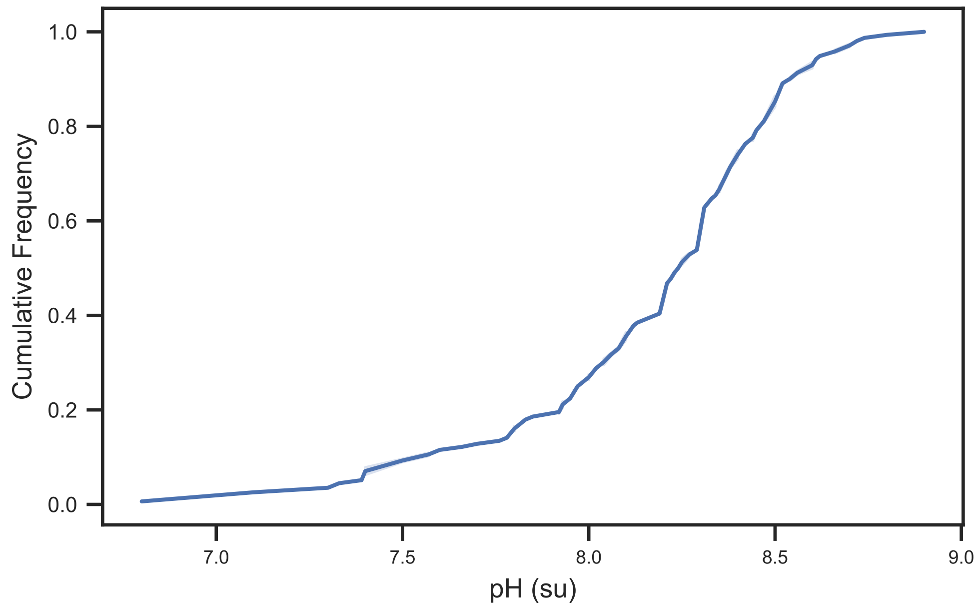
(a) Data Samples



(b) Monthly Boxplots

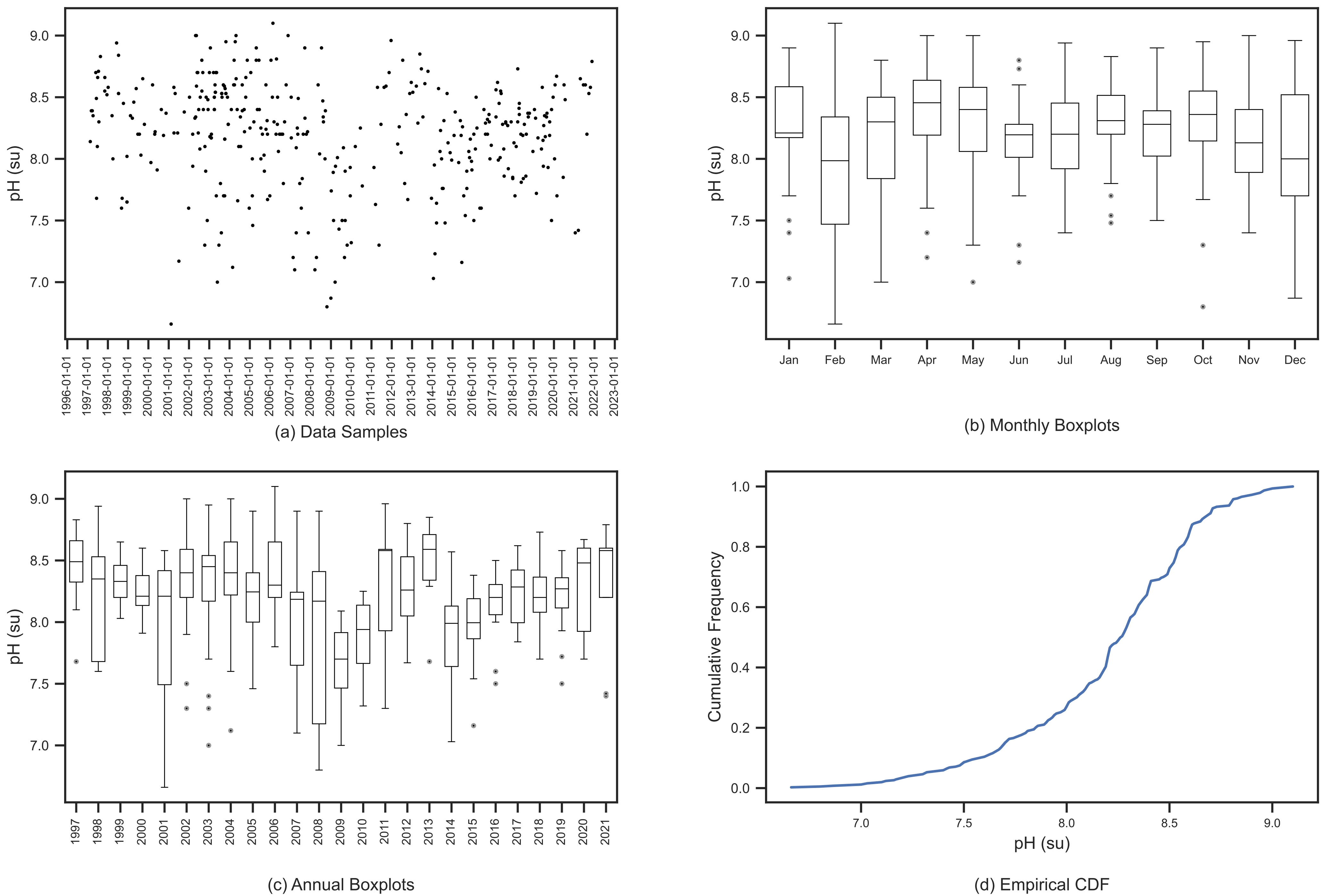


(c) Annual Boxplots

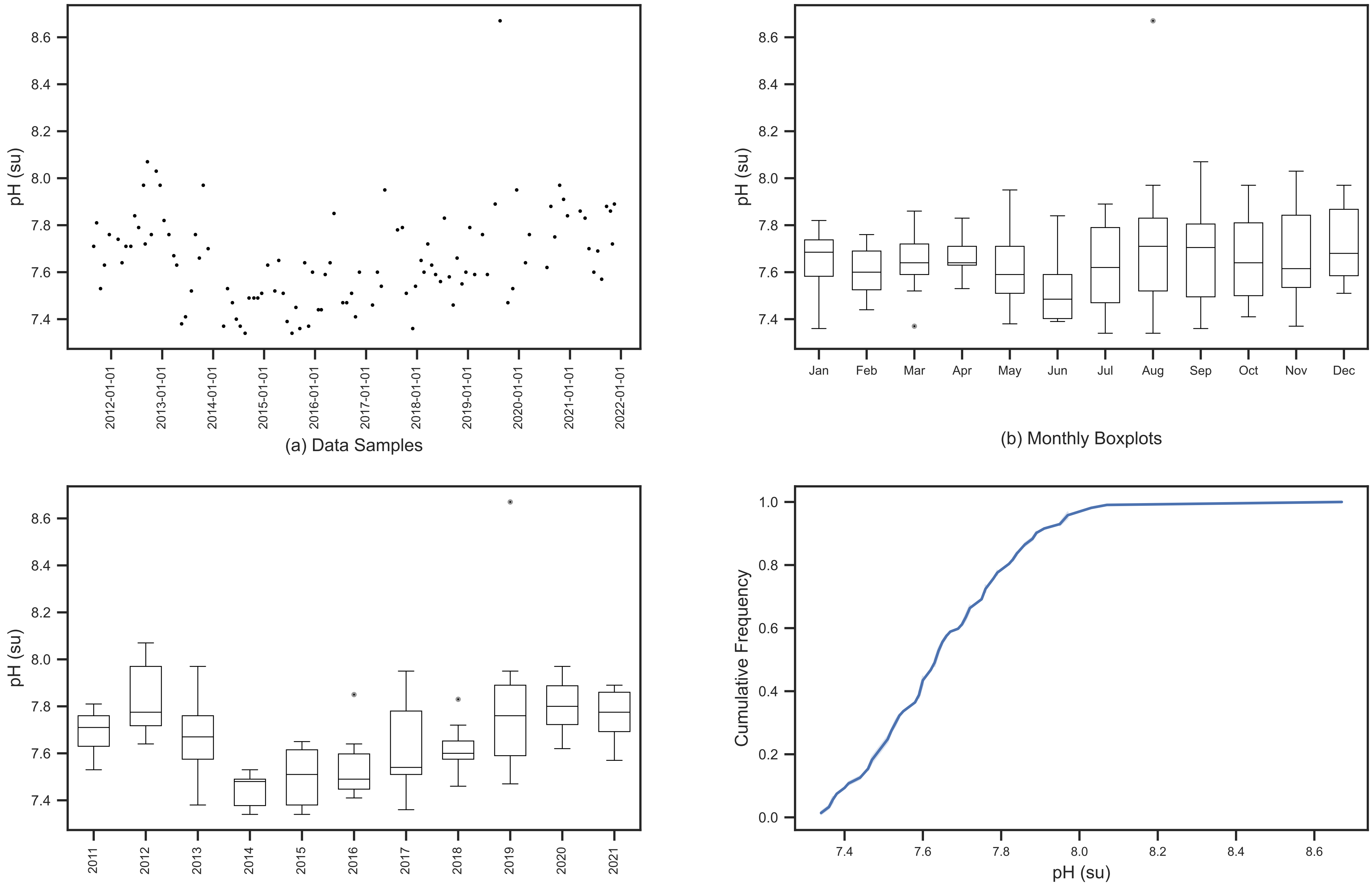


(d) Empirical CDF

Fox River at Algonquin (FR5) : pH (su)



Tyler Creek at Damisch (TC1) : pH (su)



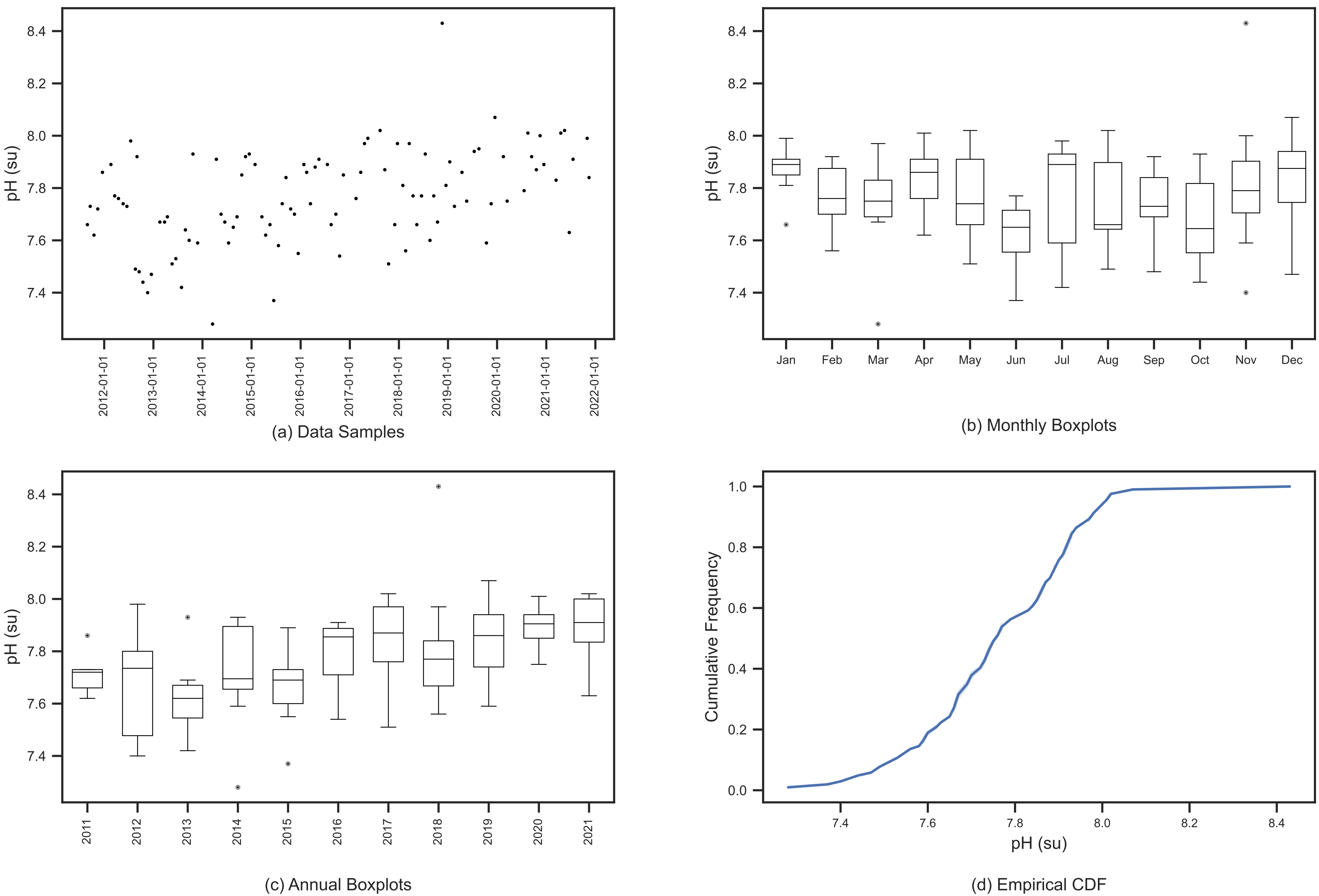
(a) Data Samples

(b) Monthly Boxplots

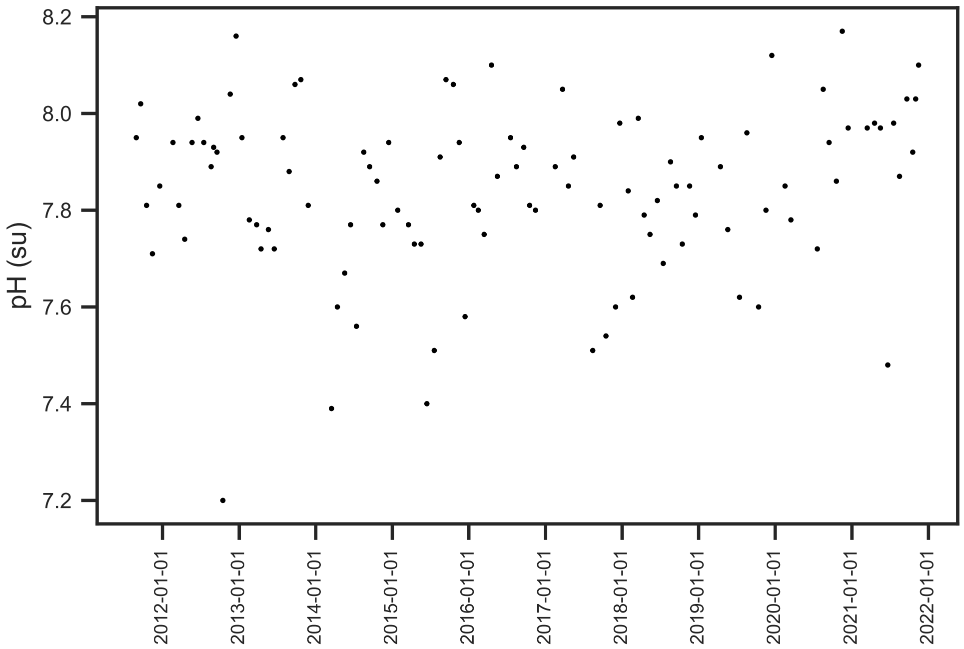
(c) Annual Boxplots

(d) Empirical CDF

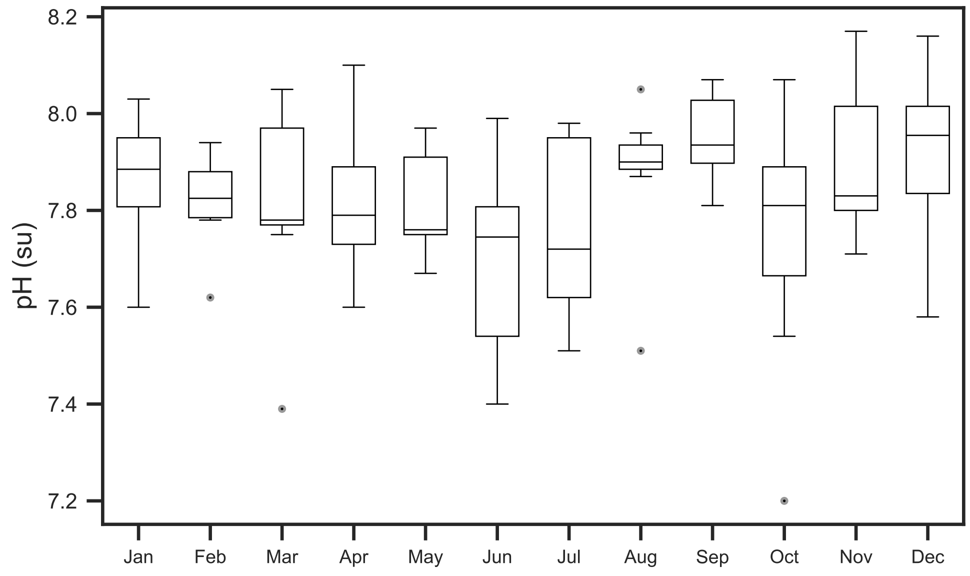
Tyler Creek at Highland (TC2) : pH (su)



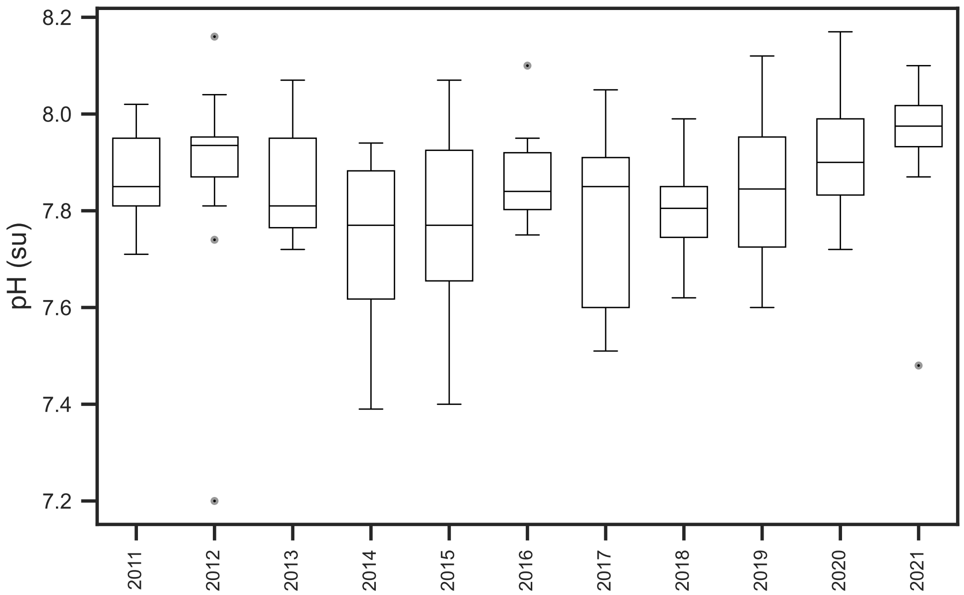
Tyler Creek at McCornack (TC3) : pH (su)



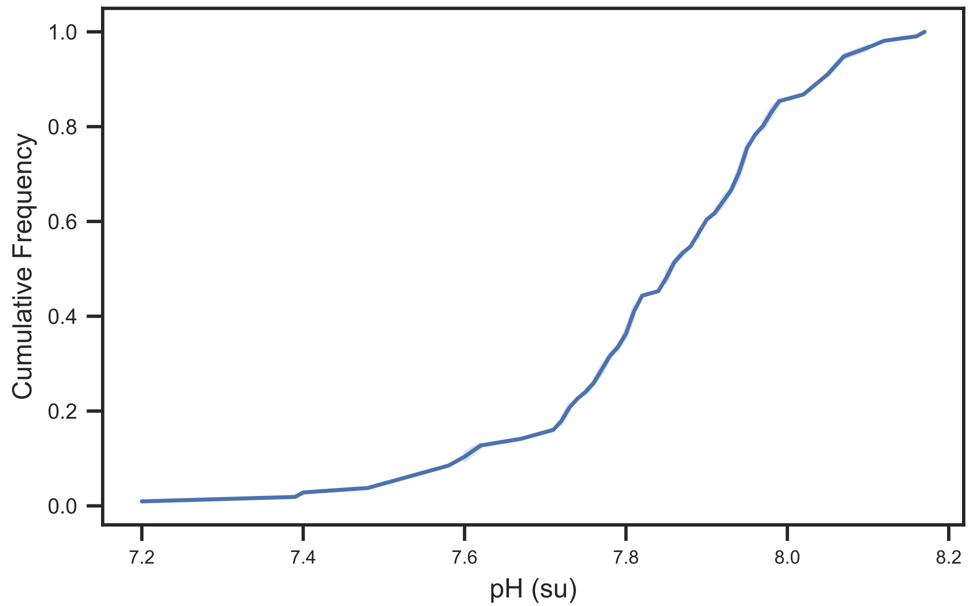
(a) Data Samples



(b) Monthly Boxplots

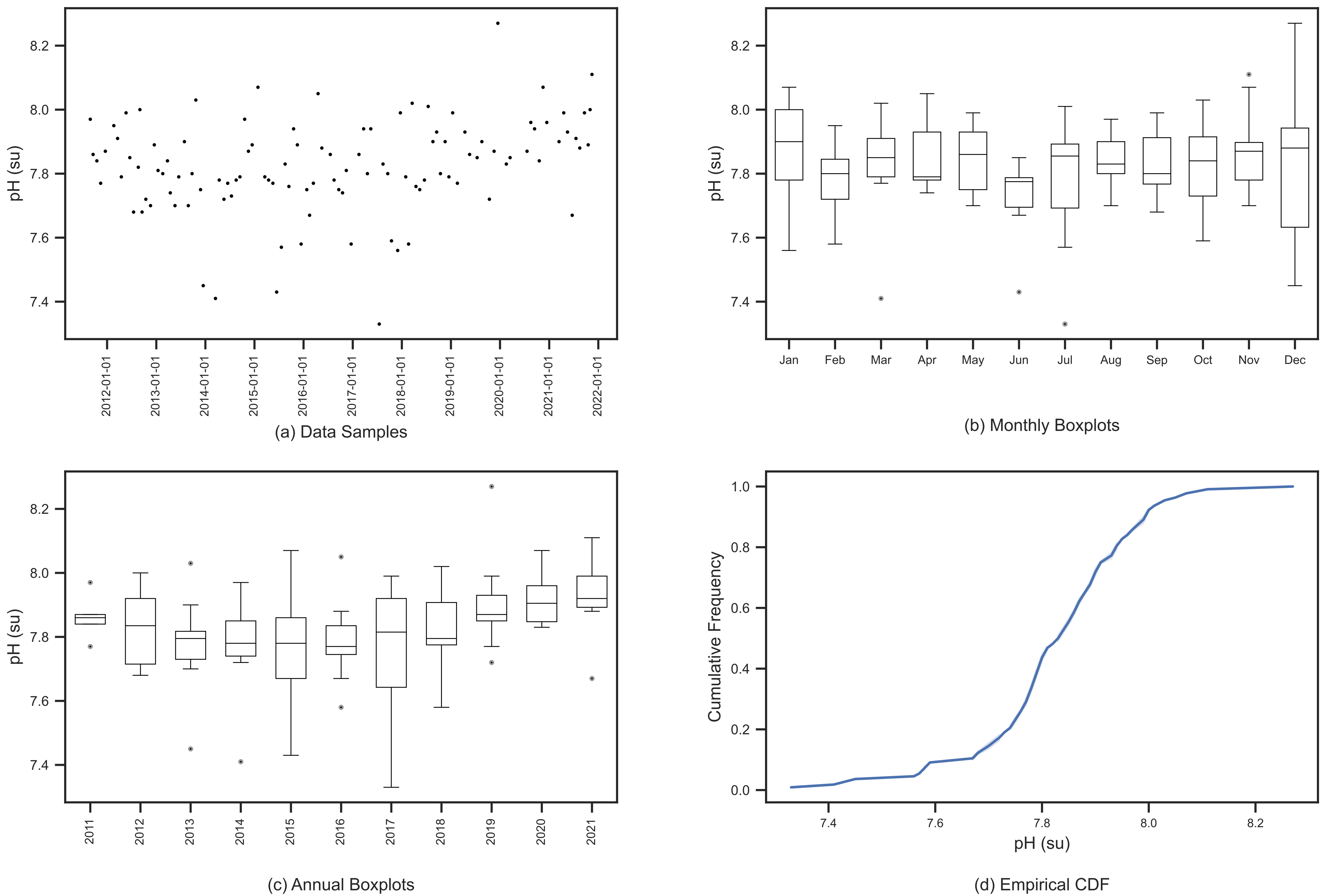


(c) Annual Boxplots



(d) Empirical CDF

Tyler Creek at Timber Trail (TC4) : pH (su)

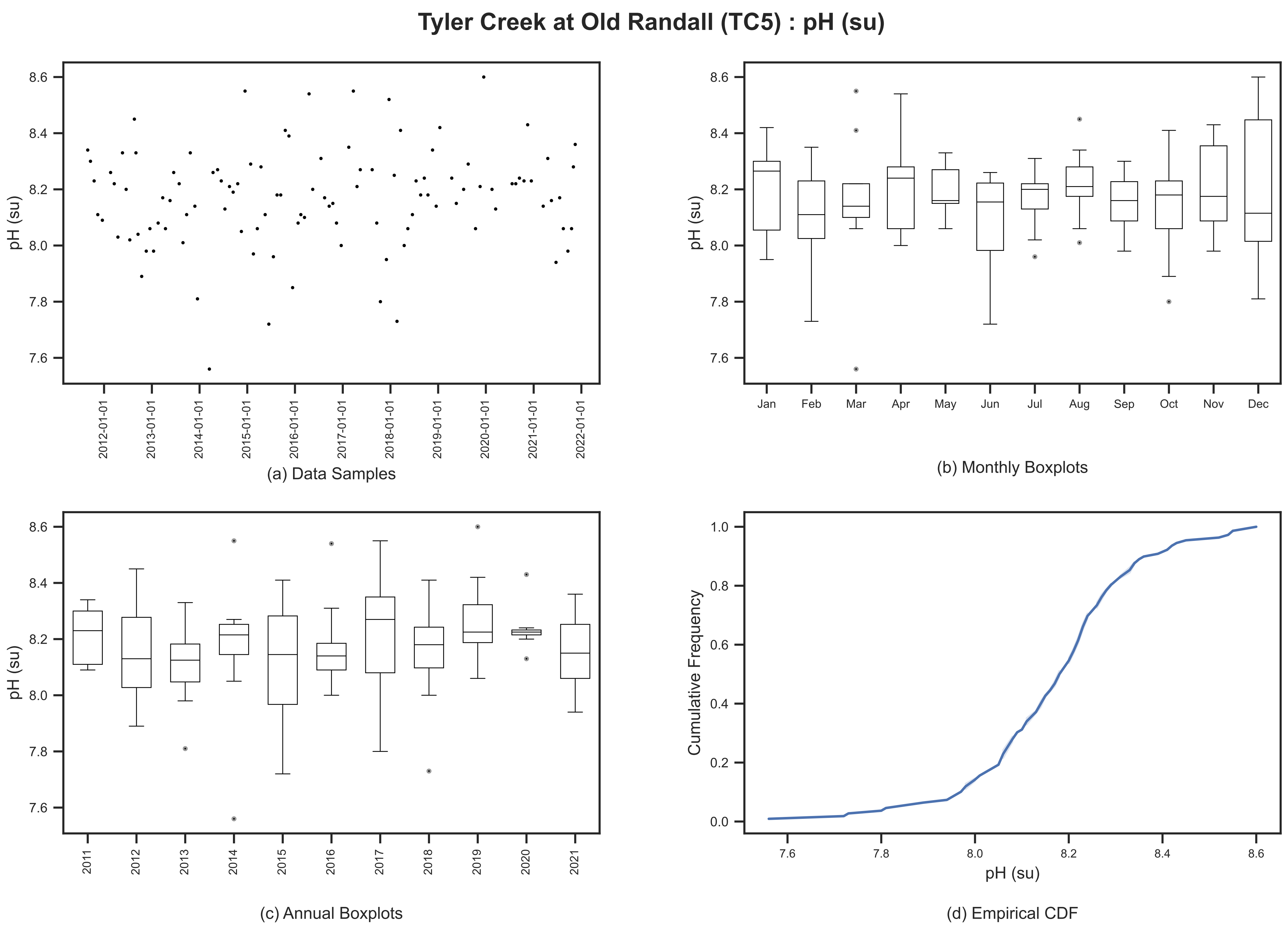


(a) Data Samples

(b) Monthly Boxplots

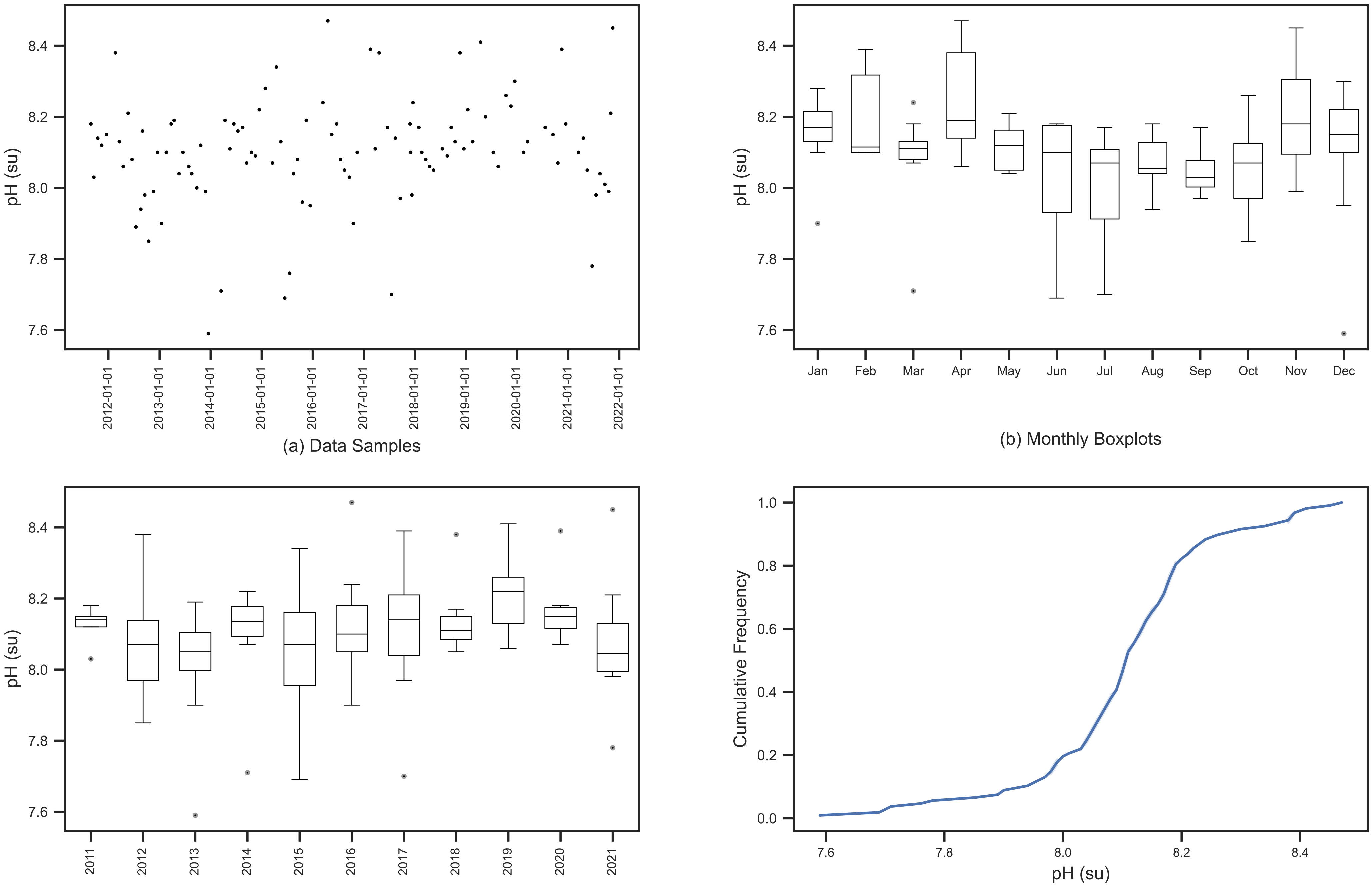
(c) Annual Boxplots

(d) Empirical CDF



Tyler Creek at Old Randall (TC5) : pH (su)
pH (su)
8.6
8.4
8.2
8.0
7.8
7.6
2012-01-01
2013-01-01
2014-01-01
2015-01-01
2016-01-01
2017-01-01
2018-01-01
2019-01-01
2020-01-01
2021-01-01
2022-01-01
(a) Data Samples
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(b) Monthly Boxplots
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
(c) Annual Boxplots
Cumulative Frequency
1.0
0.8
0.6
0.4
0.2
0.0
(d) Empirical CDF

Tyler Creek at Spring Cove (TC6) : pH (su)



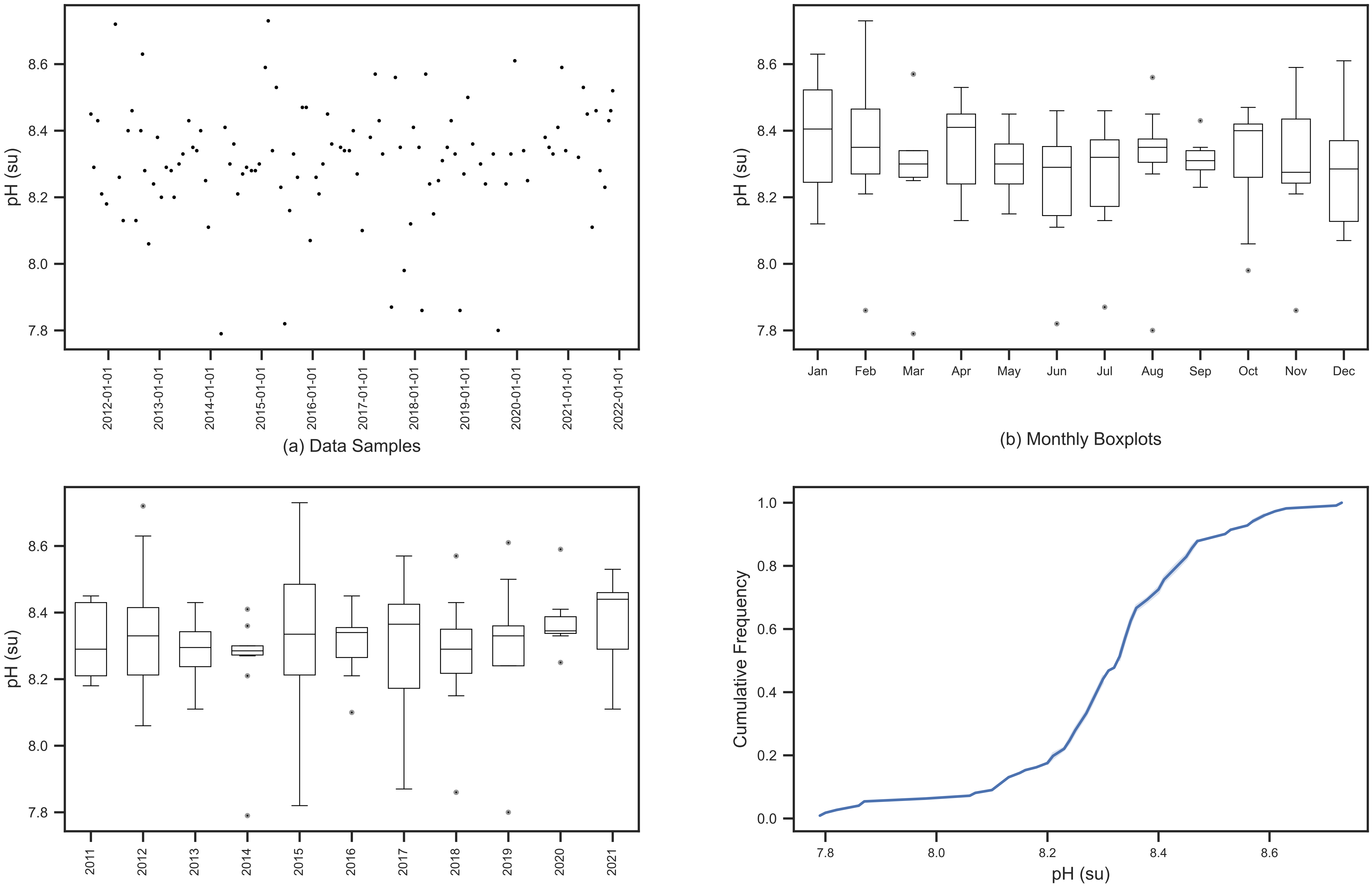
(a) Data Samples

(b) Monthly Boxplots

(c) Annual Boxplots

(d) Empirical CDF

Tyler Creek at Judson (TC7) : pH (su)



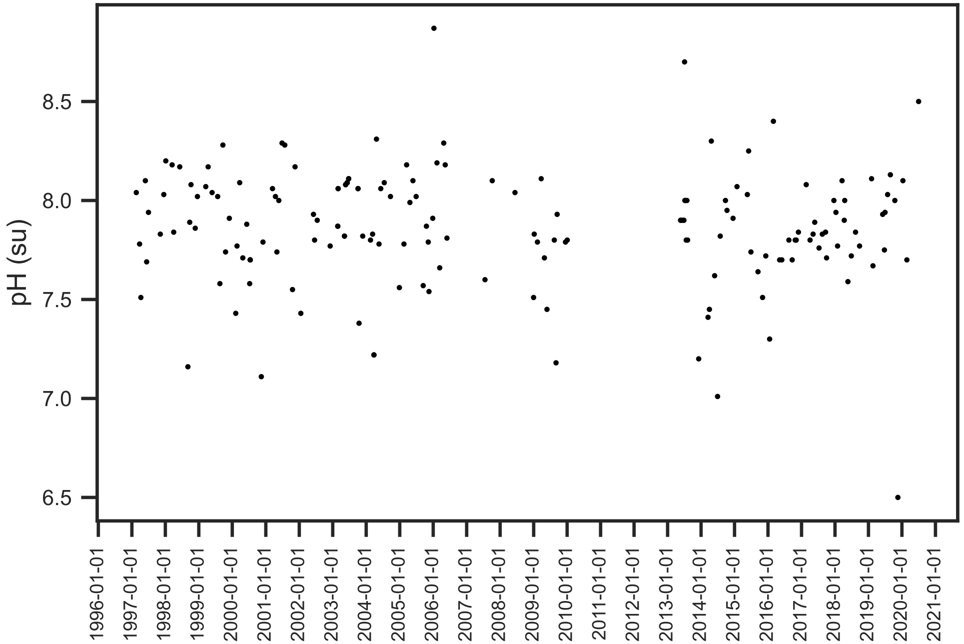
(a) Data Samples

(b) Monthly Boxplots

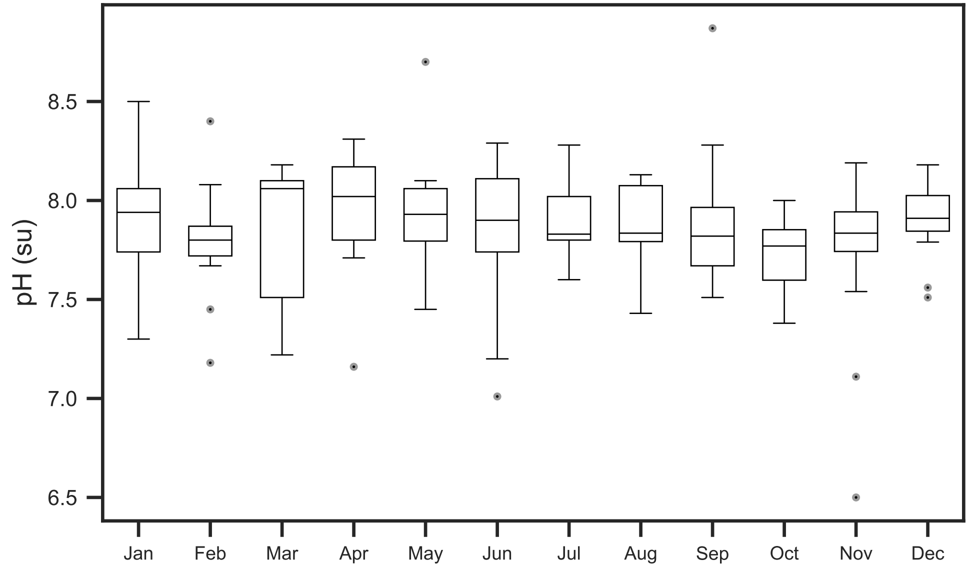
(c) Annual Boxplots

(d) Empirical CDF

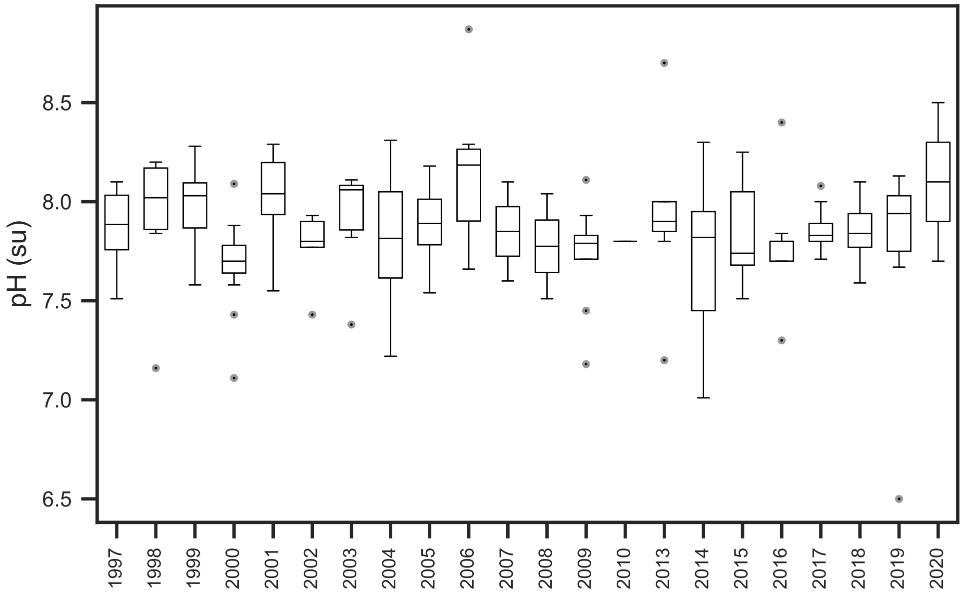
Poplar Creek at Elgin (PC1) : pH (su)



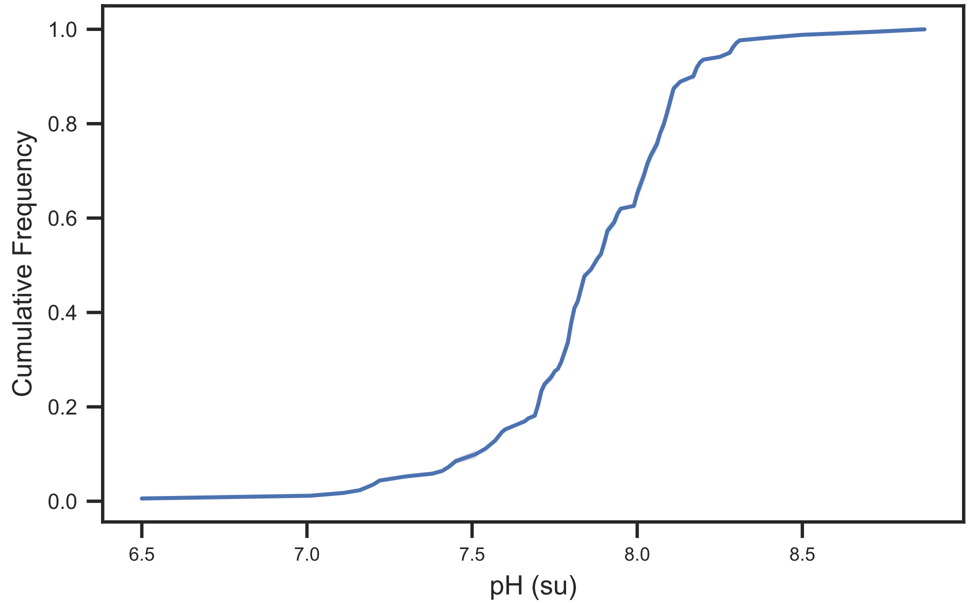
(a) Data Samples



(b) Monthly Boxplots

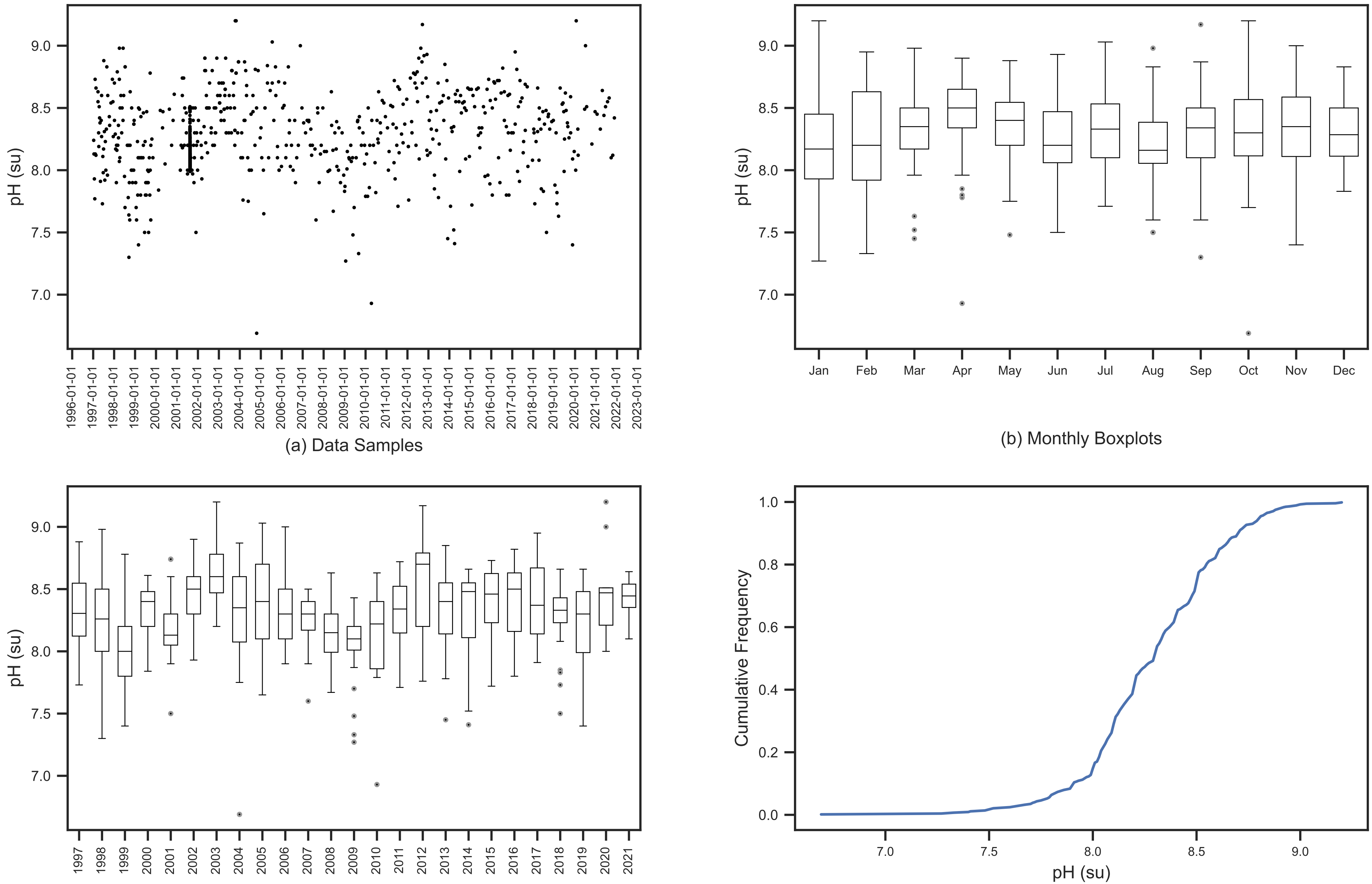


(c) Annual Boxplots



(d) Empirical CDF

Fox River at South Elgin (FR6) : pH (su)



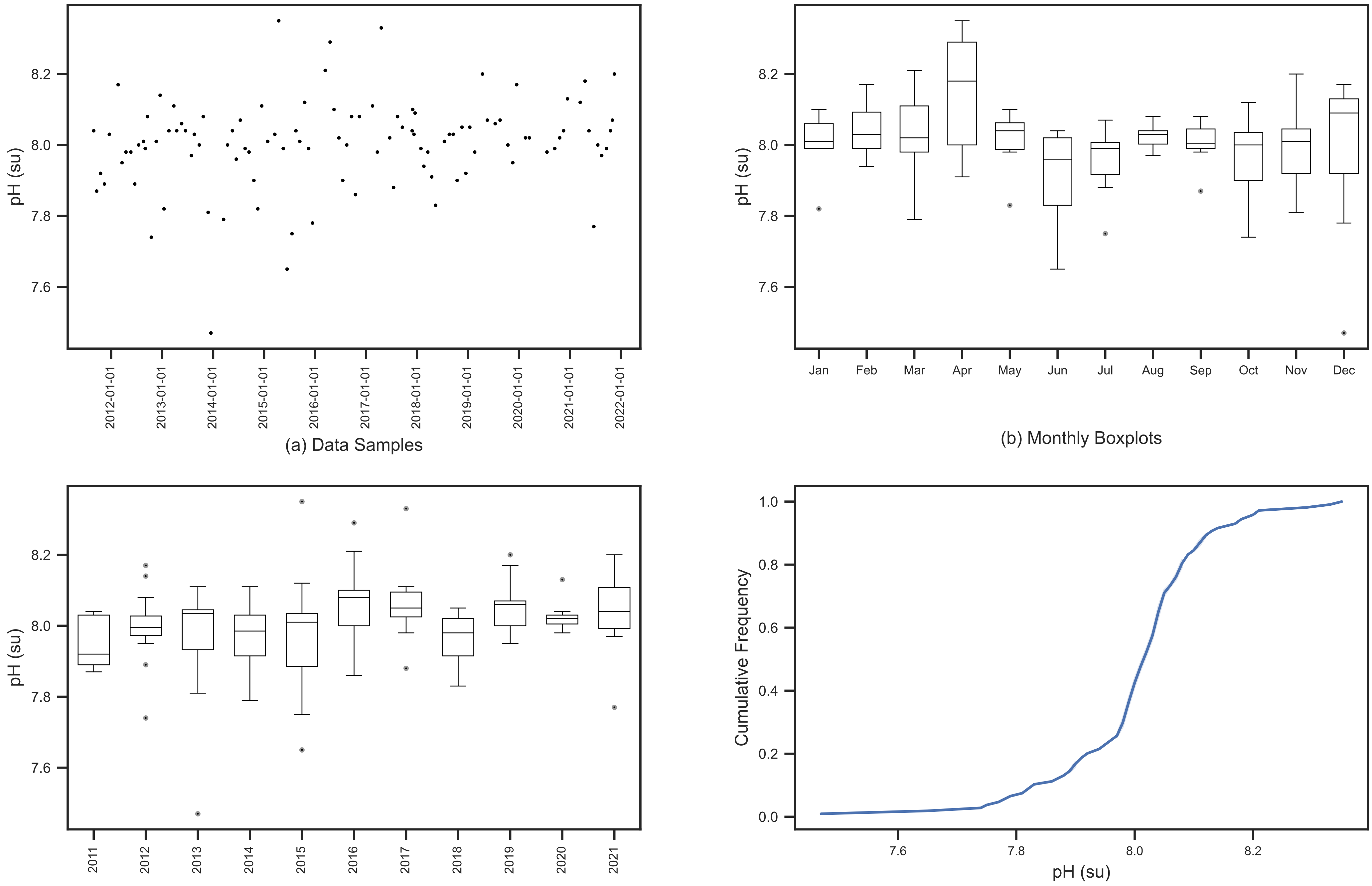
(a) Data Samples

(b) Monthly Boxplots

(c) Annual Boxplots

(d) Empirical CDF

Sandy Creek (SY1) : pH (su)



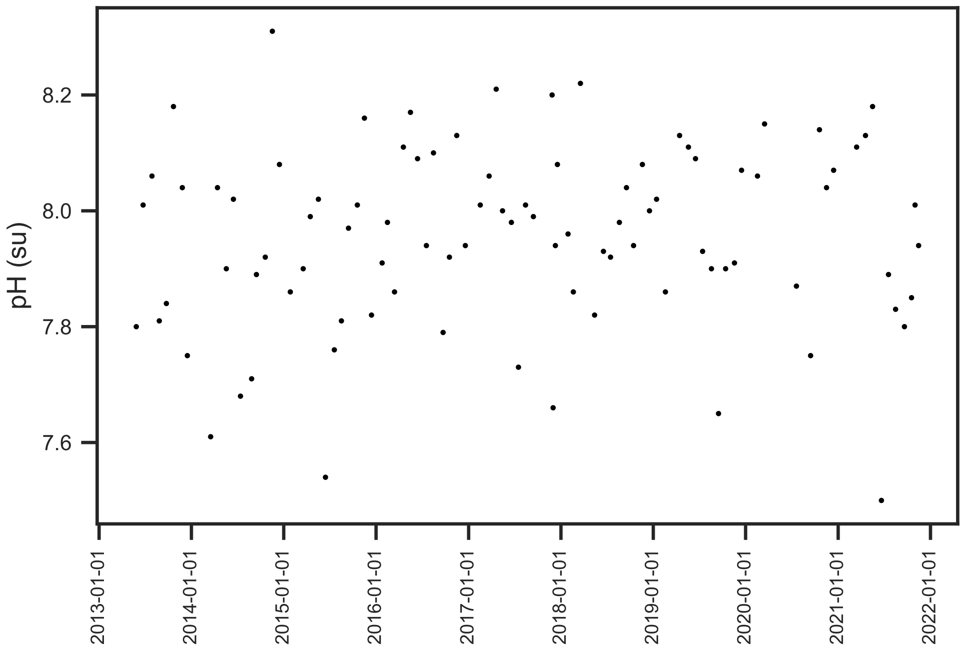
(a) Data Samples

(b) Monthly Boxplots

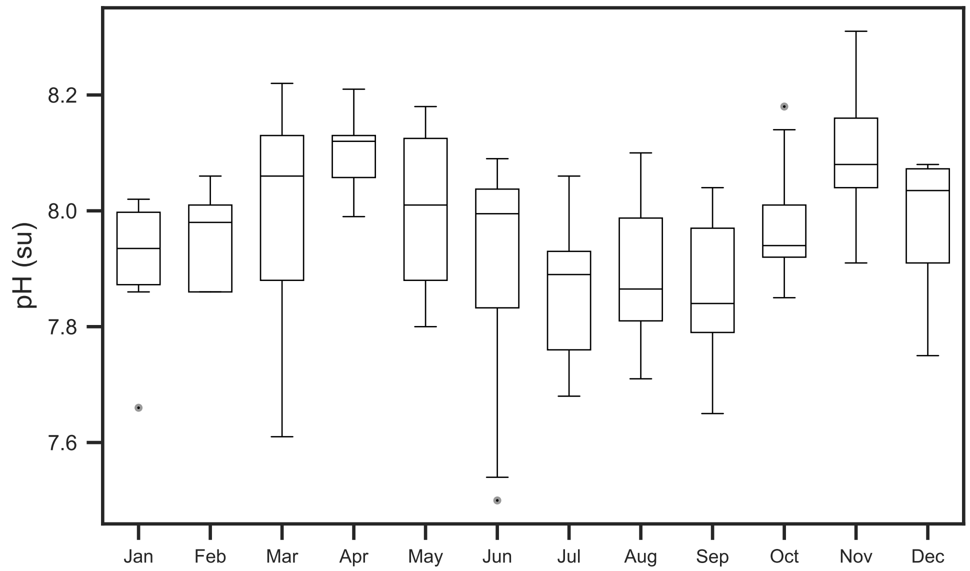
(c) Annual Boxplots

(d) Empirical CDF

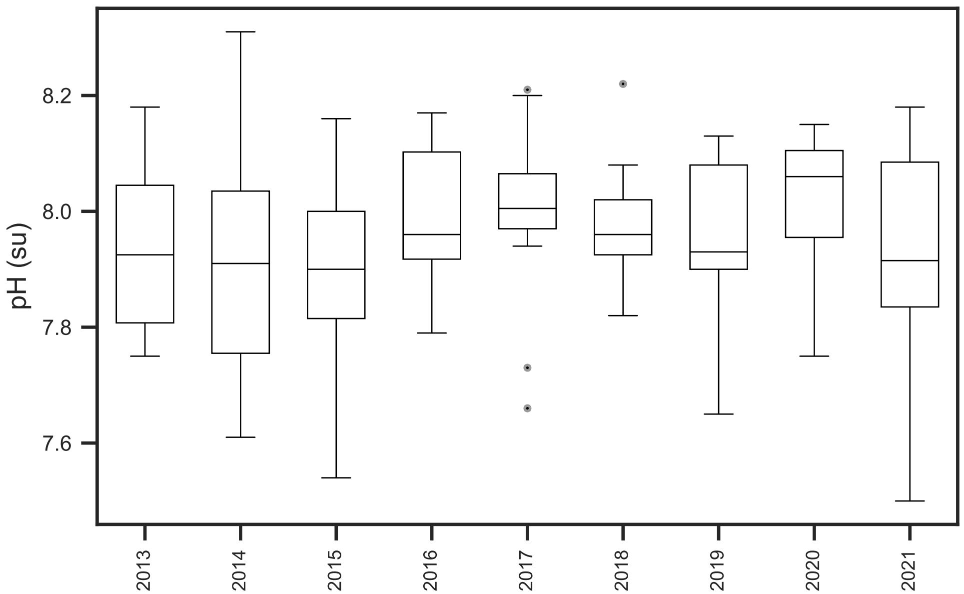
Otter Creek at Bowes Rd. (OC1) : pH (su)



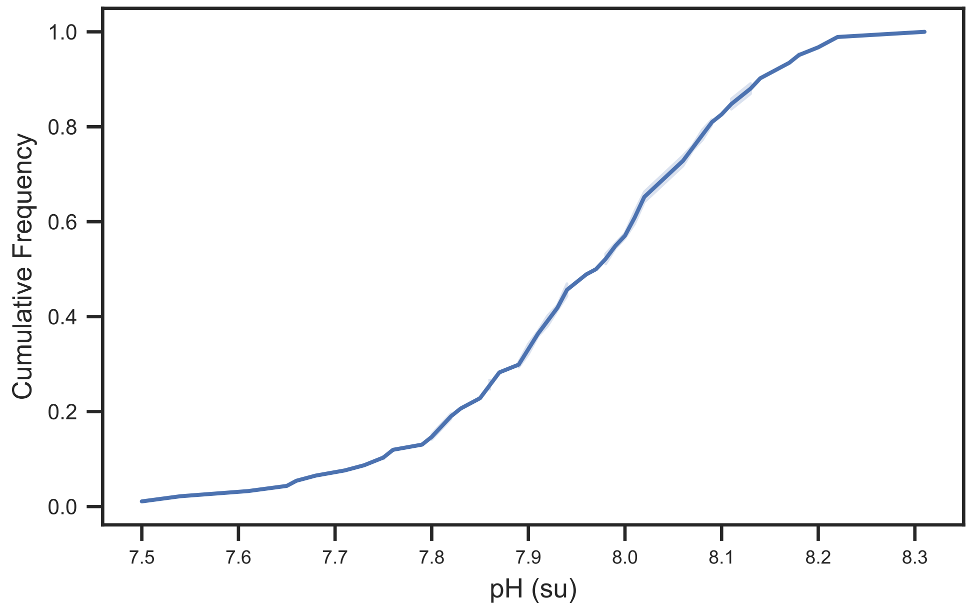
(a) Data Samples



(b) Monthly Boxplots

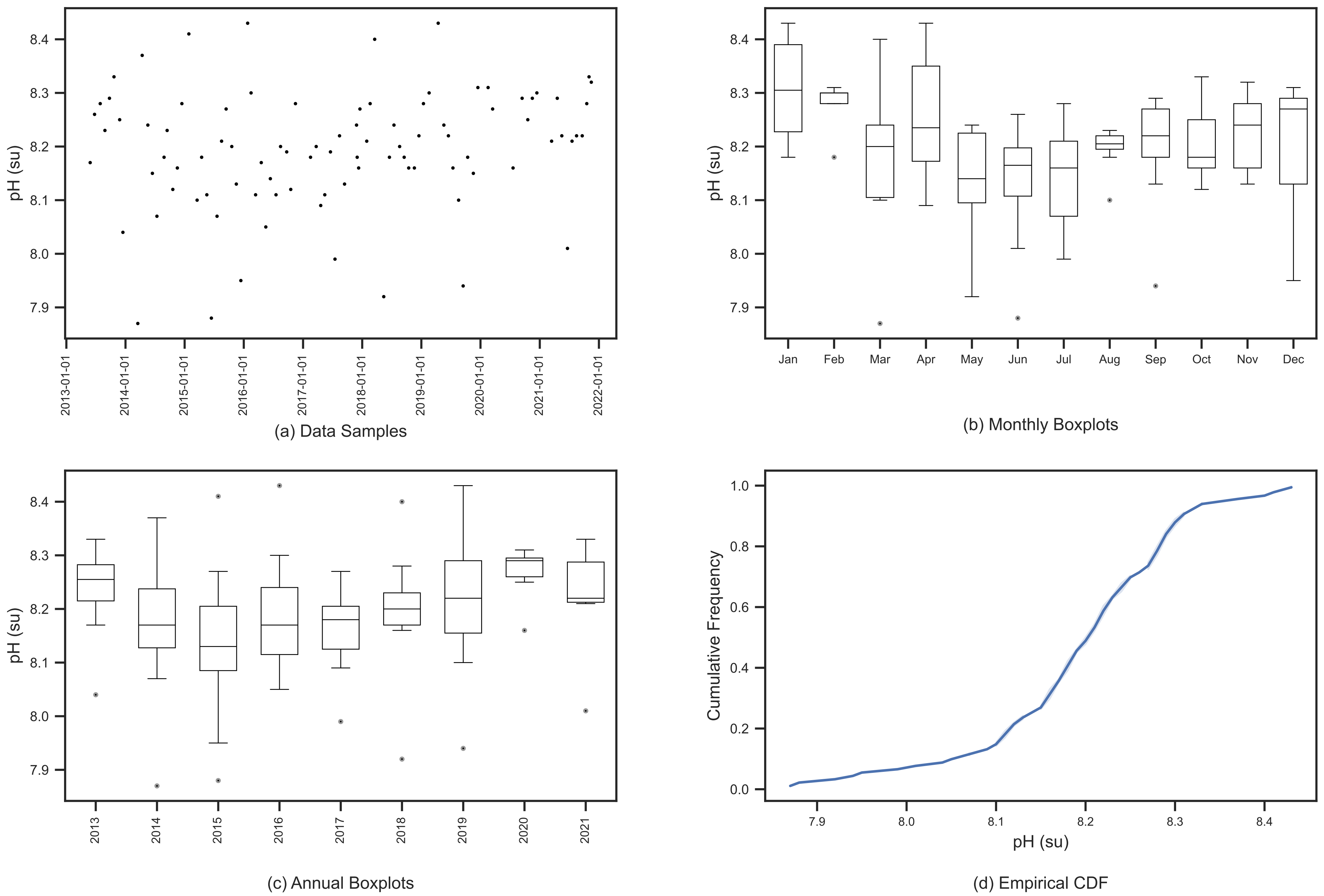


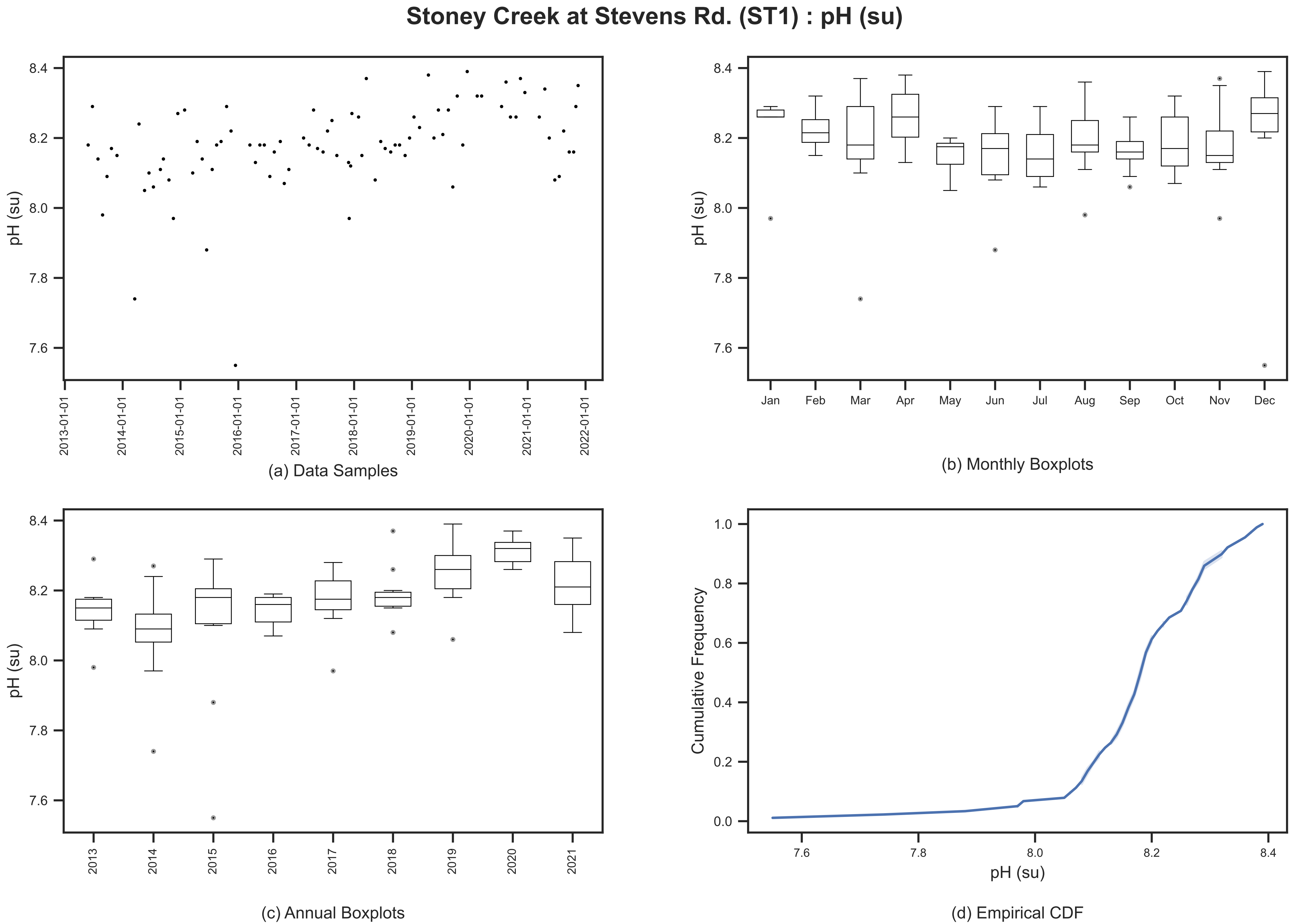
(c) Annual Boxplots



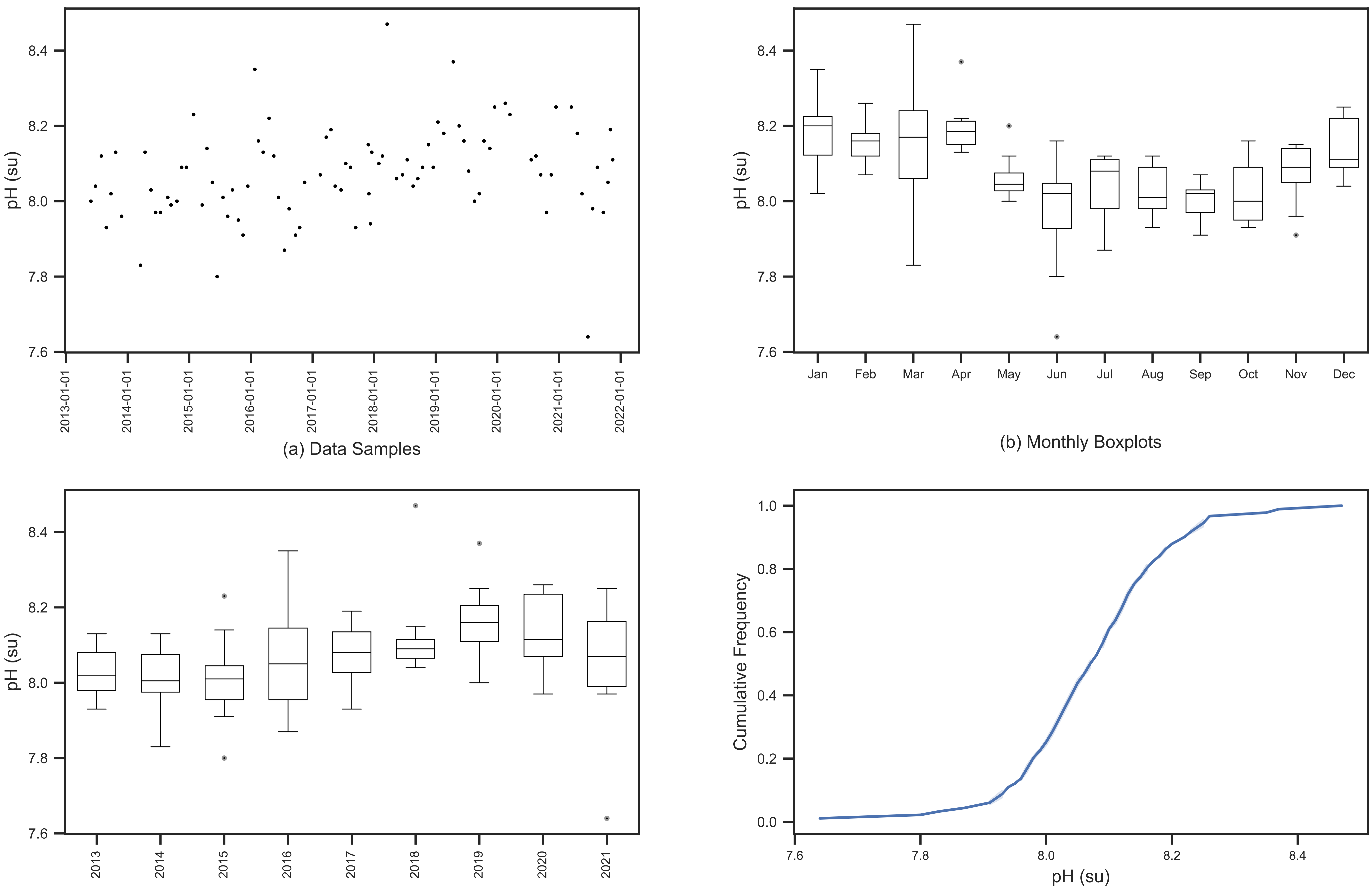
(d) Empirical CDF

Fitchie Creek at Bowes Rd. (FT1) : pH (su)




Stoney Creek at Stevens Rd. (ST1) : pH (su)
pH (su)
8.4
8.2
8.0
7.8
7.6
2013-01-01
2014-01-01
2015-01-01
2016-01-01
2017-01-01
2018-01-01
2019-01-01
2020-01-01
2021-01-01
2022-01-01
(a) Data Samples
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(b) Monthly Boxplots
2013
2014
2015
2016
2017
2018
2019
2020
2021
(c) Annual Boxplots
Cumulative Frequency
1.0
0.8
0.6
0.4
0.2
0.0
(d) Empirical CDF

Otter Creek at Burr (OC2) : pH (su)



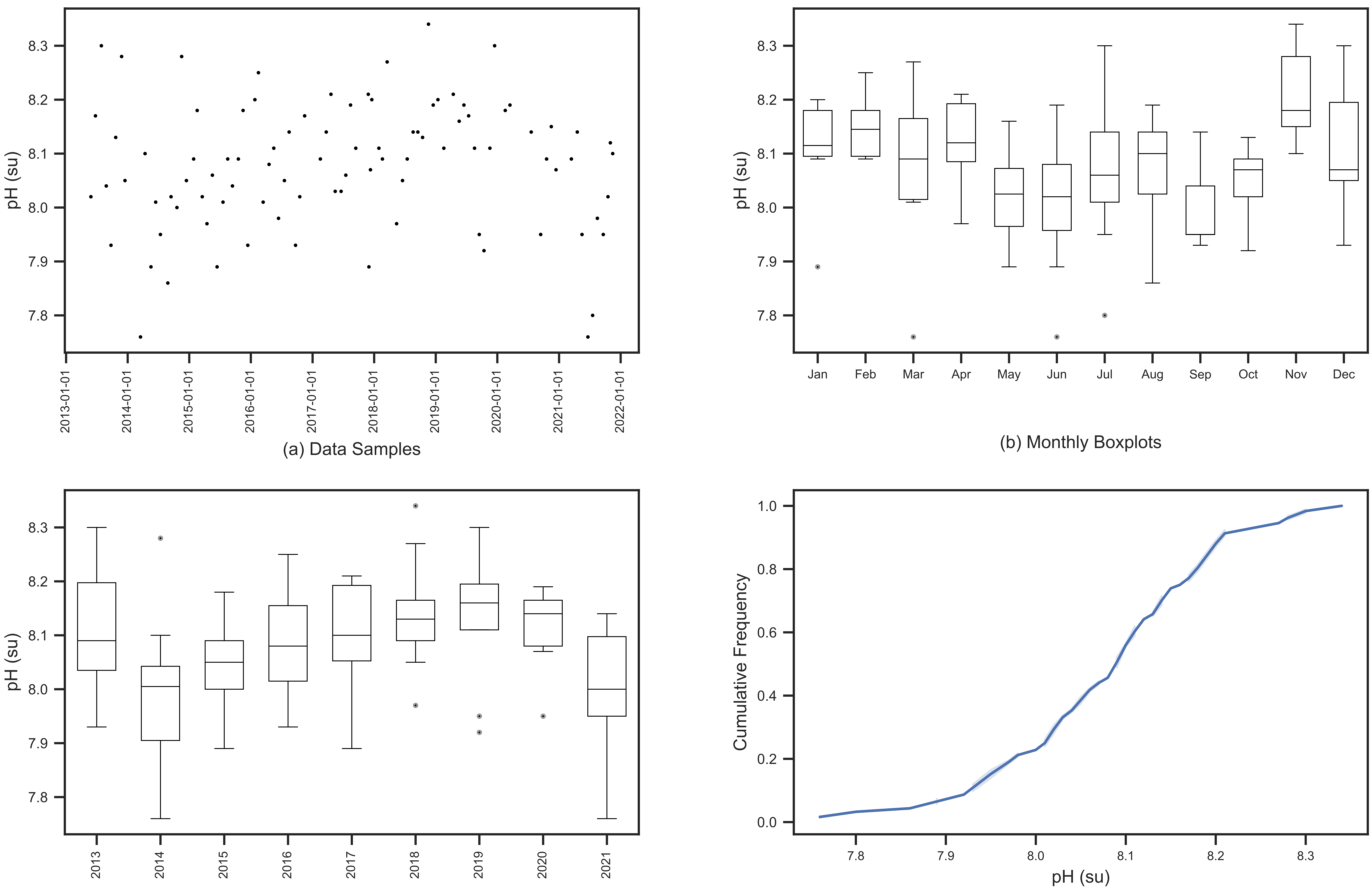
(a) Data Samples

(b) Monthly Boxplots

(c) Annual Boxplots

(d) Empirical CDF

Otter Creek at Silver Glen Rd. (OC3) : pH (su)



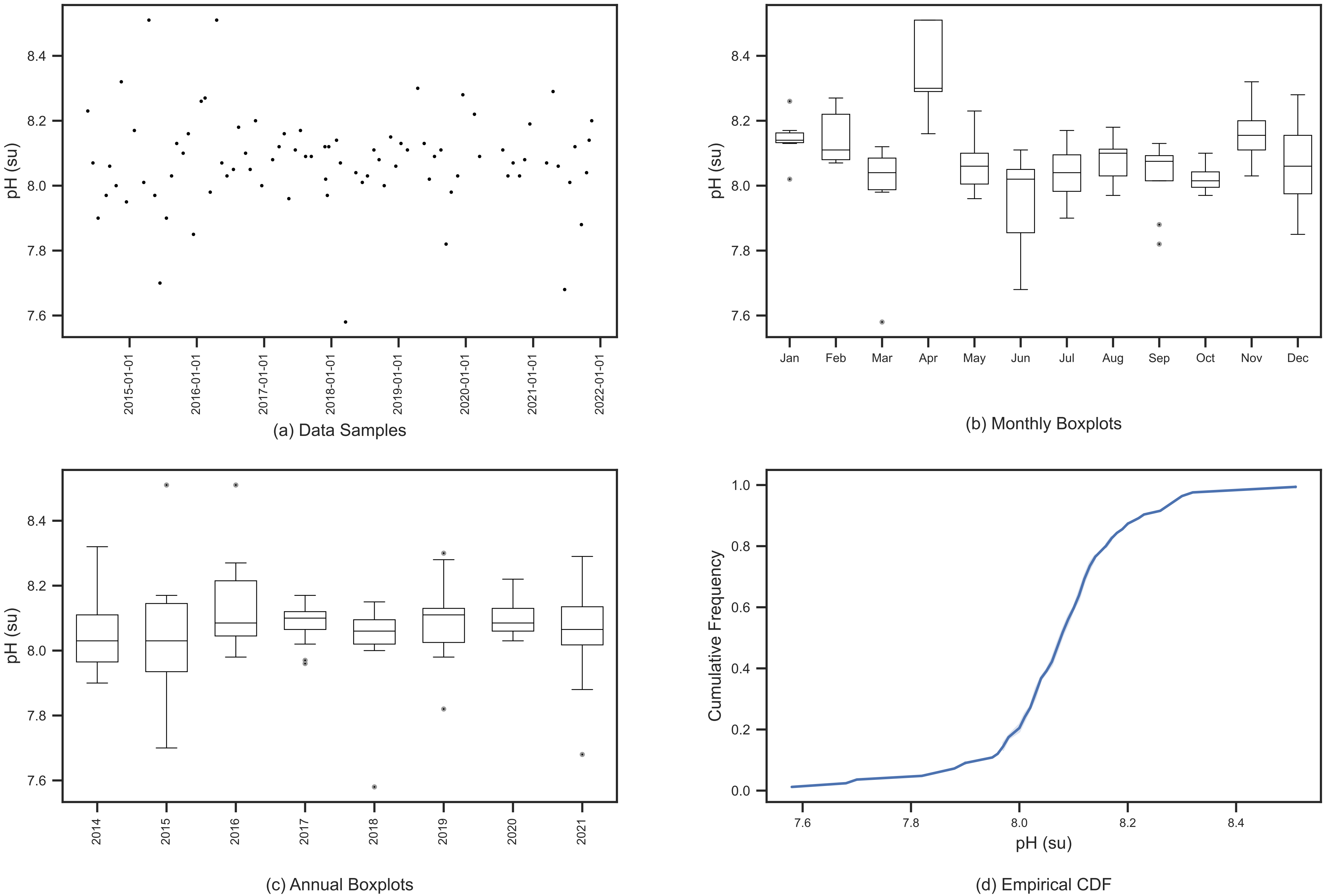
(a) Data Samples

(b) Monthly Boxplots

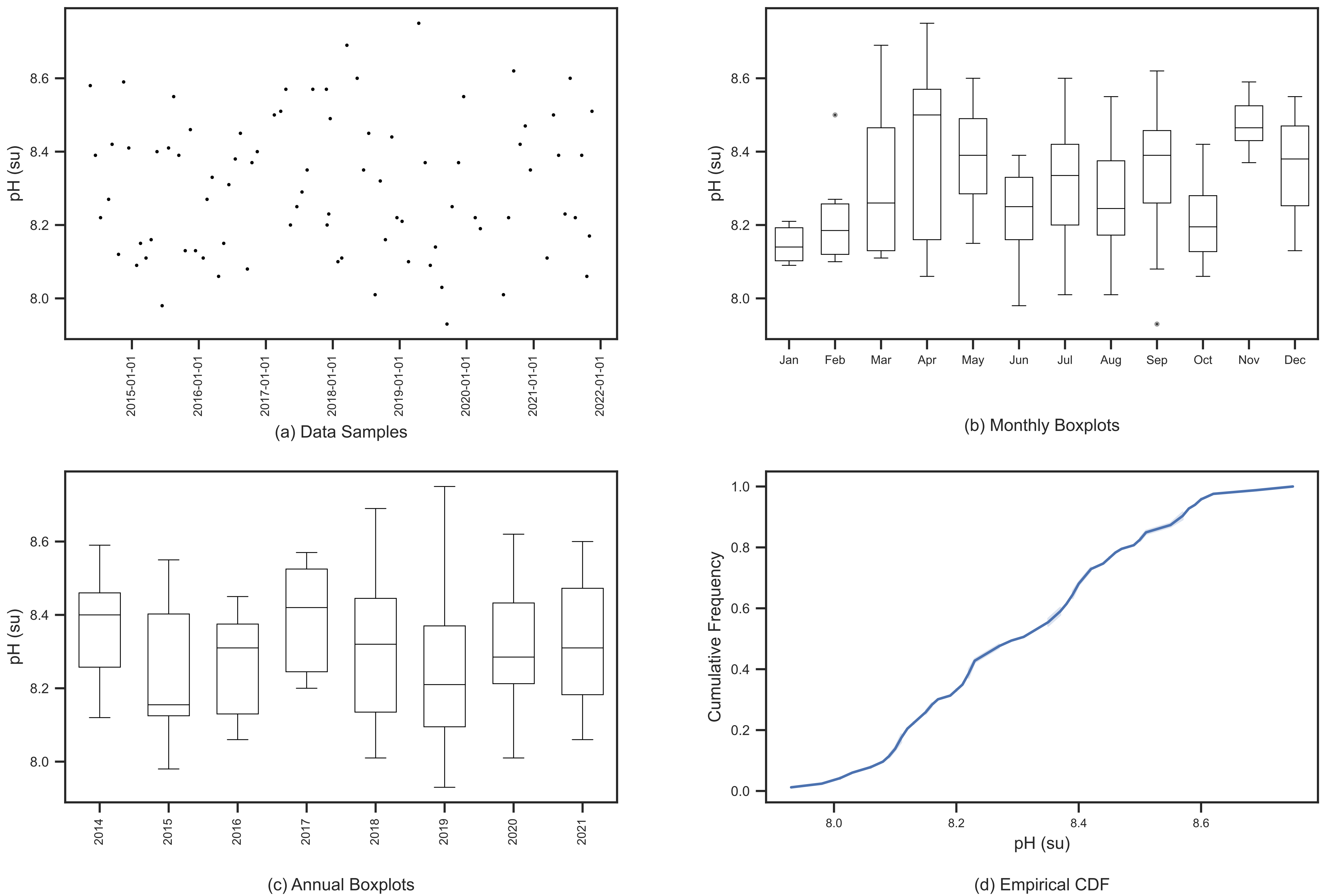
(c) Annual Boxplots

(d) Empirical CDF

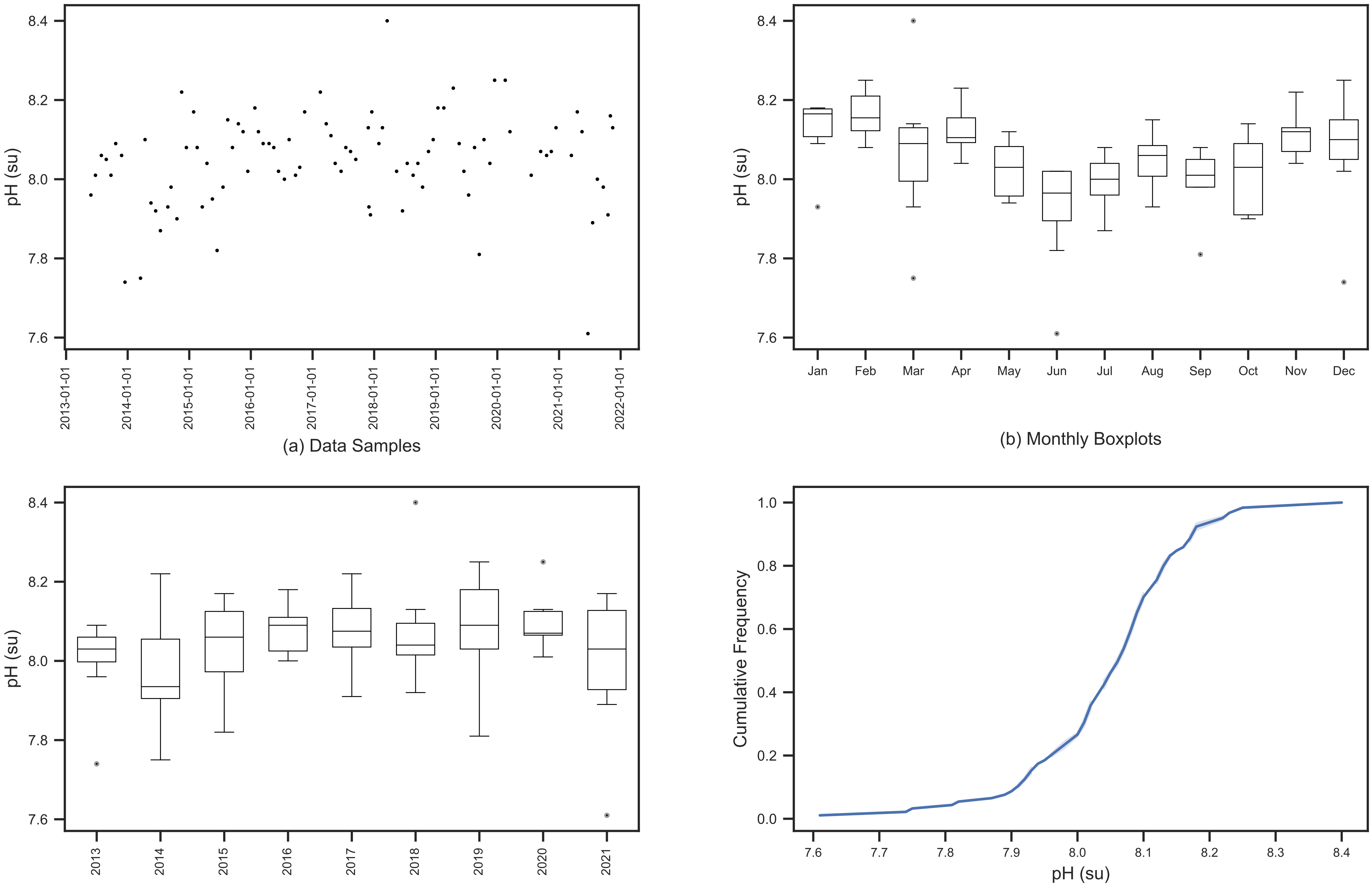
Ferson Creek at Hidden Springs (FC1) : pH (su)



Ferson Creek at Burlington & Corran Rds. (FC2) : pH (su)



Ferson Creek at Burr (FC3) : pH (su)



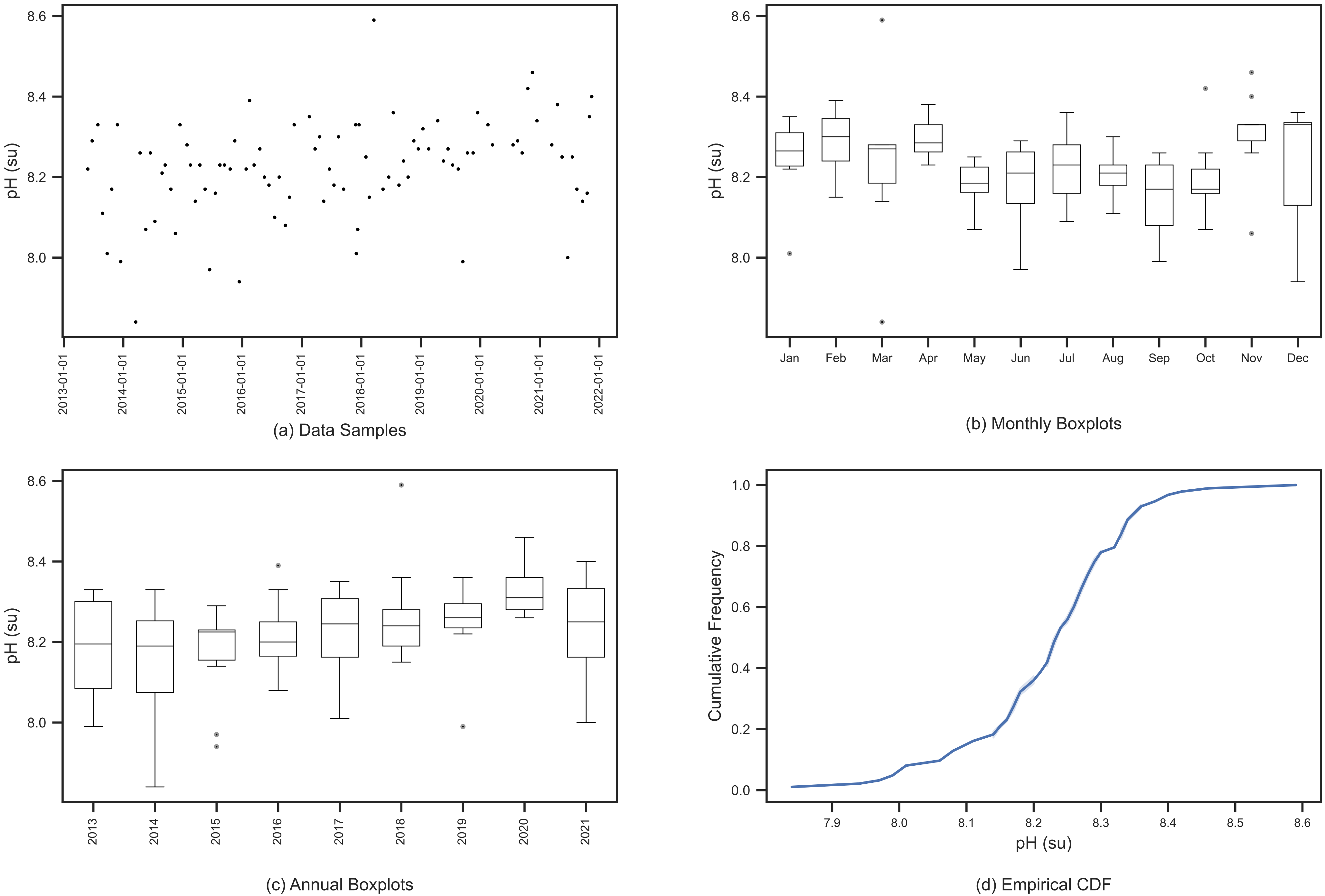
(a) Data Samples

(b) Monthly Boxplots

(c) Annual Boxplots

(d) Empirical CDF

Ferson Creek at Randall Rd. (FC4) : pH (su)



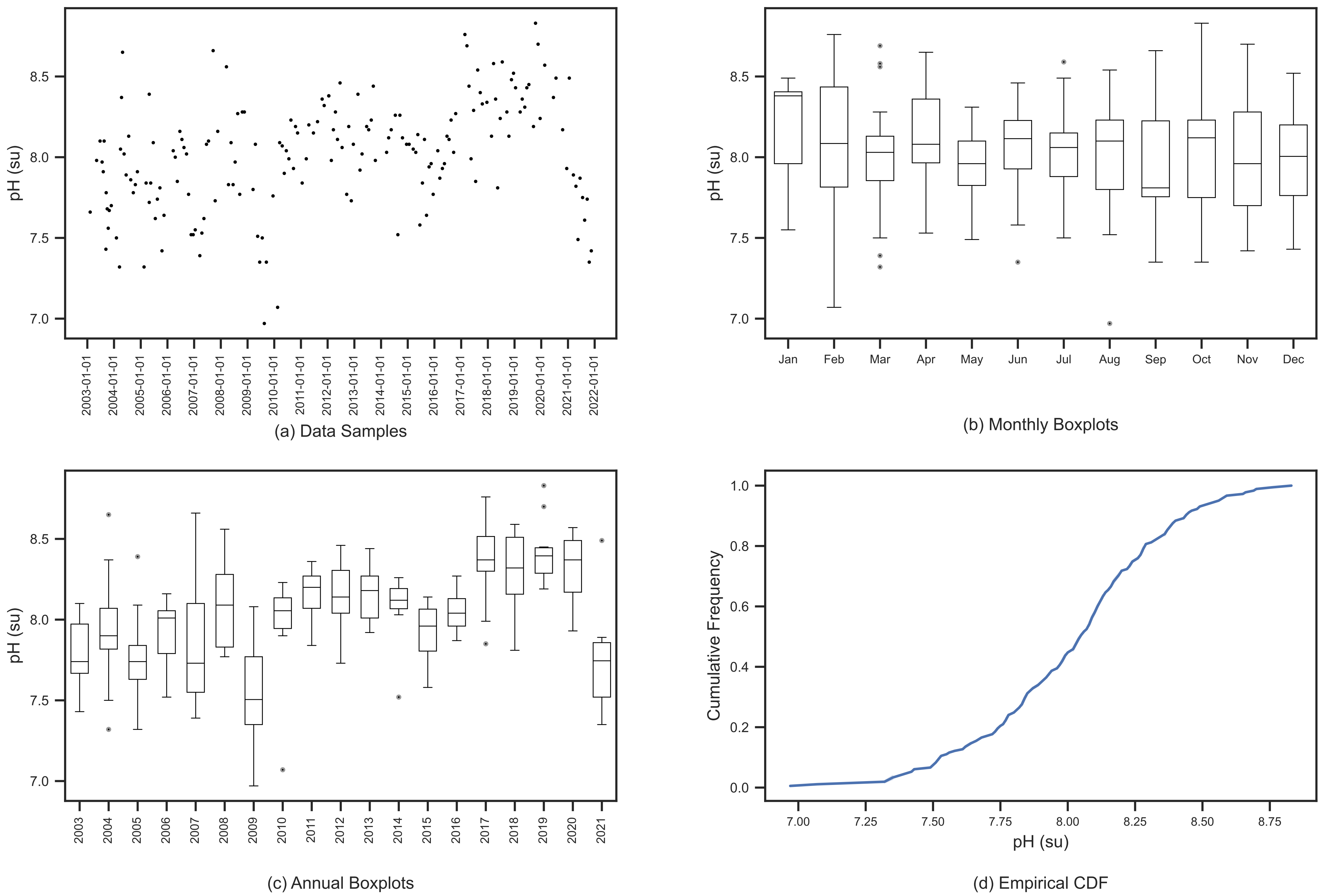
(a) Data Samples

(b) Monthly Boxplots

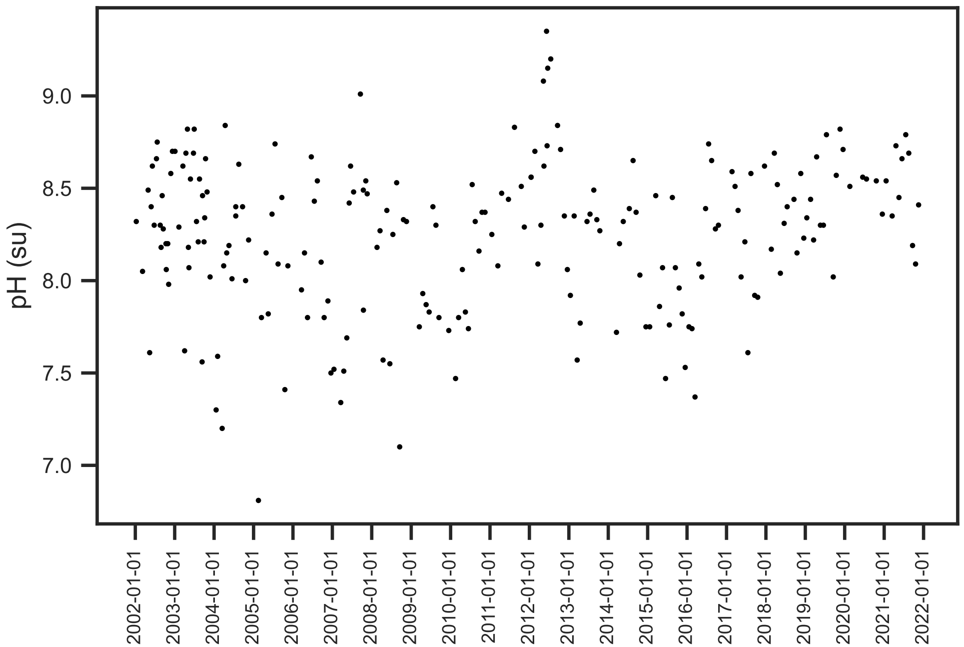
(c) Annual Boxplots

(d) Empirical CDF

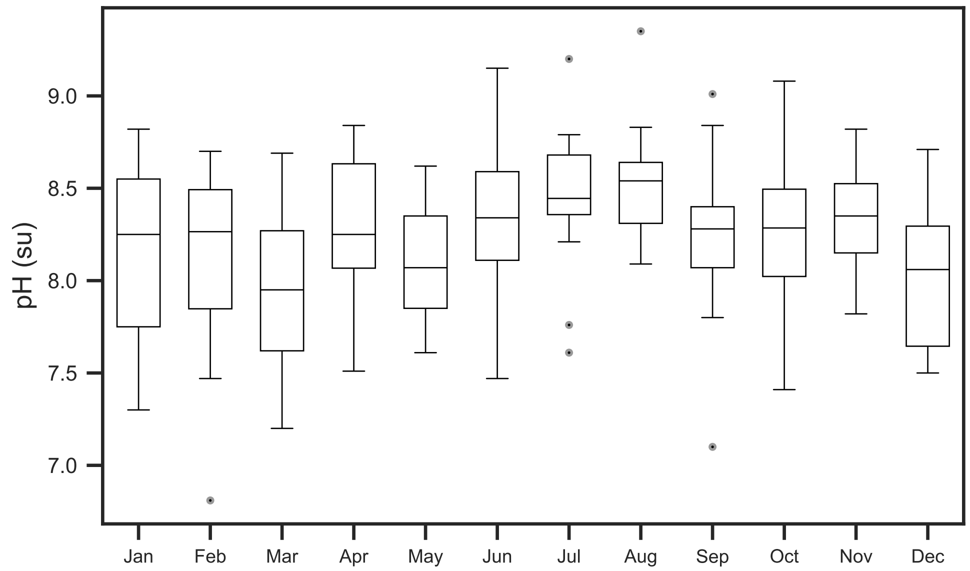
Ferson Creek near St. Charles (FC5) : pH (su)



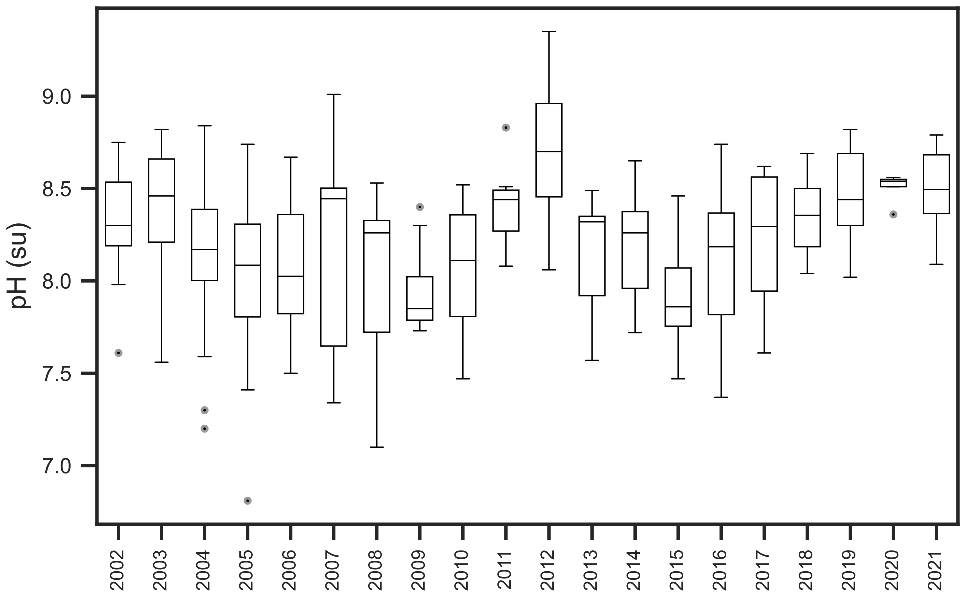
Fox River at Fabyan Pk-Geneva (FR7) : pH (su)



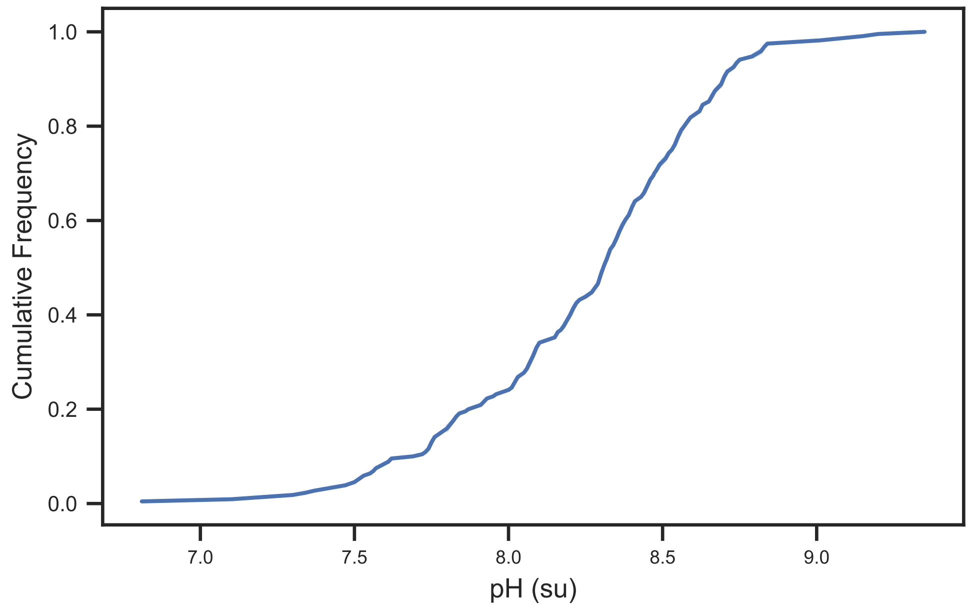
(a) Data Samples



(b) Monthly Boxplots

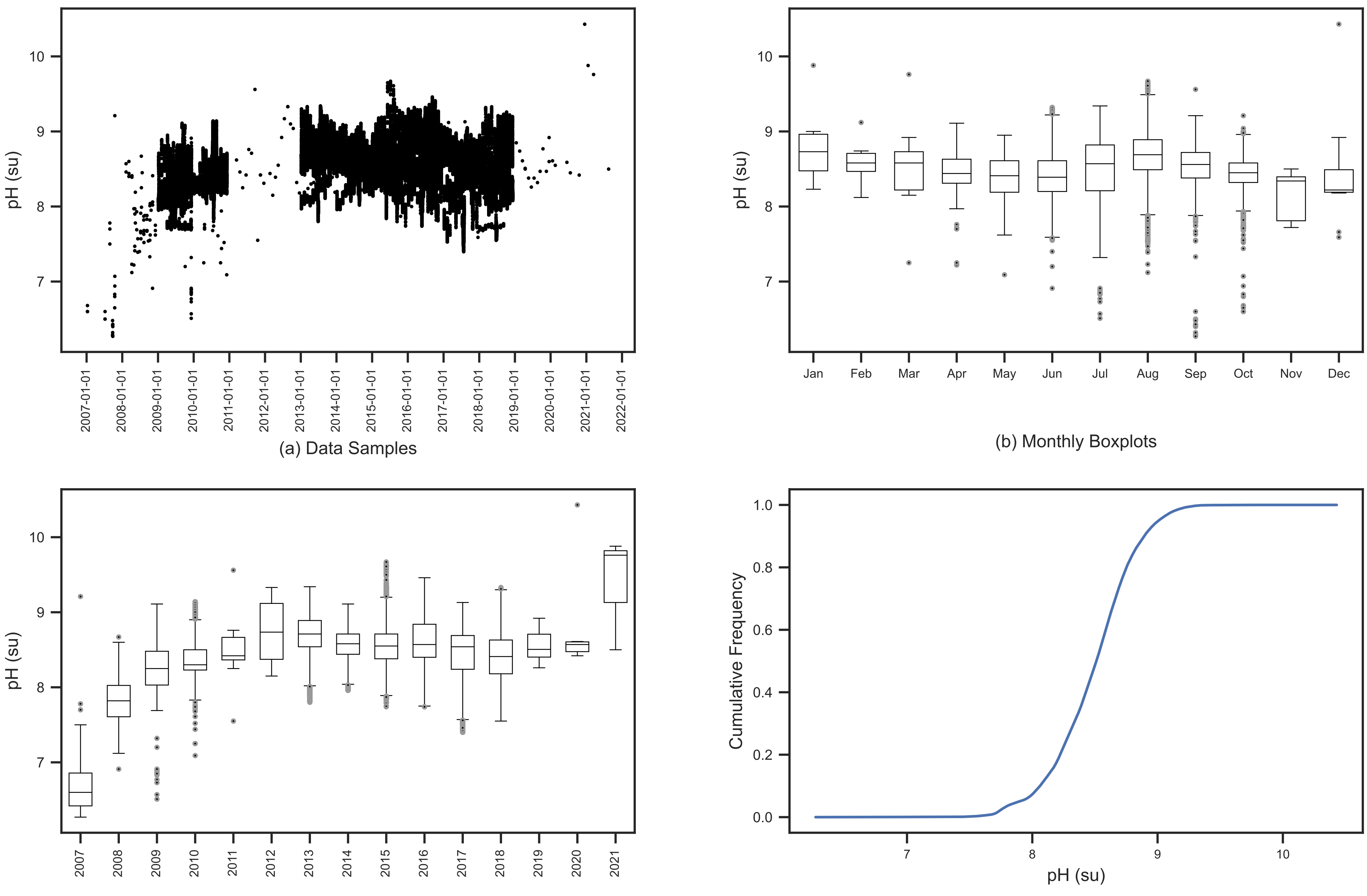


(c) Annual Boxplots



(d) Empirical CDF

Fox River at Sullivan Br. (FR8) : pH (su)



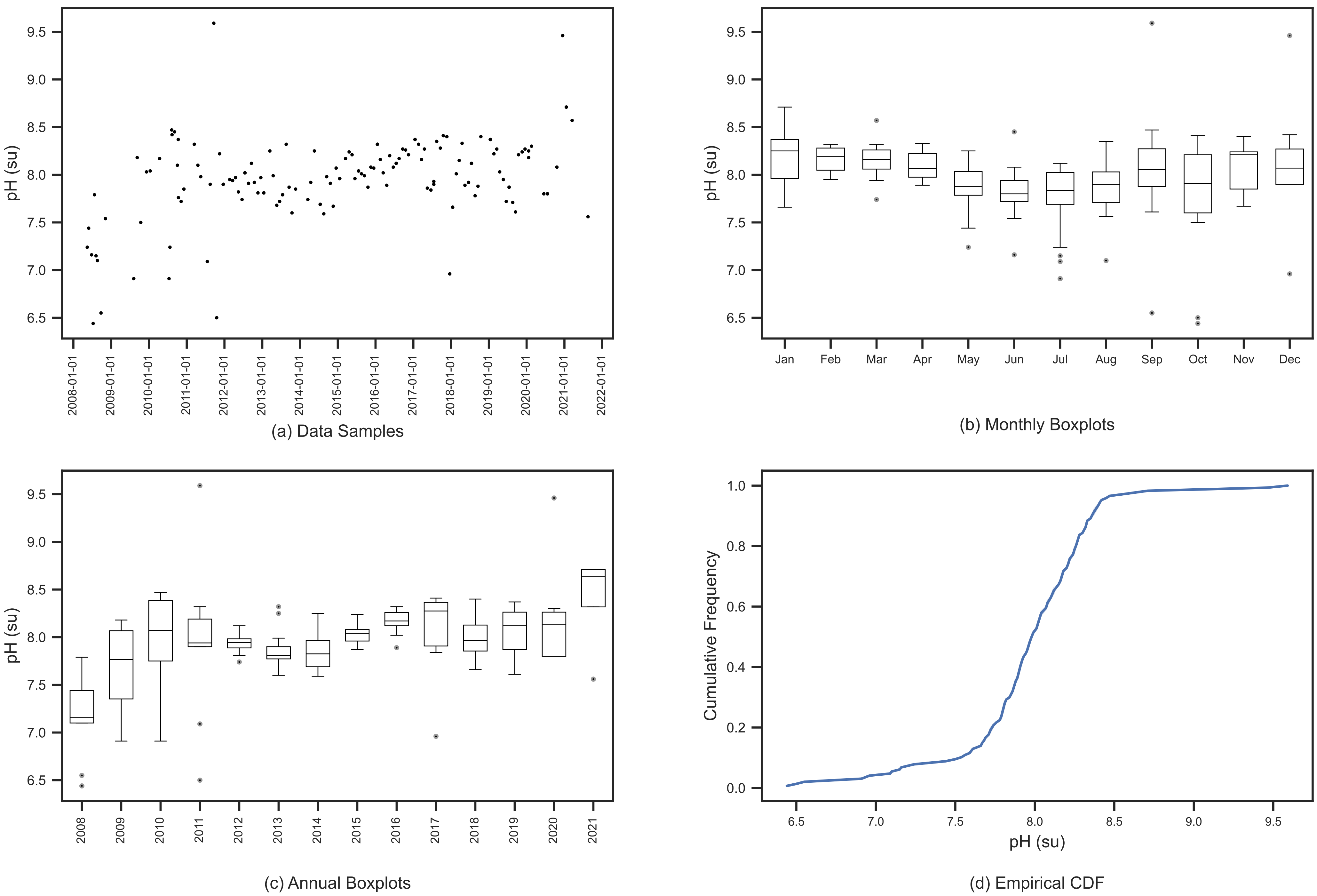
(a) Data Samples

(b) Monthly Boxplots

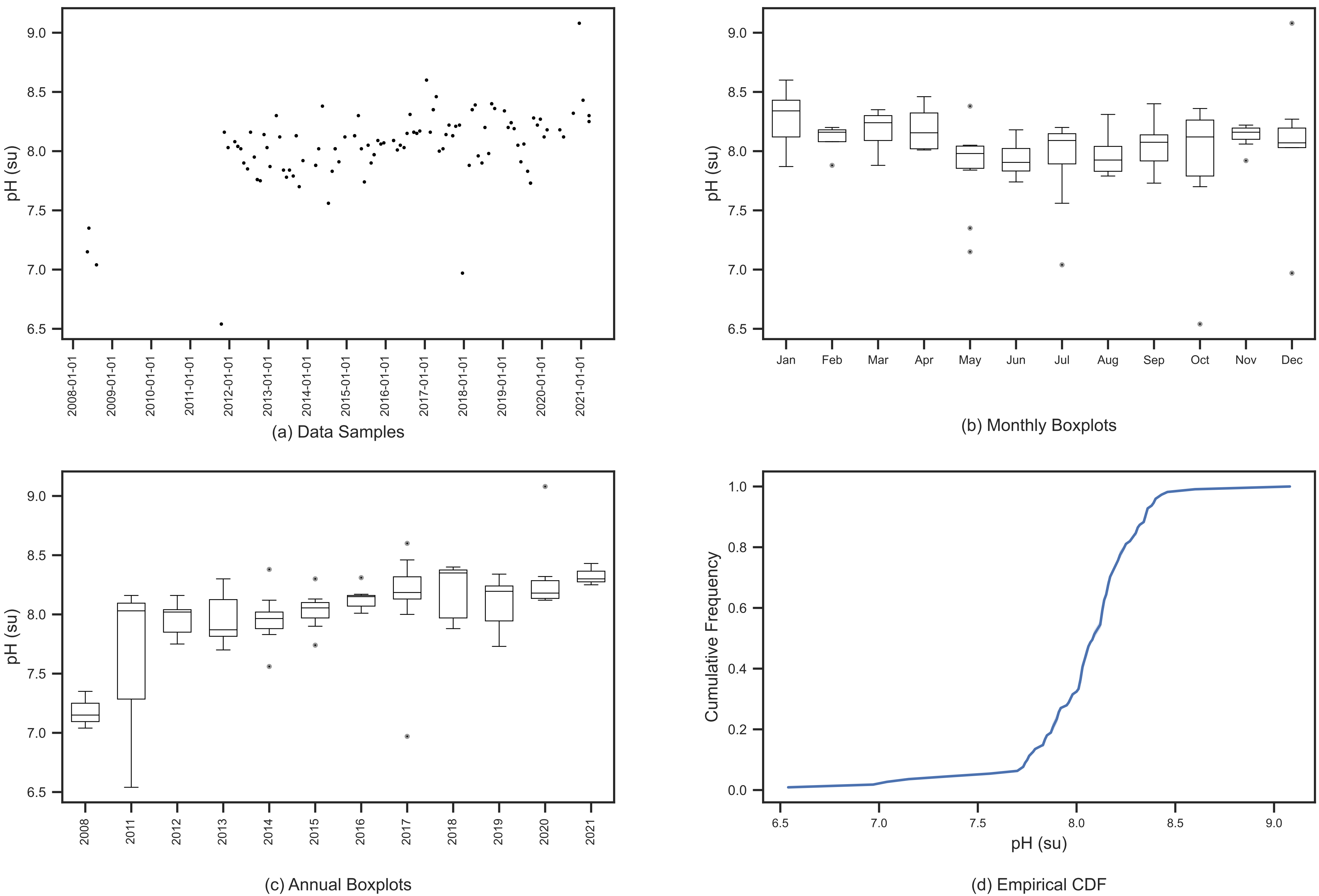
(c) Annual Boxplots

(d) Empirical CDF

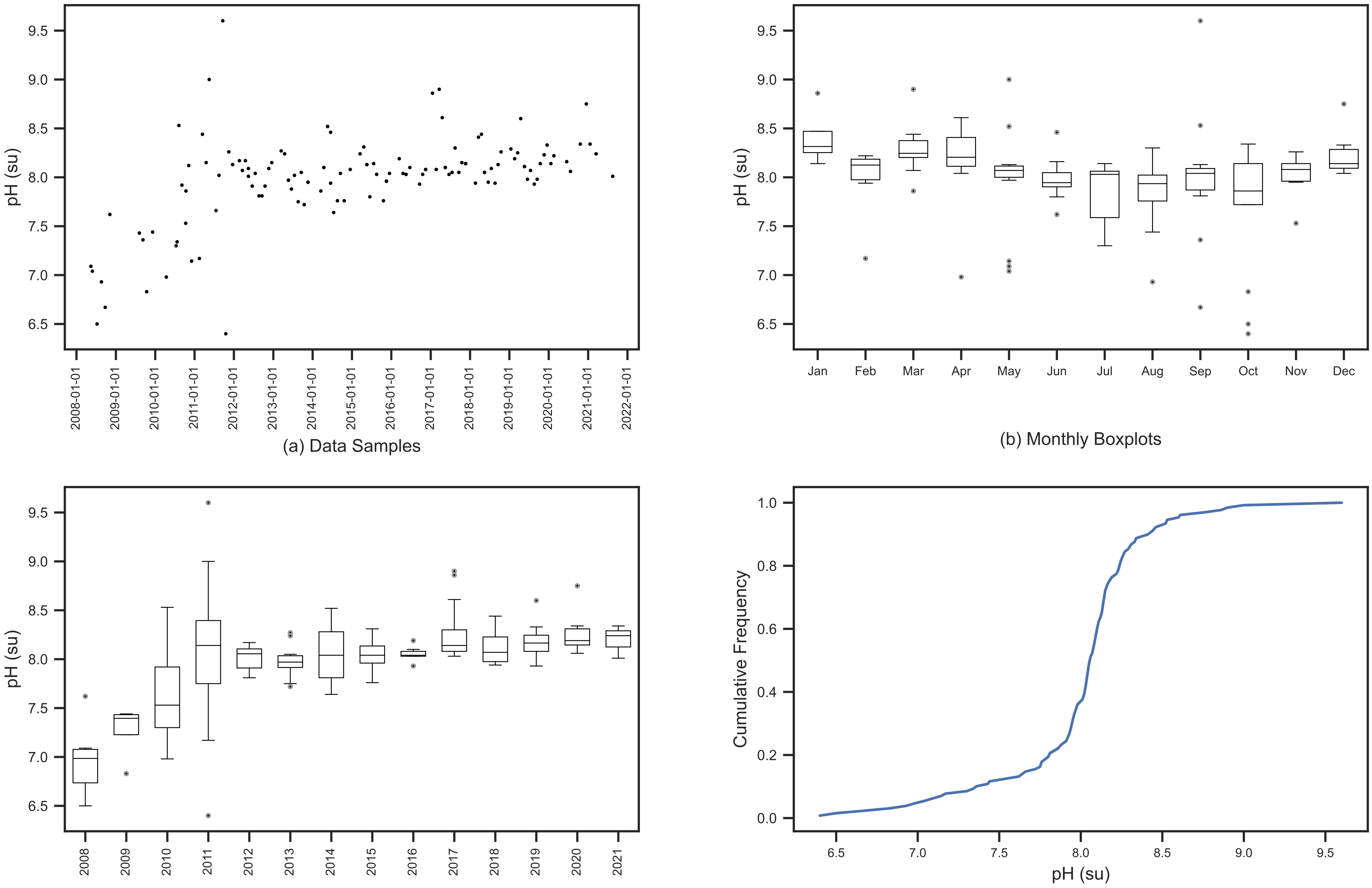
Indian Creek at Reckinger Rd. (IC1) : pH (su)



Indian Creek ups Outfall (IC2) : pH (su)



Indian Creek dns Outfall (IC3) : pH (su)



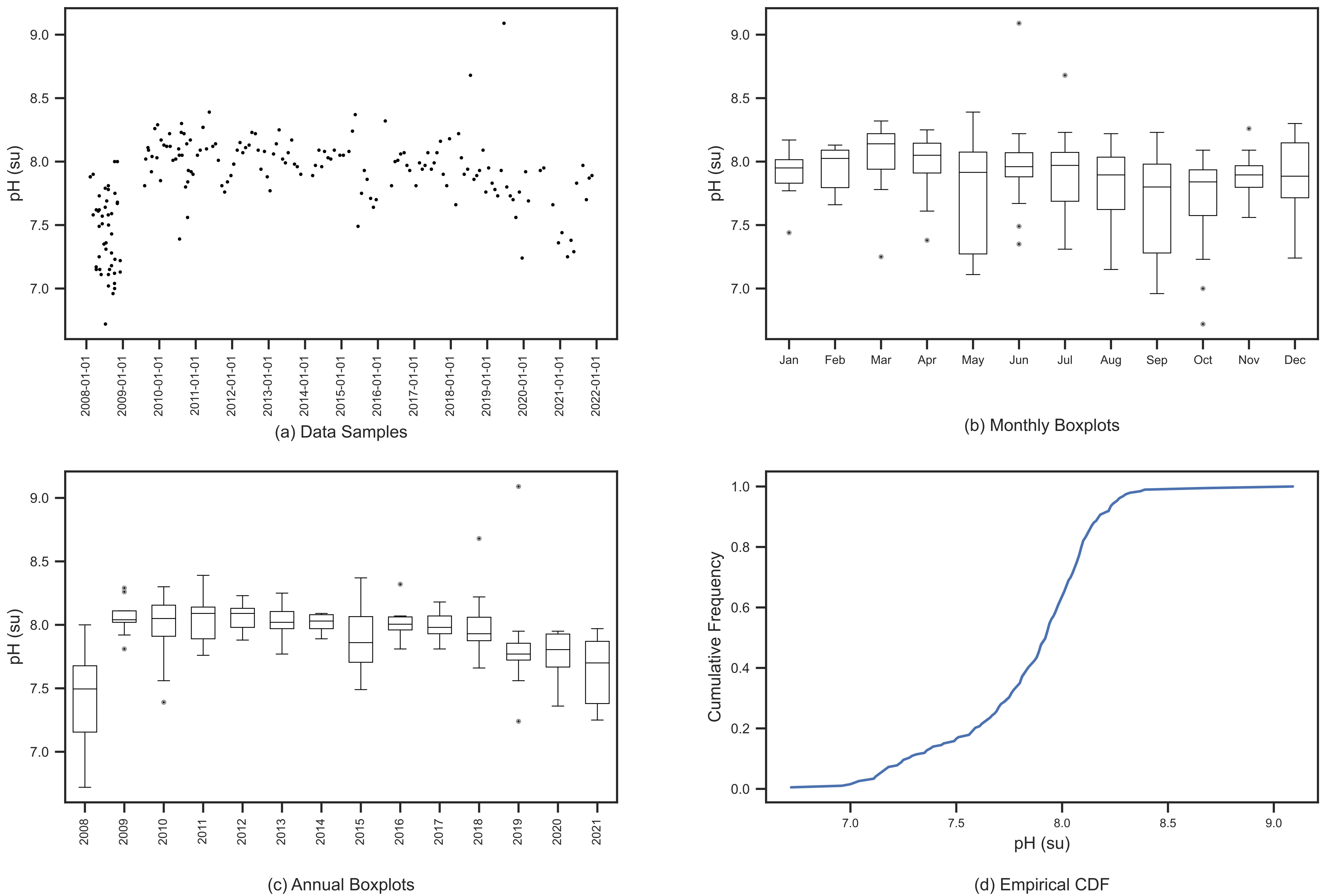
(a) Data Samples

(b) Monthly Boxplots

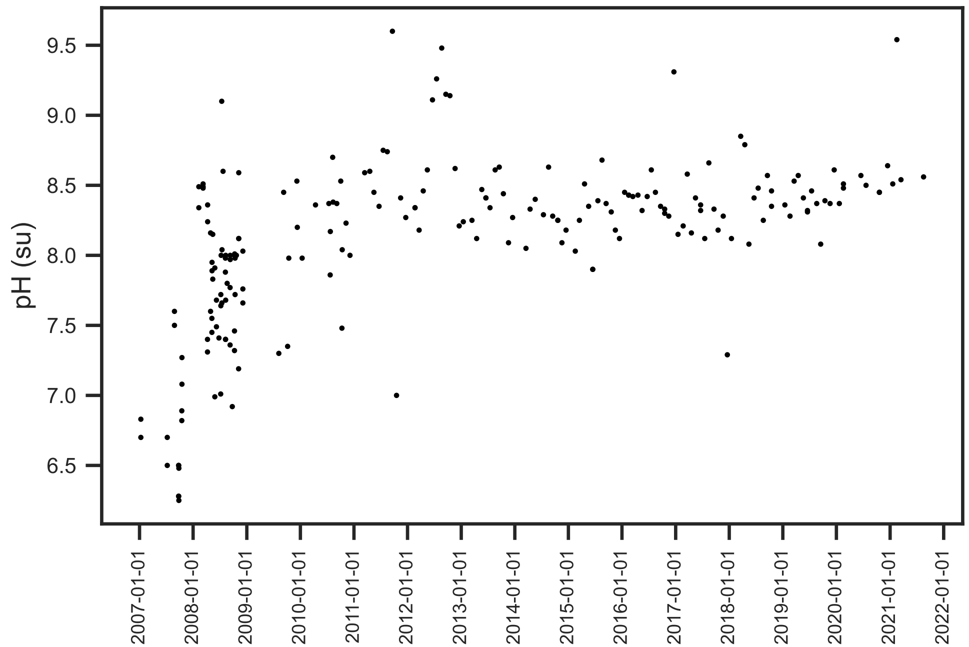
(c) Annual Boxplots

(d) Empirical CDF

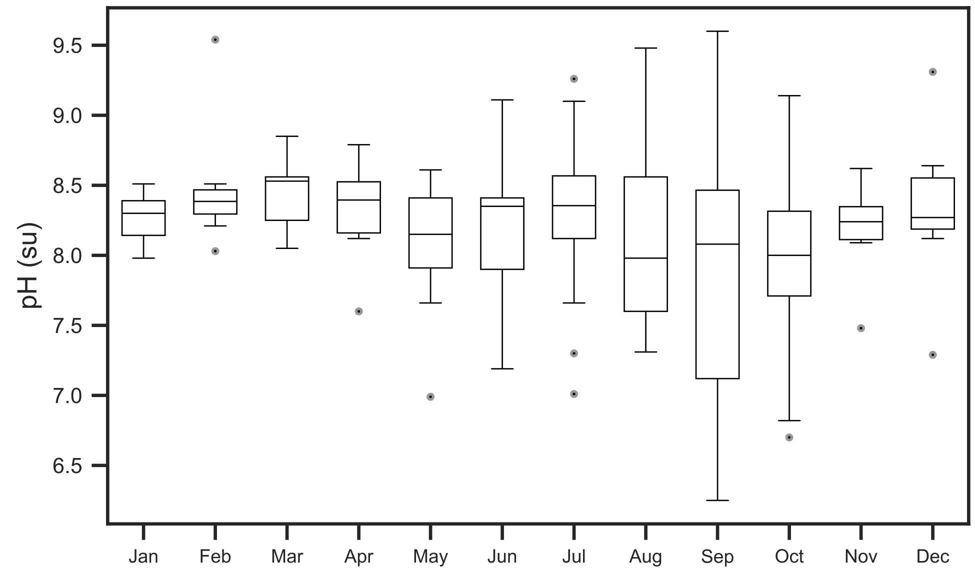
Indian Creek u/s Rt. 25 (IC4) : pH (su)



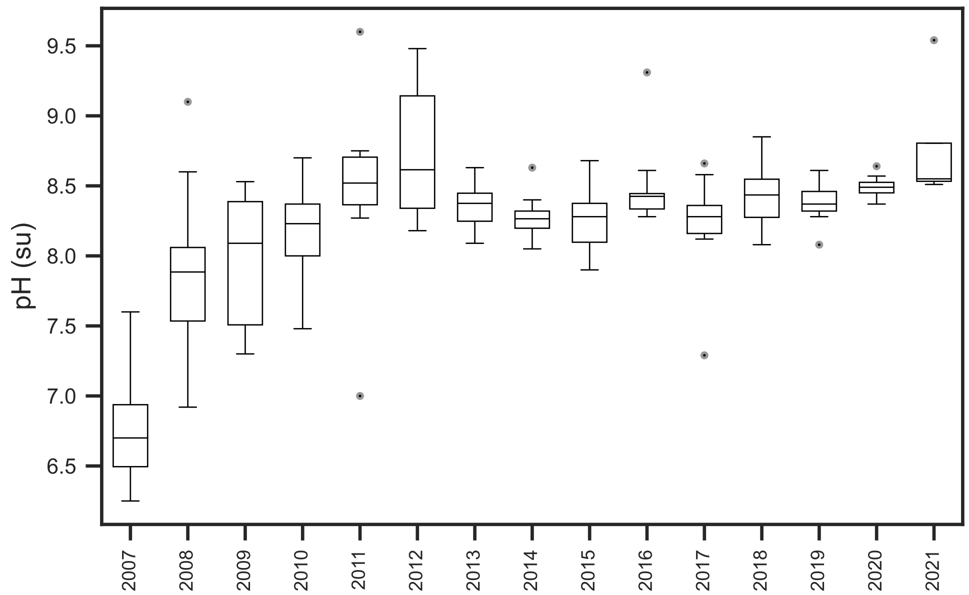
Fox River at North Ave. Br. (FR9) : pH (su)



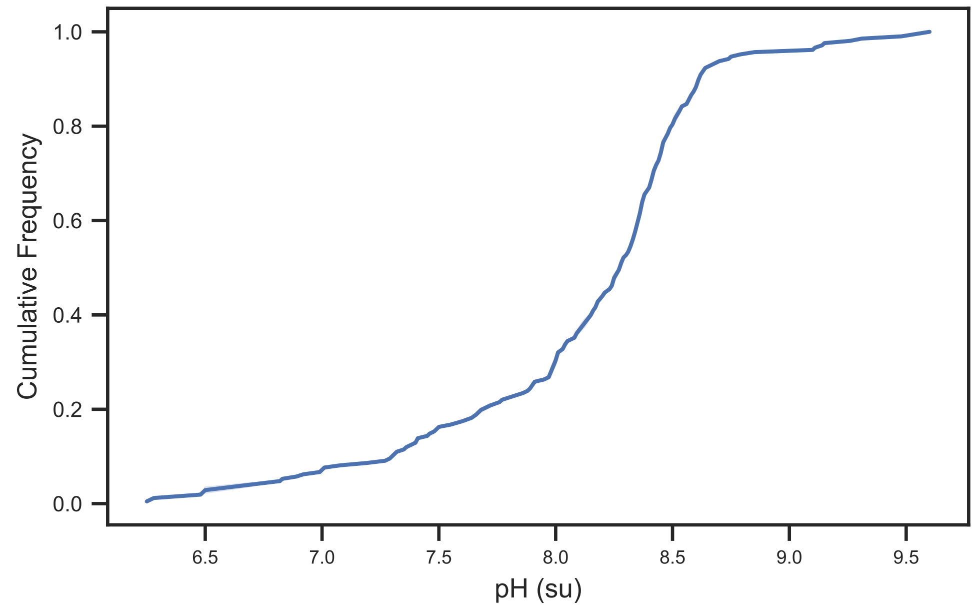
(a) Data Samples



(b) Monthly Boxplots

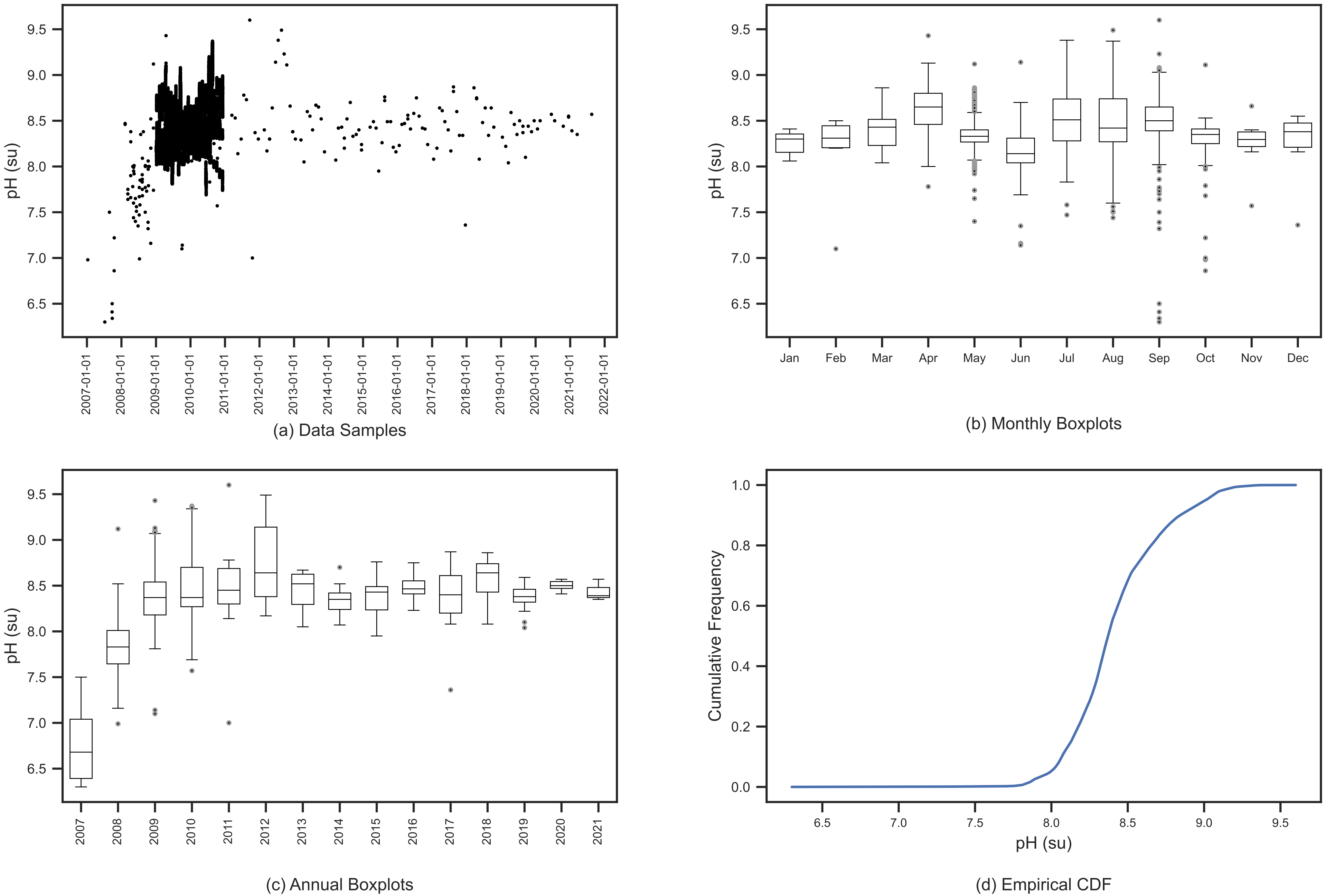


(c) Annual Boxplots



(d) Empirical CDF

Fox River at Ashland Ave. (FR10) : pH (su)



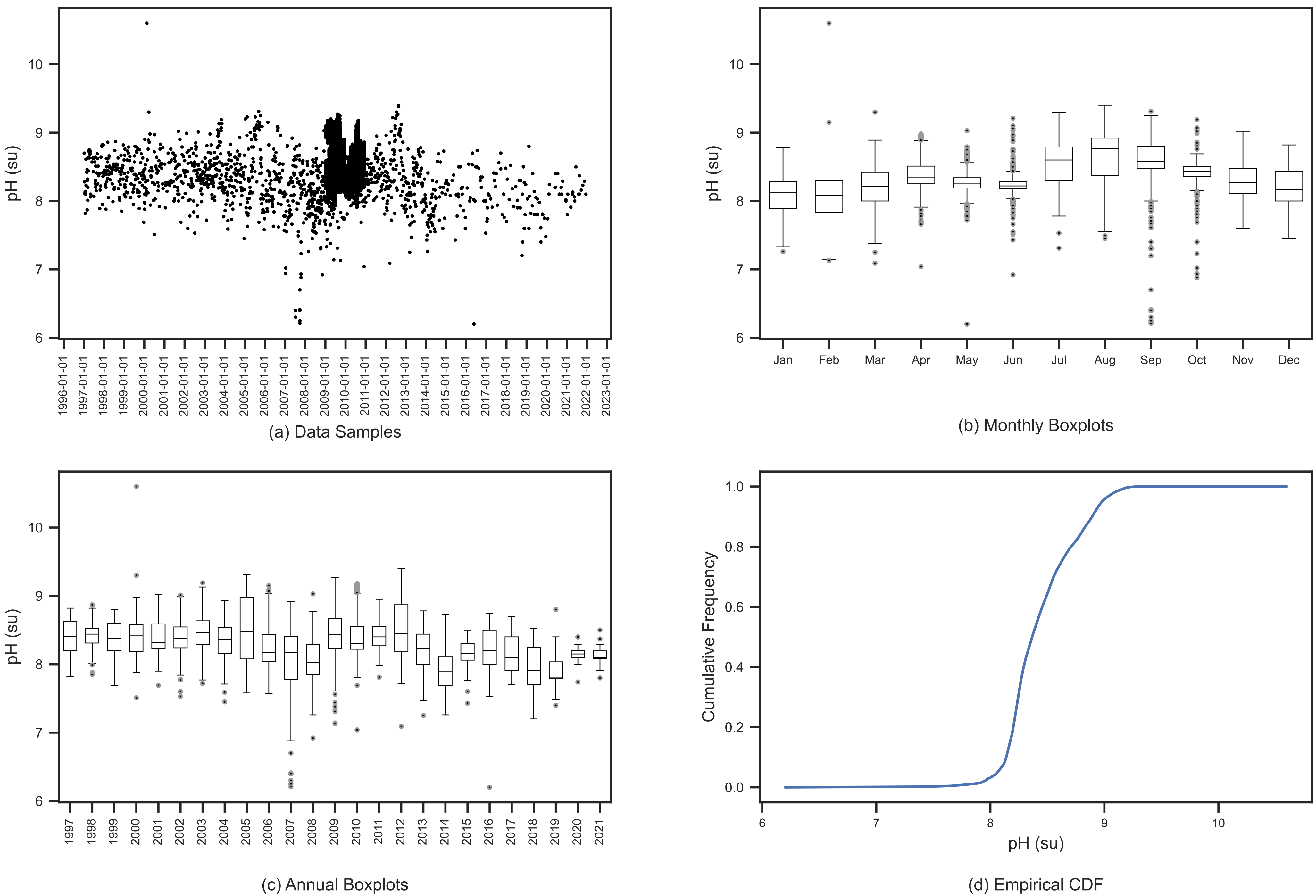
(a) Data Samples

(b) Monthly Boxplots

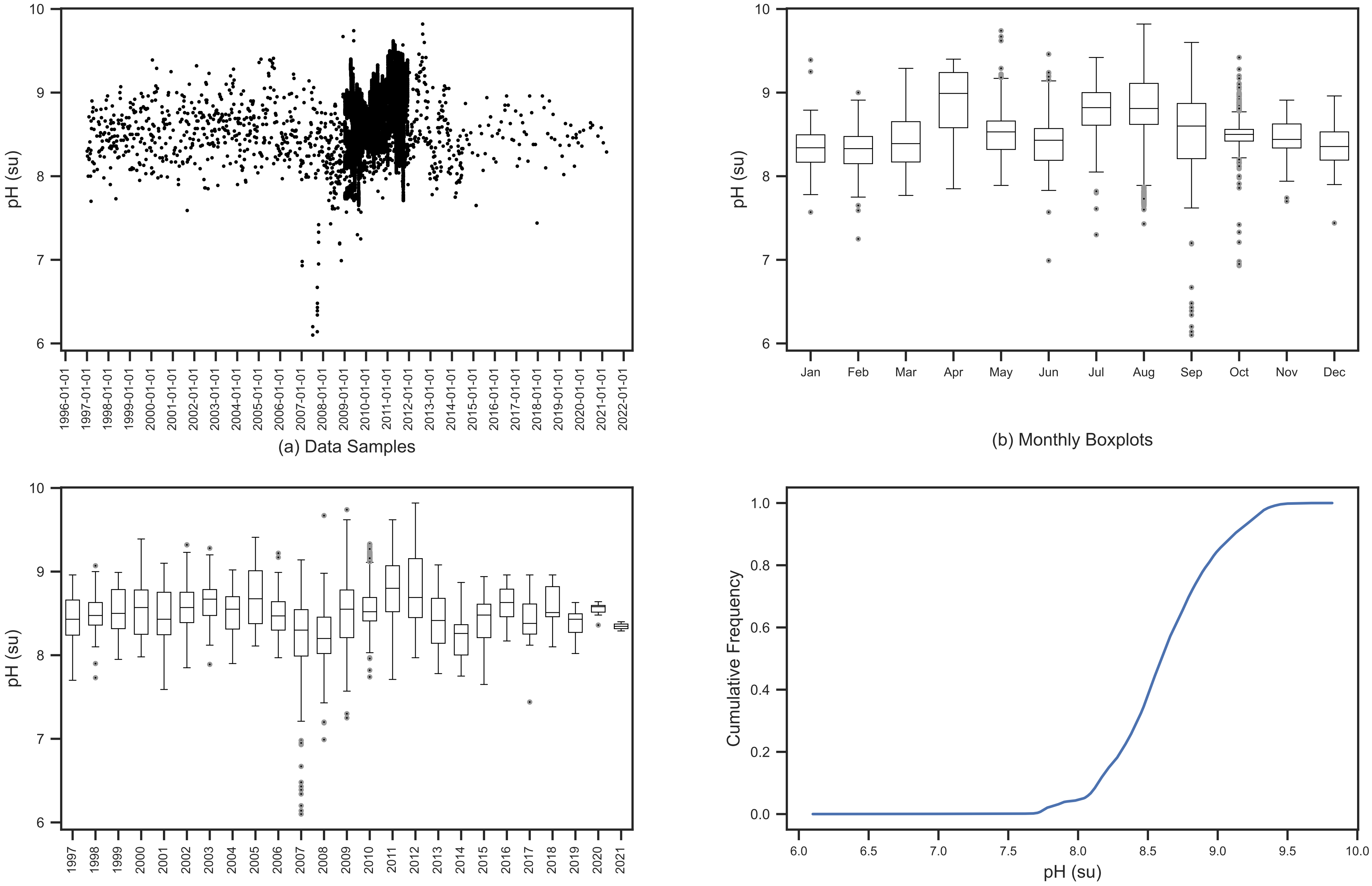
(c) Annual Boxplots

(d) Empirical CDF

Fox River at Montgomery (FR11) : pH (su)



Fox River at Rt. 34, Oswego (FR12) : pH (su)



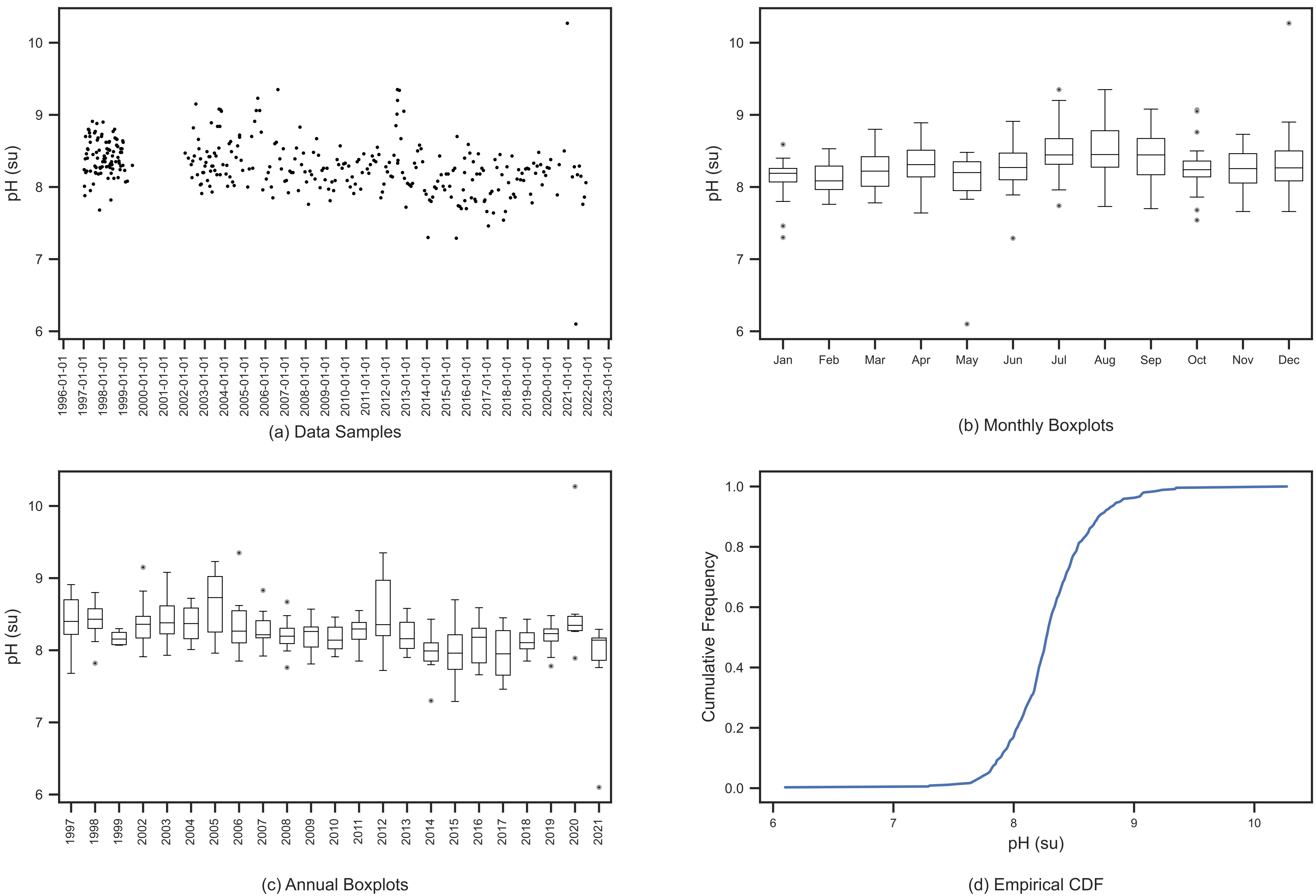
(a) Data Samples

(b) Monthly Boxplots

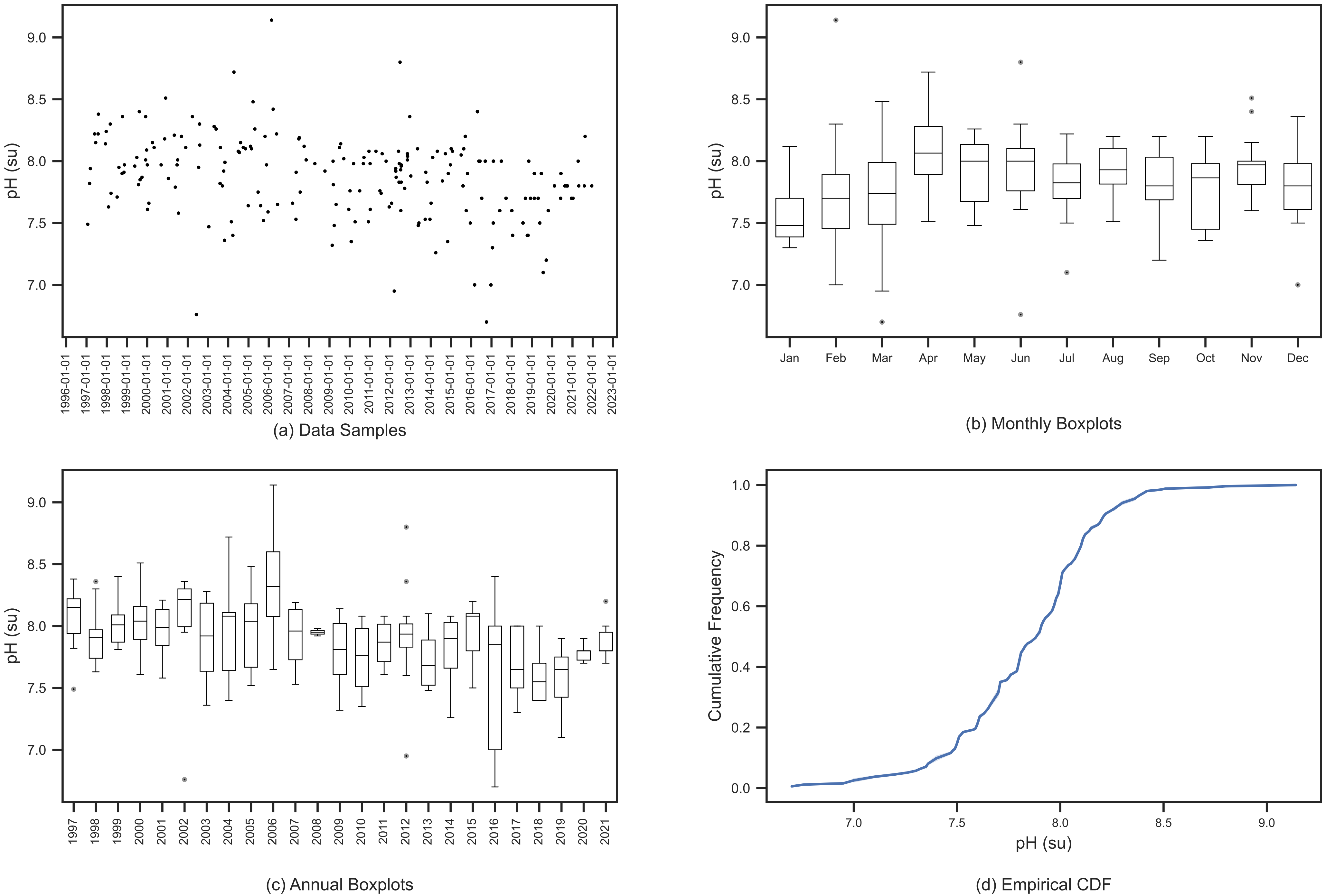
(c) Annual Boxplots

(d) Empirical CDF

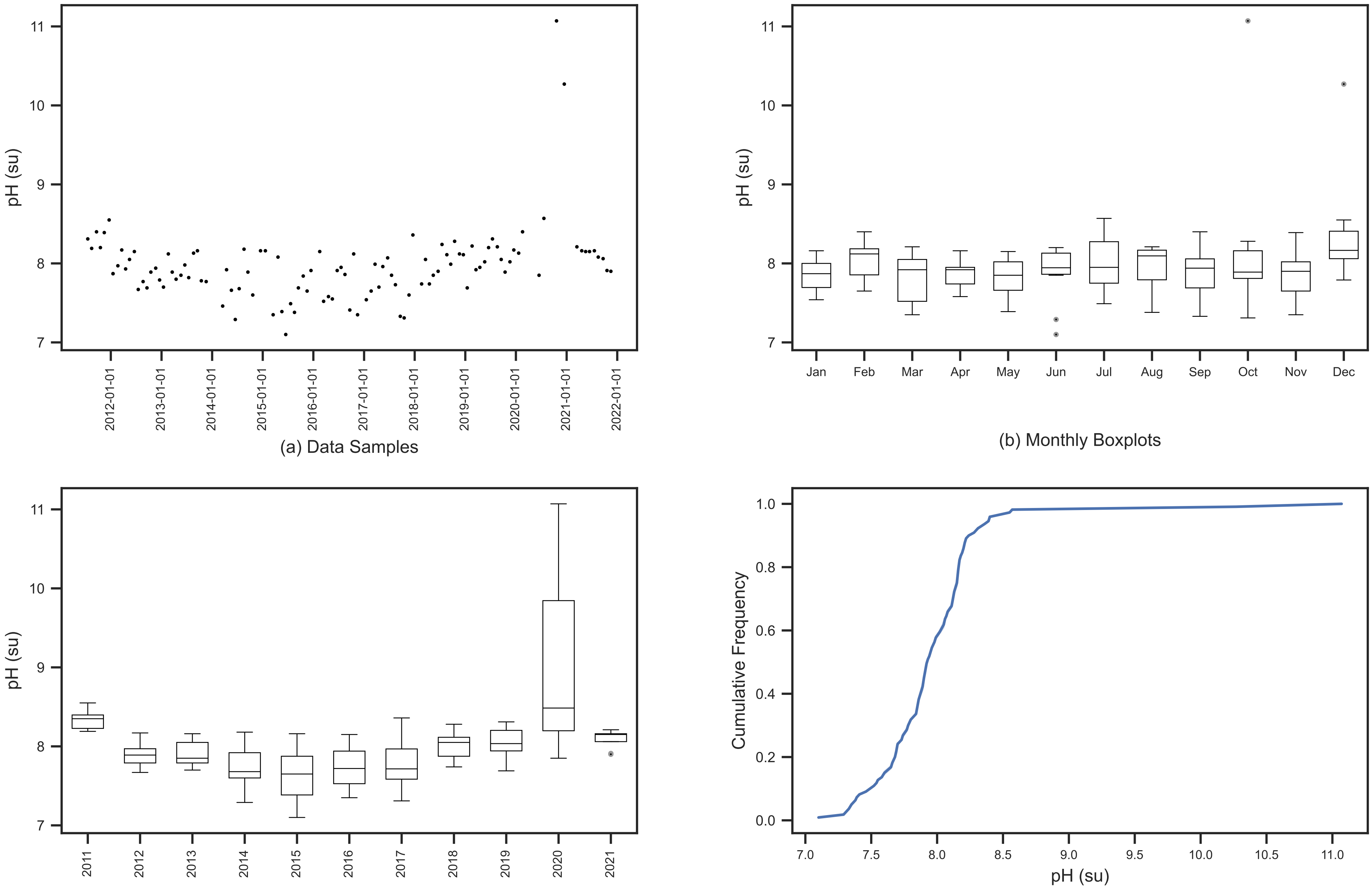
Fox River at Yorkville (FR13) : pH (su)



Blackberry Creek near Yorkville (BC1) : pH (su)



Blackberry Creek near Yorkville Side Rd. (BC2) : pH (su)



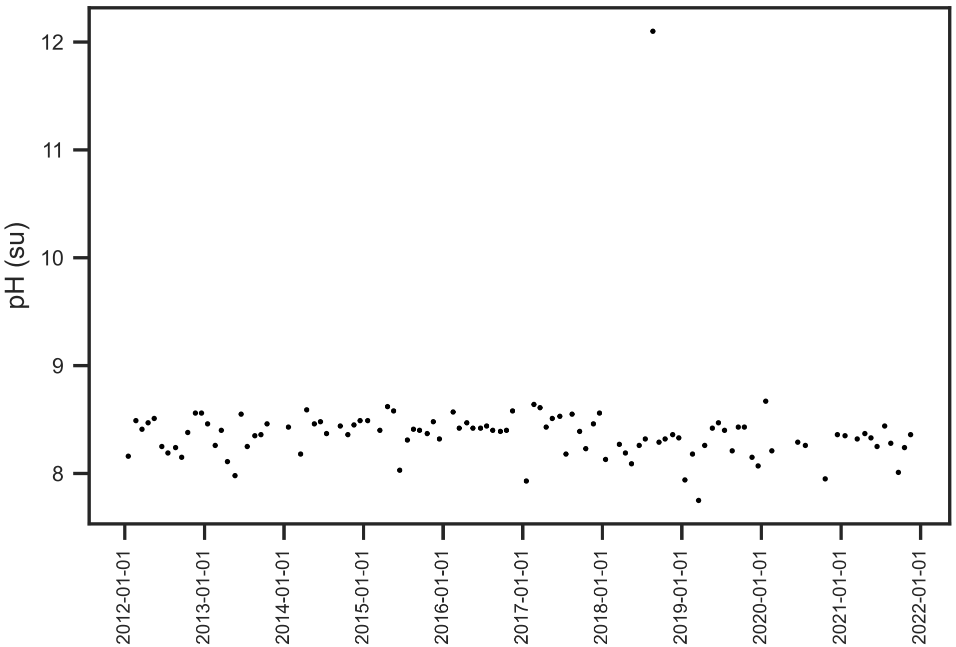
(a) Data Samples

(b) Monthly Boxplots

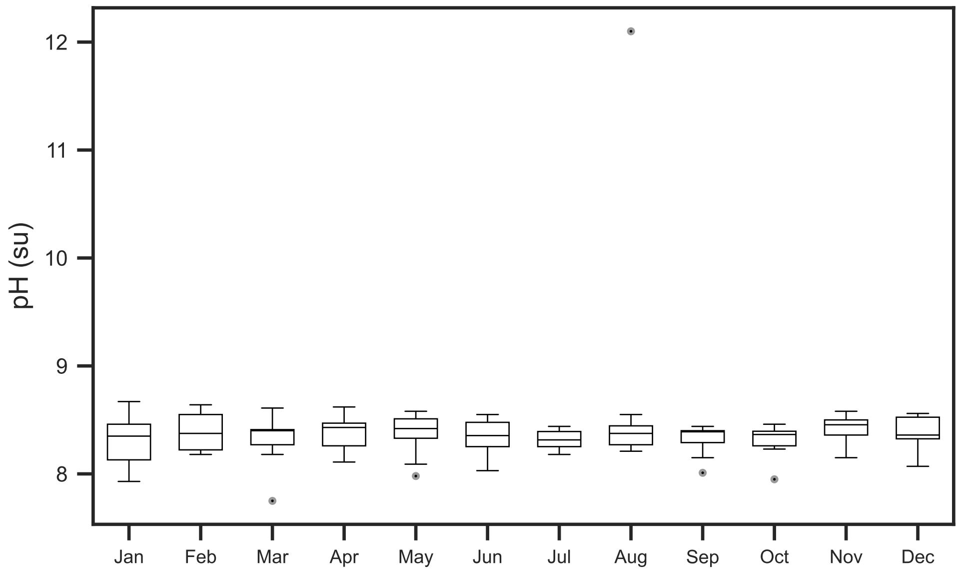
(c) Annual Boxplots

(d) Empirical CDF

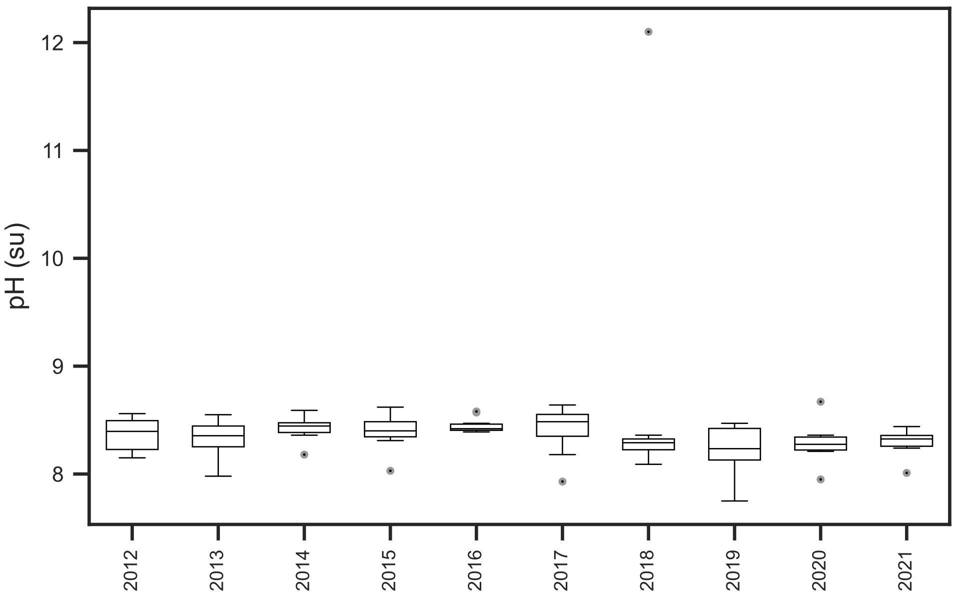
Little Indian Creek at dns Unversity Rd. Br. (LC1) : pH (su)



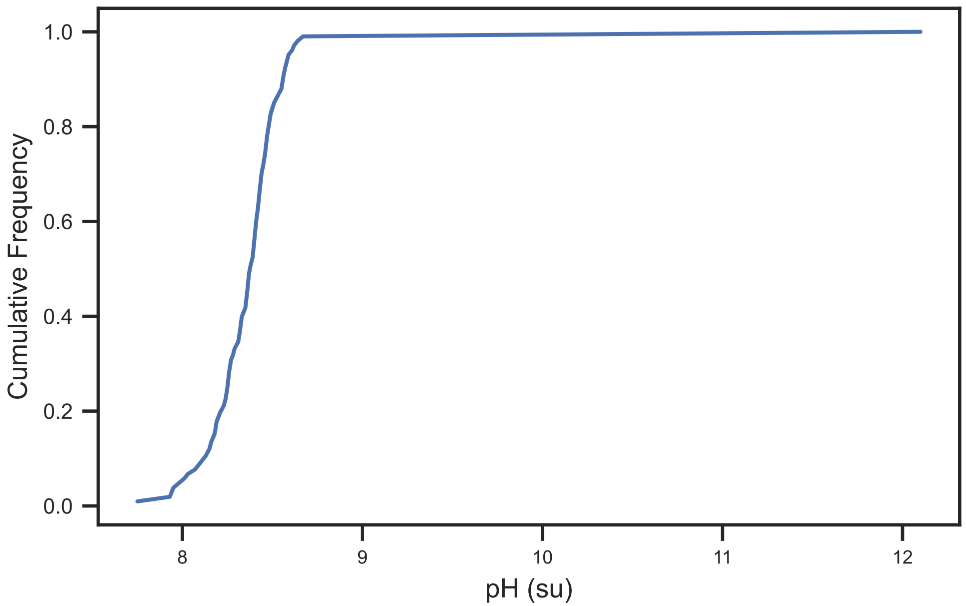
(a) Data Samples



(b) Monthly Boxplots

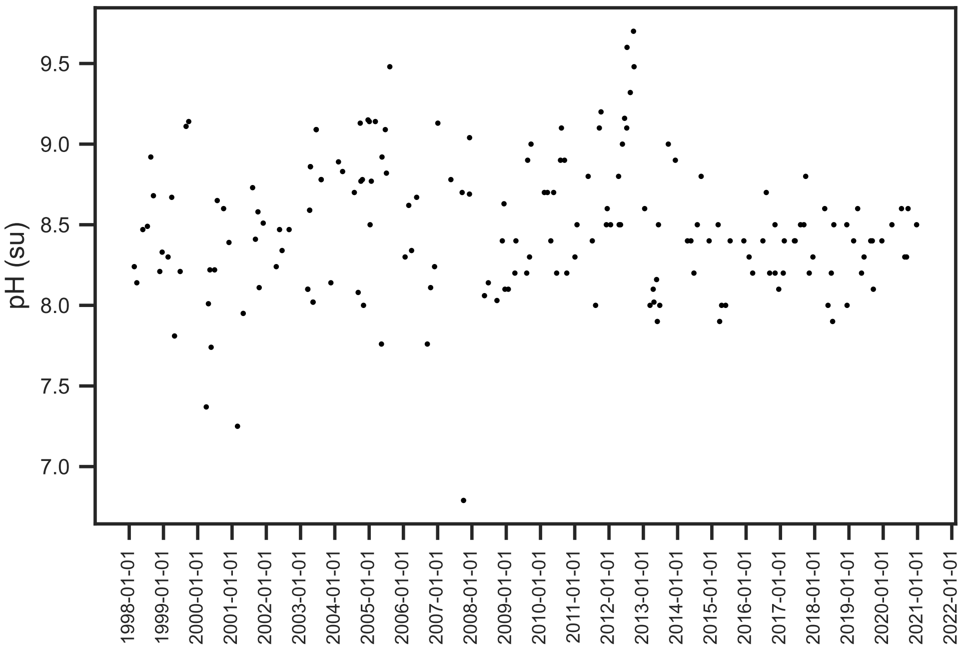


(c) Annual Boxplots

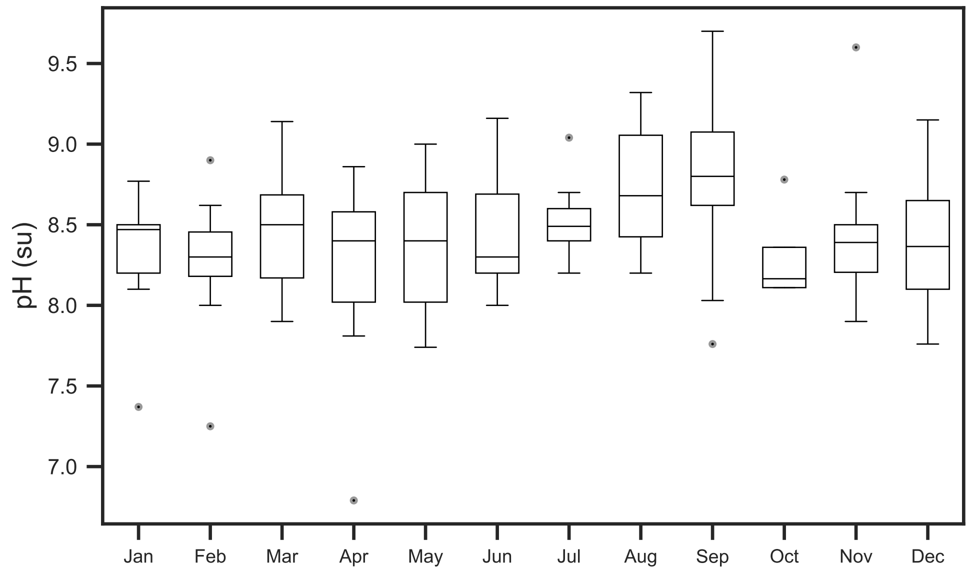


(d) Empirical CDF

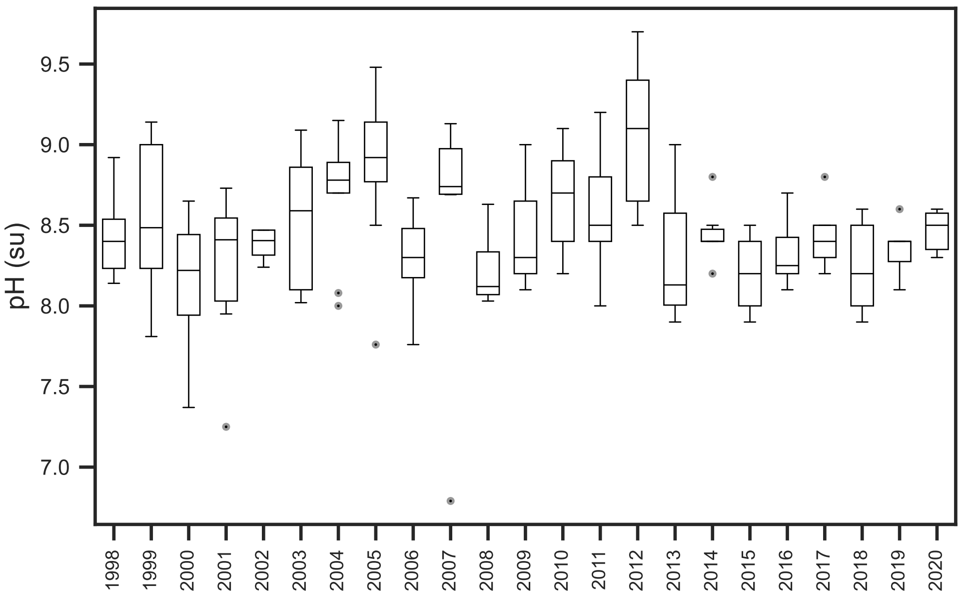
Fox River at Rt. 71 (FR14) : pH (su)



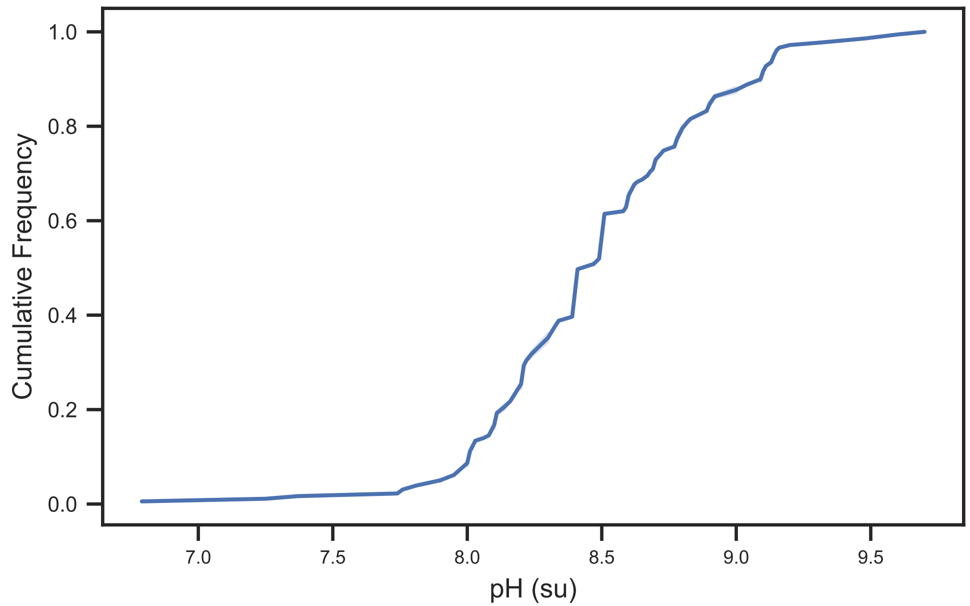
(a) Data Samples



(b) Monthly Boxplots

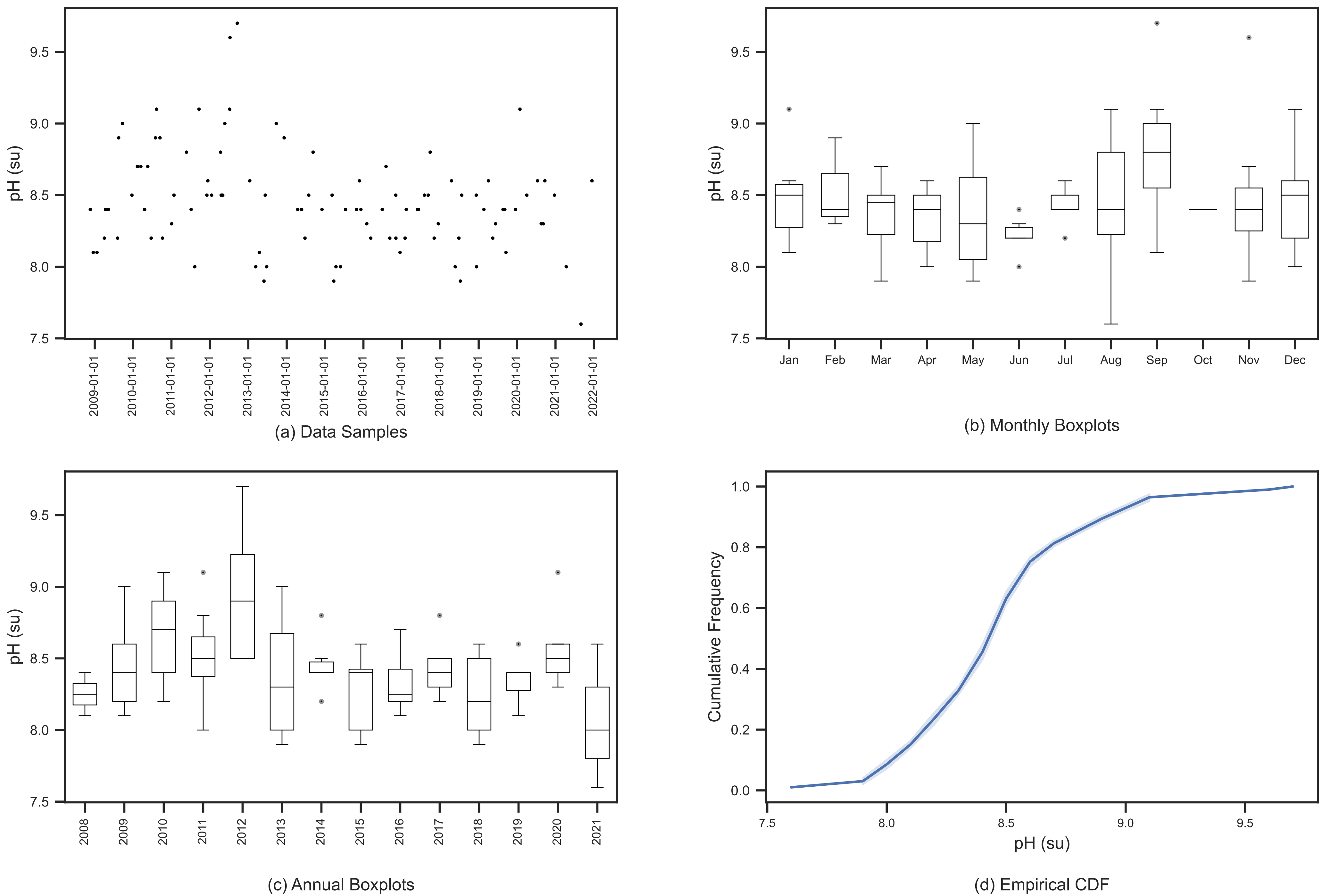


(c) Annual Boxplots



(d) Empirical CDF

Fox River at Ottawa (FR15) : pH (su)



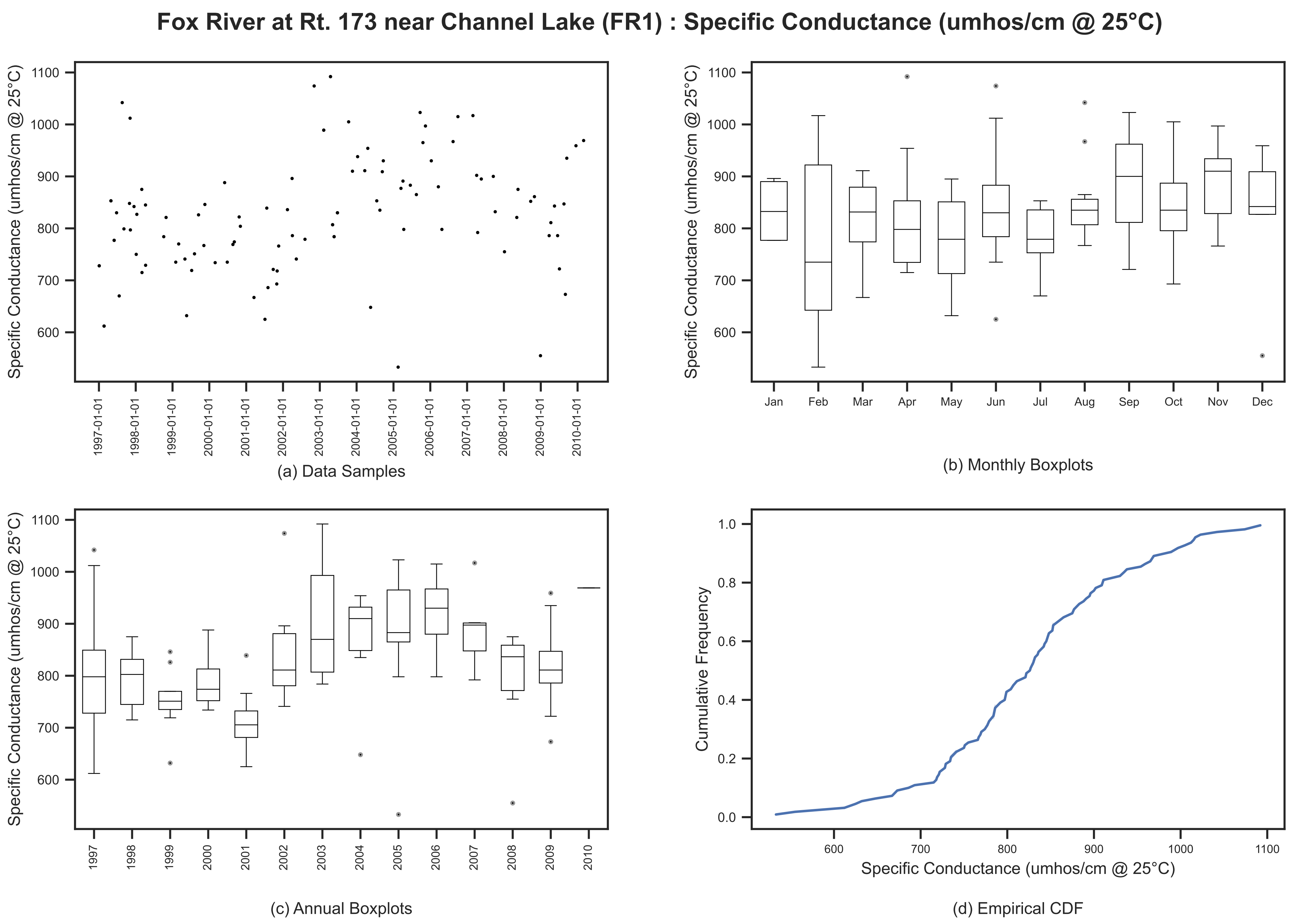
(a) Data Samples

(b) Monthly Boxplots

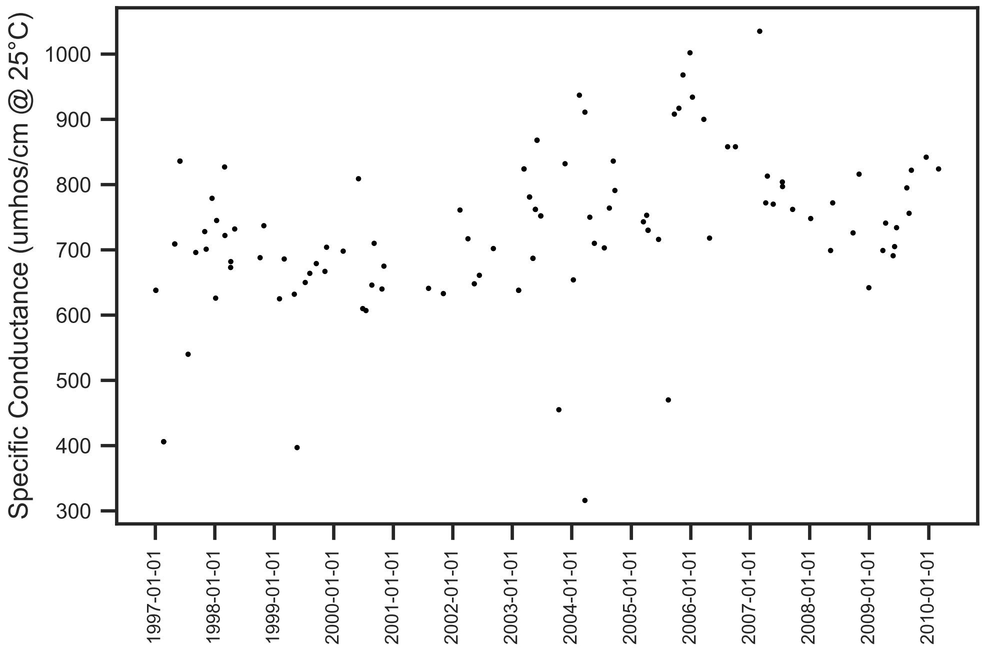
(c) Annual Boxplots

(d) Empirical CDF

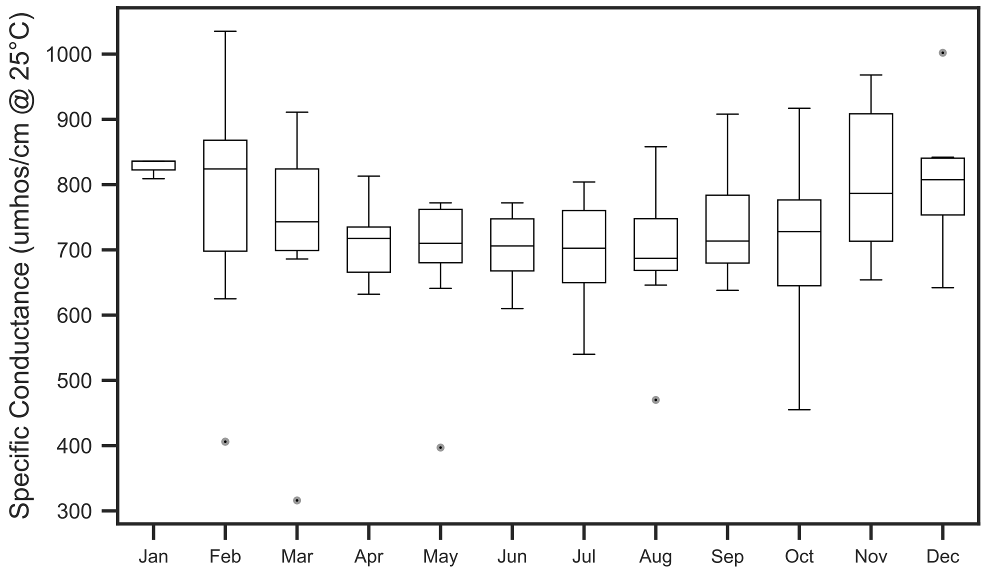
EDA Outputs for Specific Conductance (μmhos/cm @ 25^{0}C)


Fox River at Rt. 173 near Channel Lake (FR1) : Specific Conductance (umhos/cm @ 25°C)
Specific Conductance (umhos/cm @ 25°C)
(a) Data Samples
(b) Monthly Boxplots
(c) Annual Boxplots
Cumulative Frequency
(d) Empirical CDF

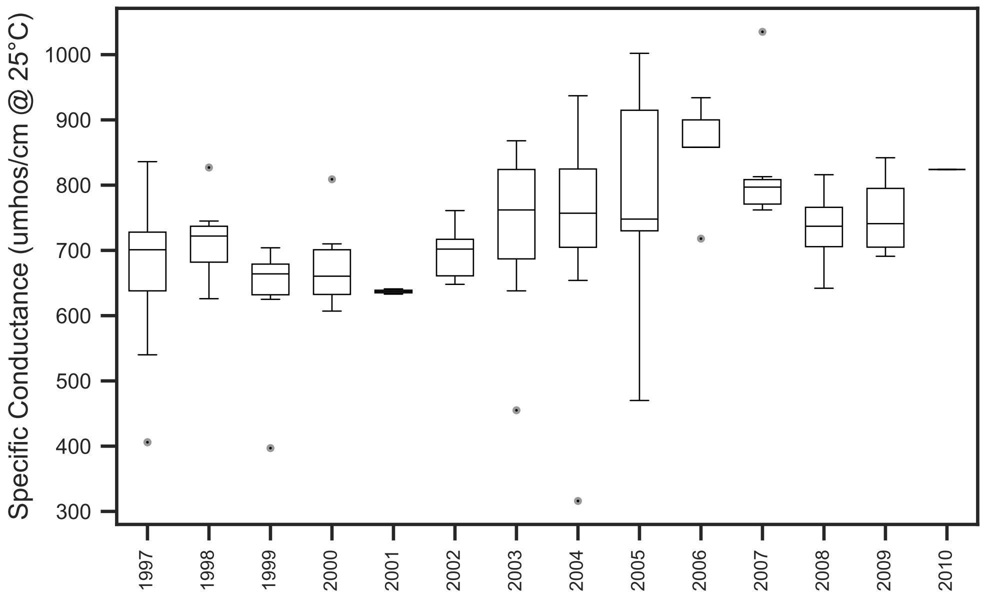
Nippersink Creek near Spring Grove (NC1) : Specific Conductance (umhos/cm @ 25°C)



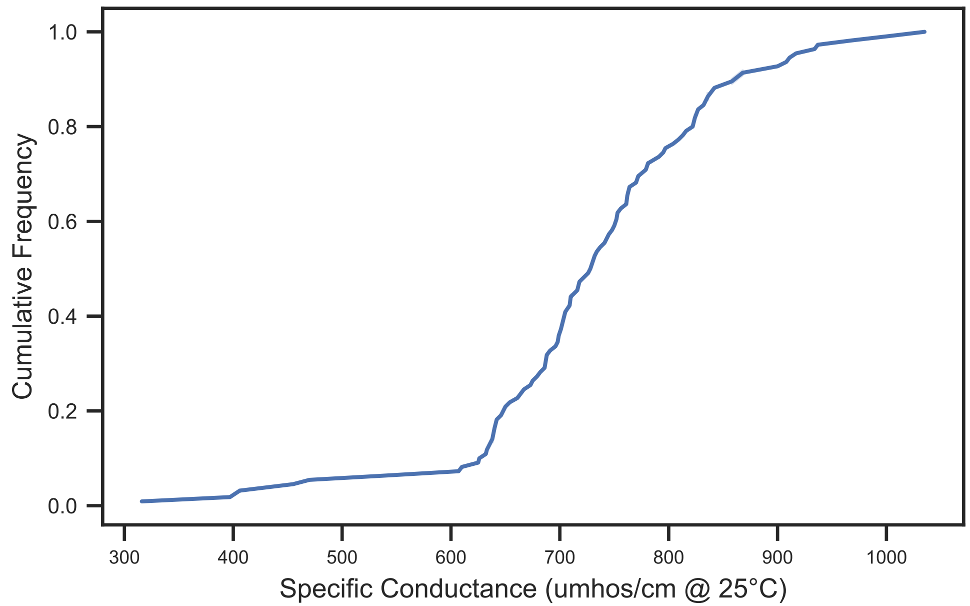
(a) Data Samples



(b) Monthly Boxplots

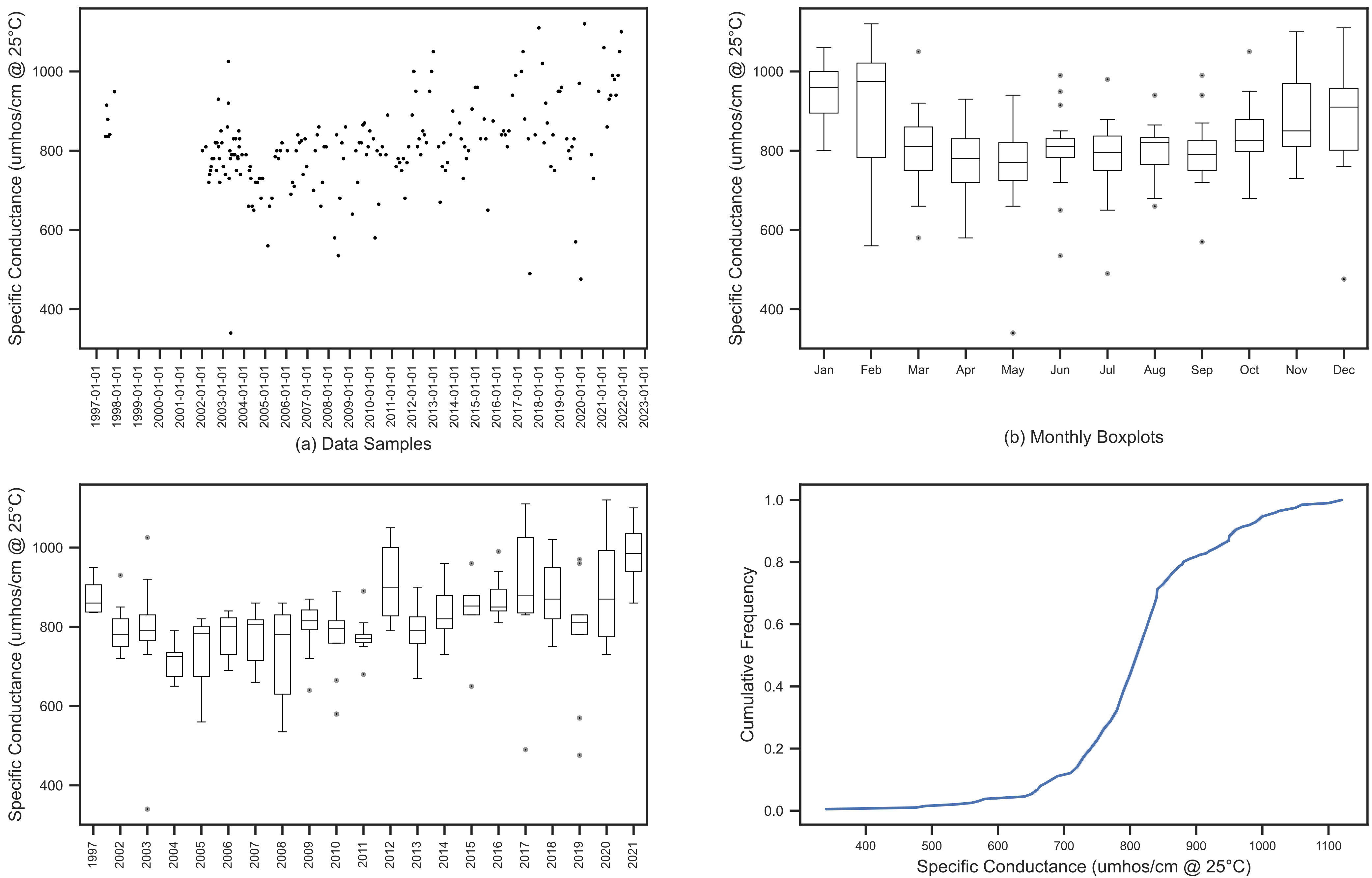


(c) Annual Boxplots



(d) Empirical CDF

Fox River at Chapel Rd, Johnsburg (FR2) : Specific Conductance (umhos/cm @ 25°C)



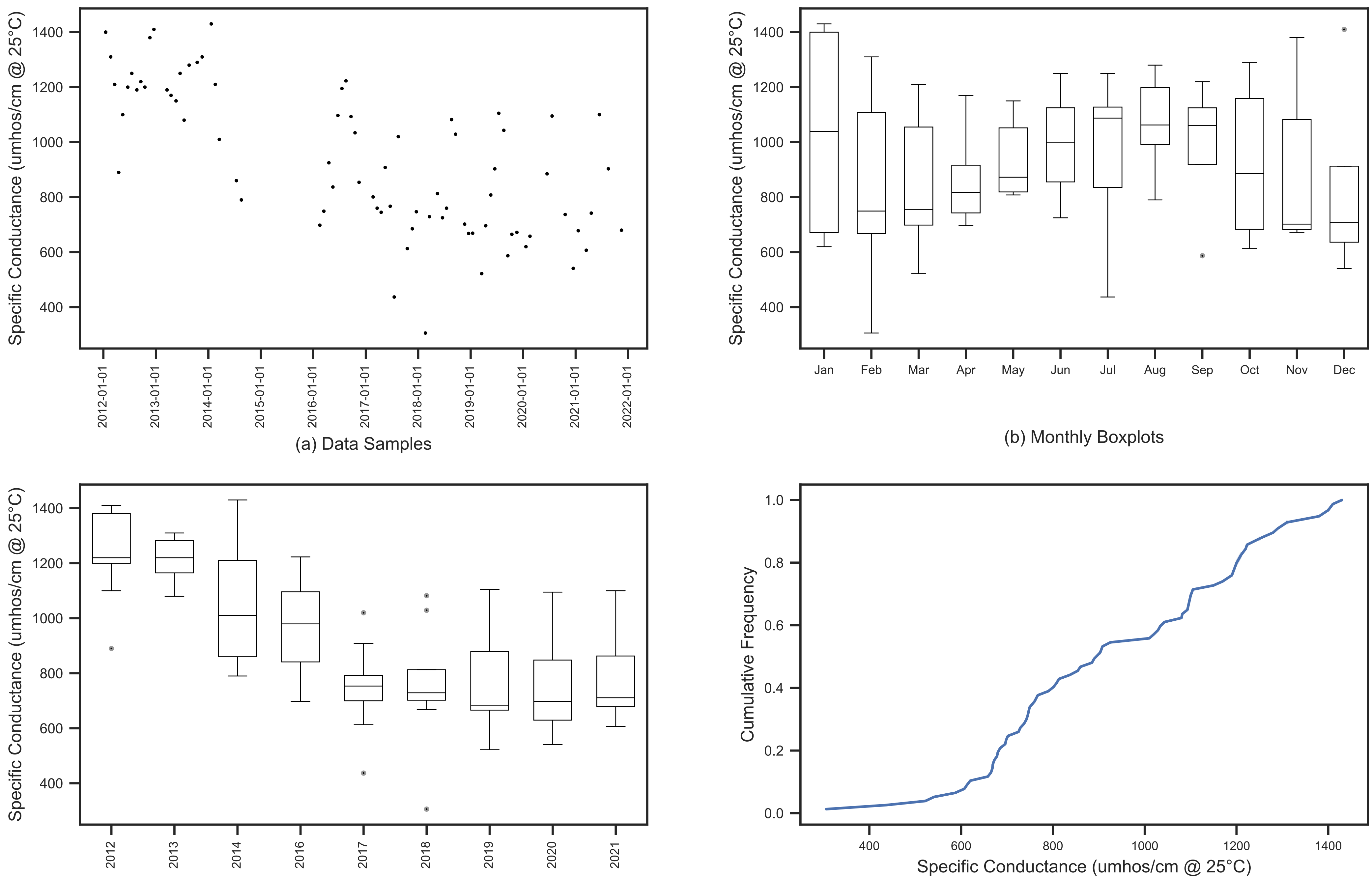
(a) Data Samples

(b) Monthly Boxplots

(c) Annual Boxplots

(d) Empirical CDF

Sleepy Hollow Creek at Stilling Ln. (SH1) : Specific Conductance (umhos/cm @ 25°C)

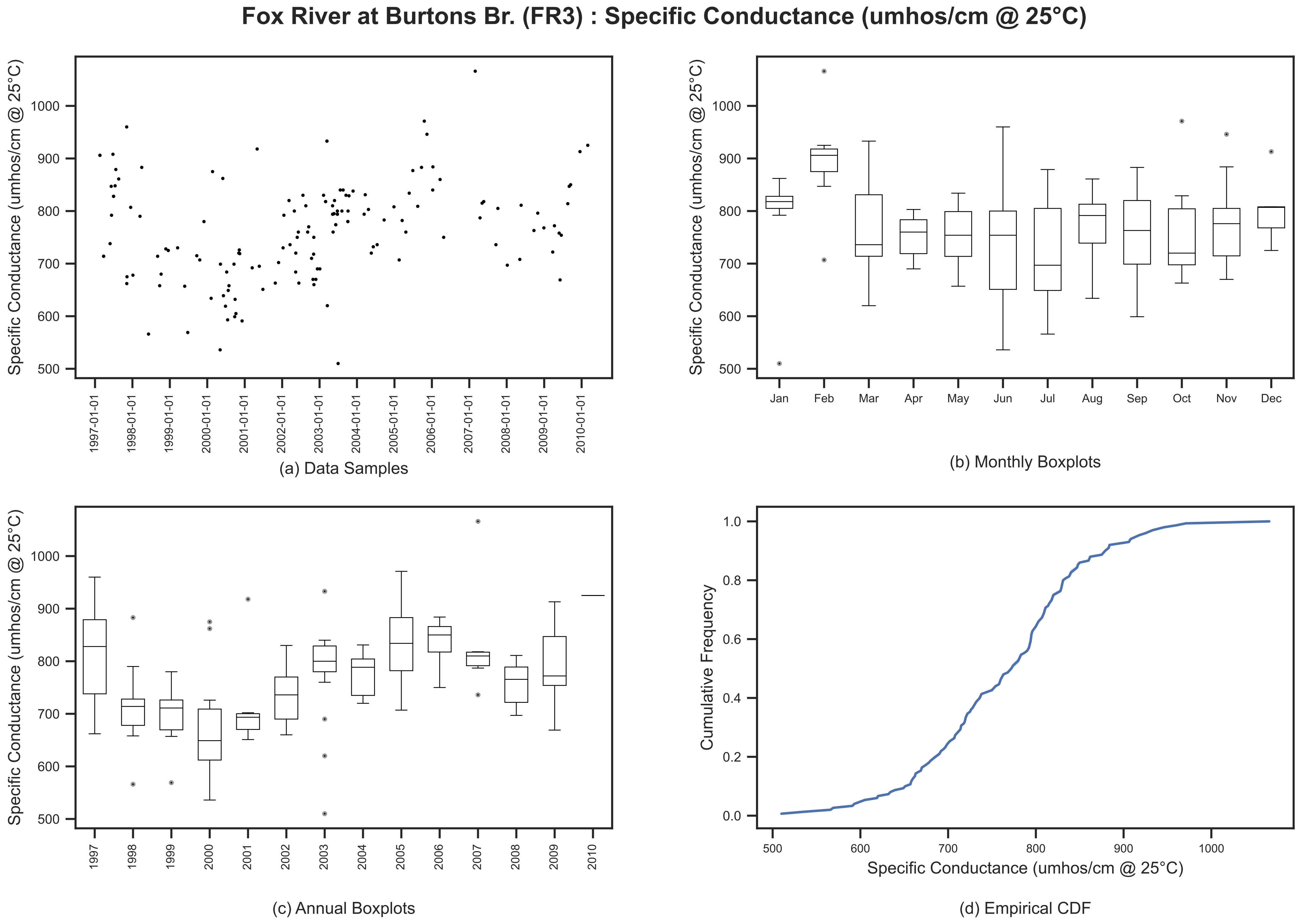


(a) Data Samples

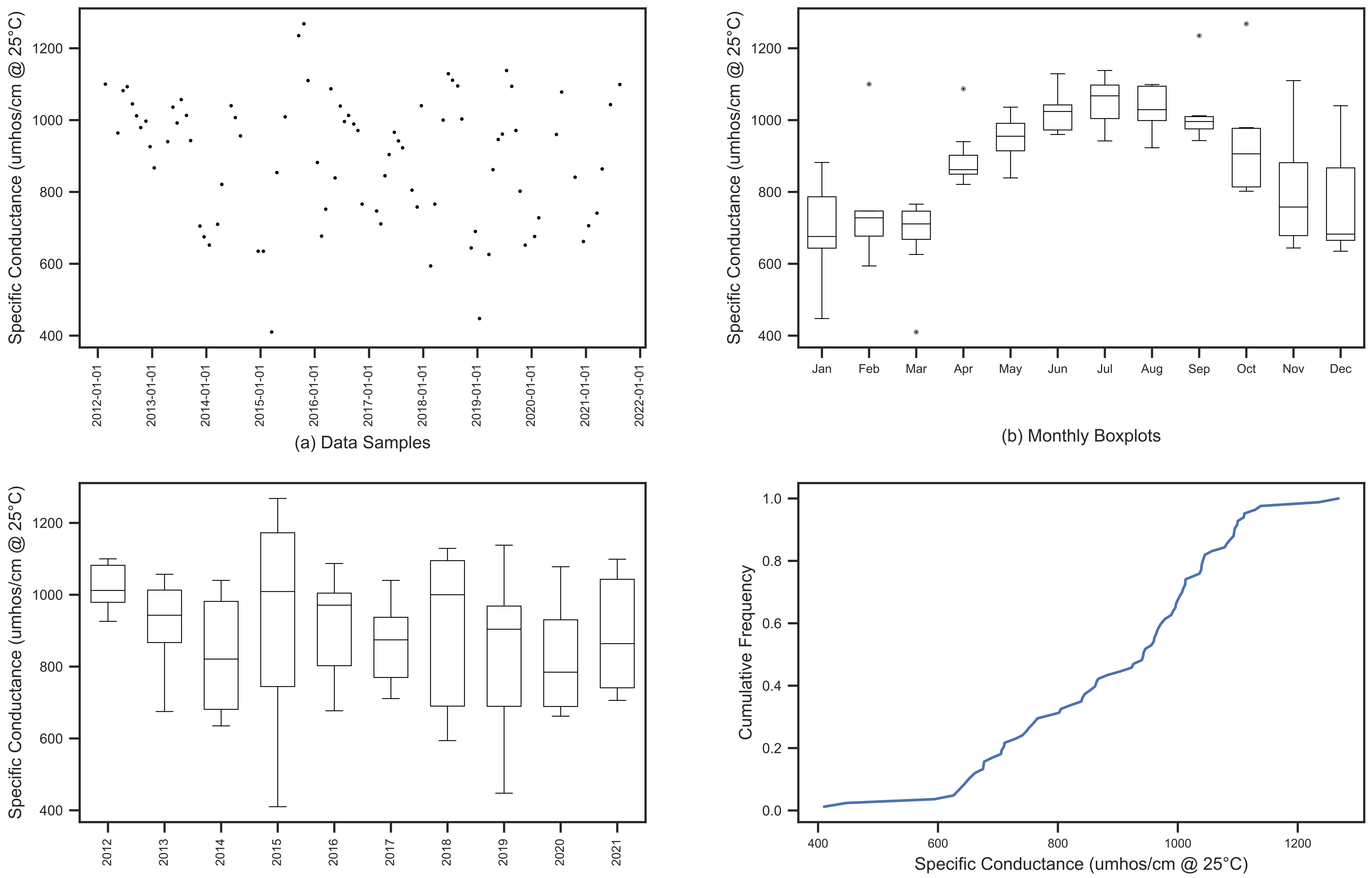
(b) Monthly Boxplots

(c) Annual Boxplots

(d) Empirical CDF


Fox River at Burtons Br. (FR3) : Specific Conductance (umhos/cm @ 25°C)
Specific Conductance (umhos/cm @ 25°C)
Cumulative Frequency
(a) Data Samples
(b) Monthly Boxplots
(c) Annual Boxplots
(d) Empirical CDF

Silver Creek at Lk shore Dr. & E. Park Ln. (SC1) : Specific Conductance (umhos/cm @ 25°C)



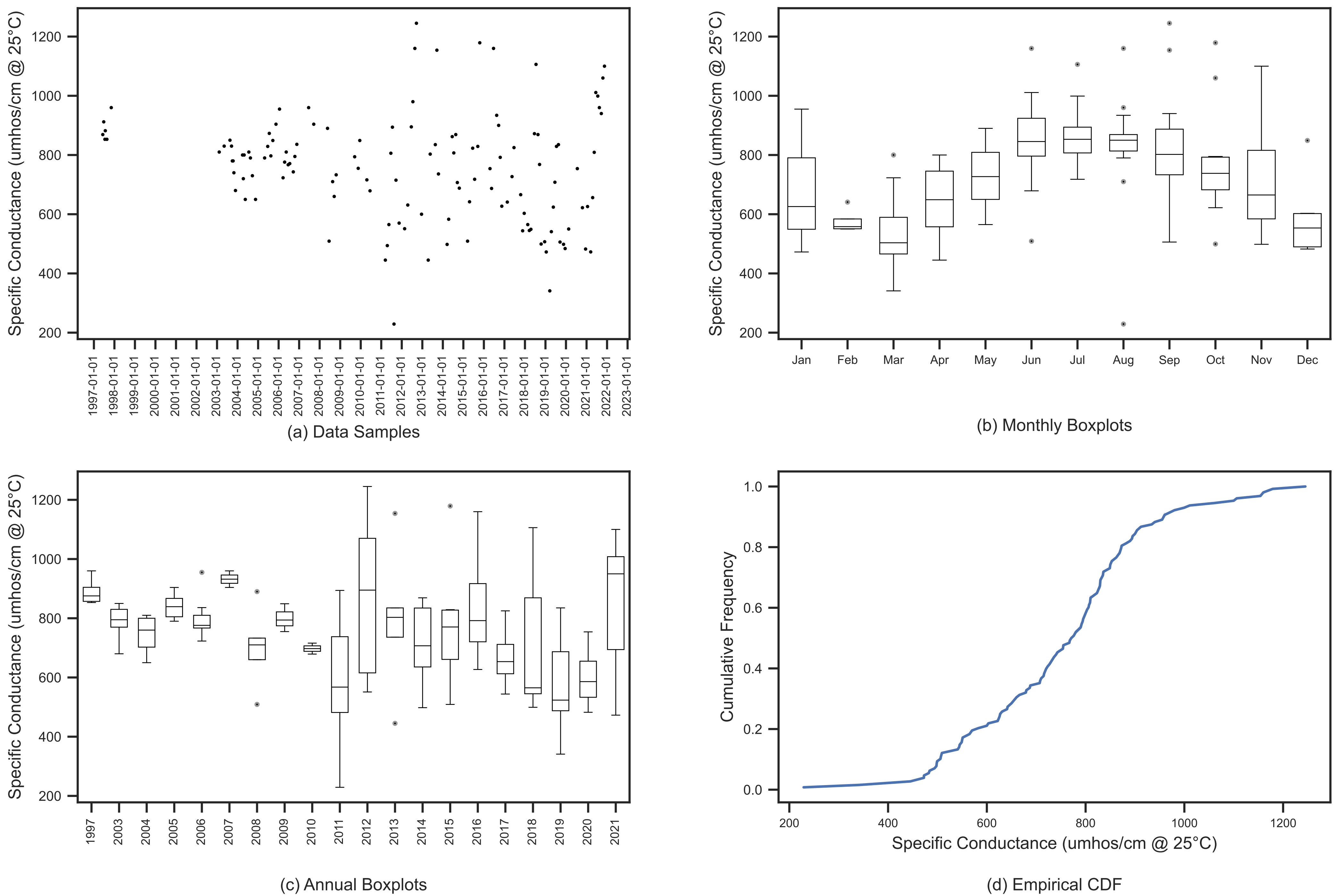
(a) Data Samples

(b) Monthly Boxplots

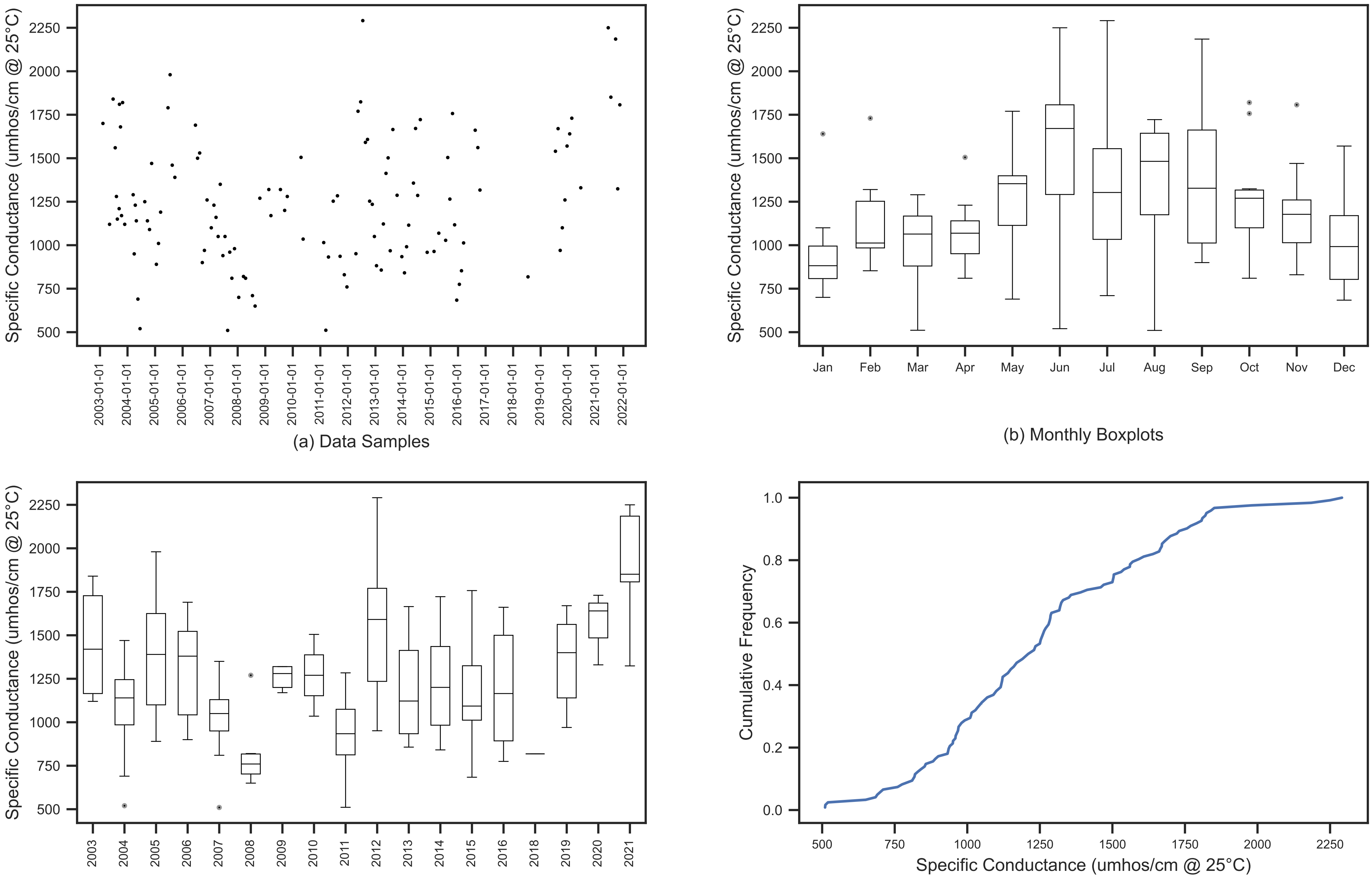
(c) Annual Boxplots

(d) Empirical CDF

Fox River at Rawson Rd., E Oakwood Hills (FR4) : Specific Conductance (umhos/cm @ 25°C)



Crystal Lk Outlet-Rt 31, Algonquin (CL1) : Specific Conductance (umhos/cm @ 25°C)



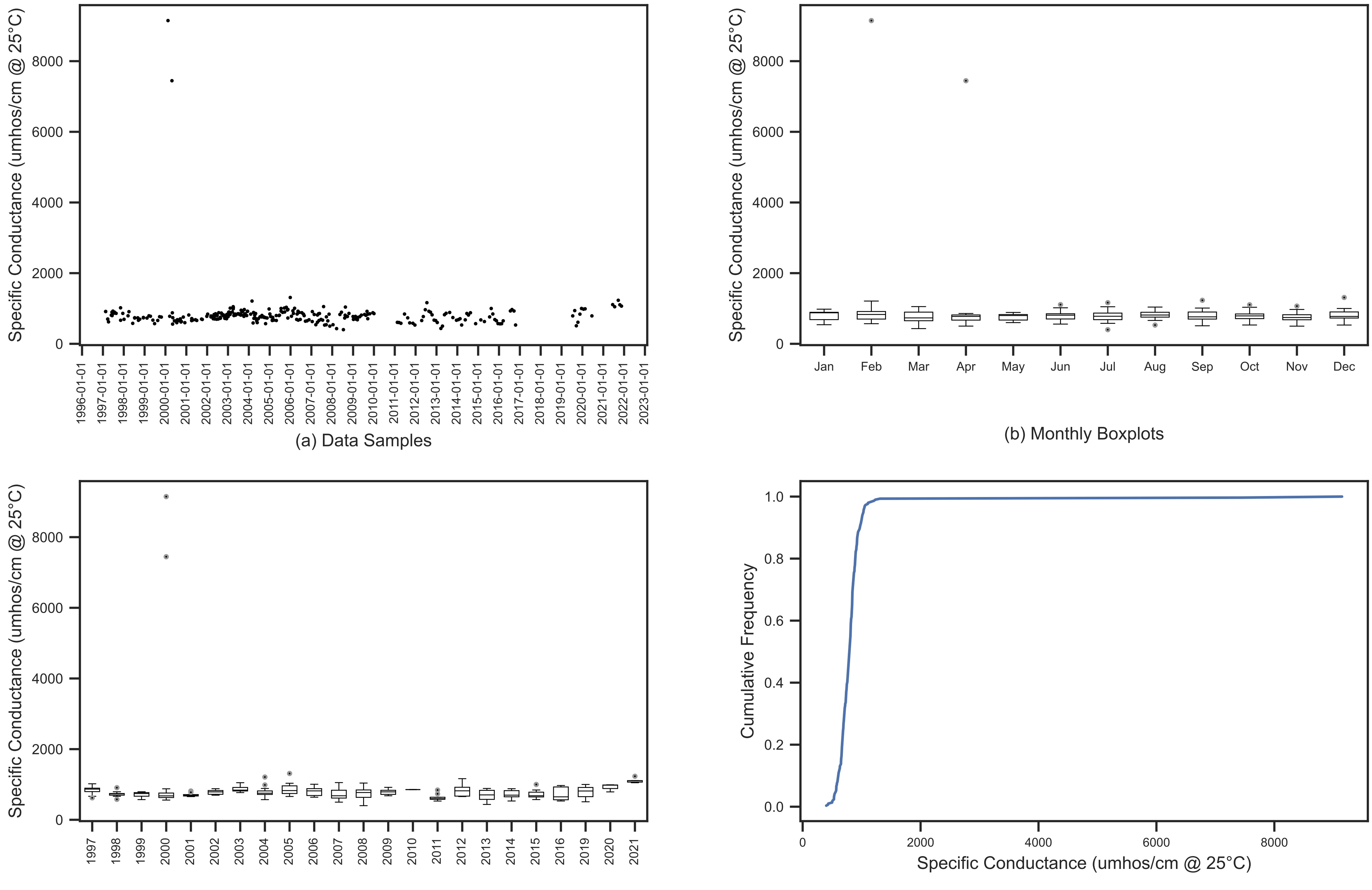
(a) Data Samples

(b) Monthly Boxplots

(c) Annual Boxplots

(d) Empirical CDF

Fox River at Algonquin (FR5) : Specific Conductance (umhos/cm @ 25°C)



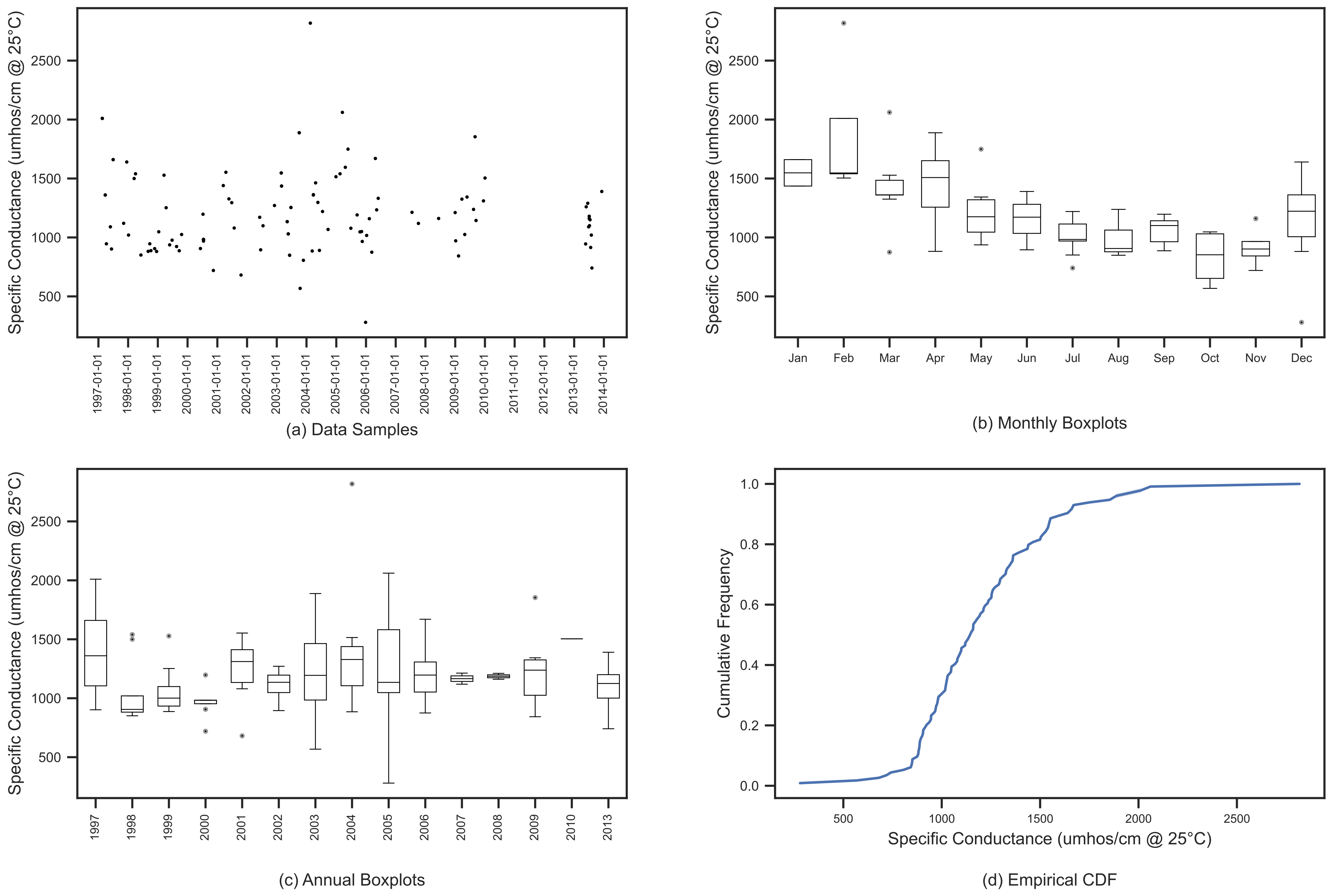
(a) Data Samples

(b) Monthly Boxplots

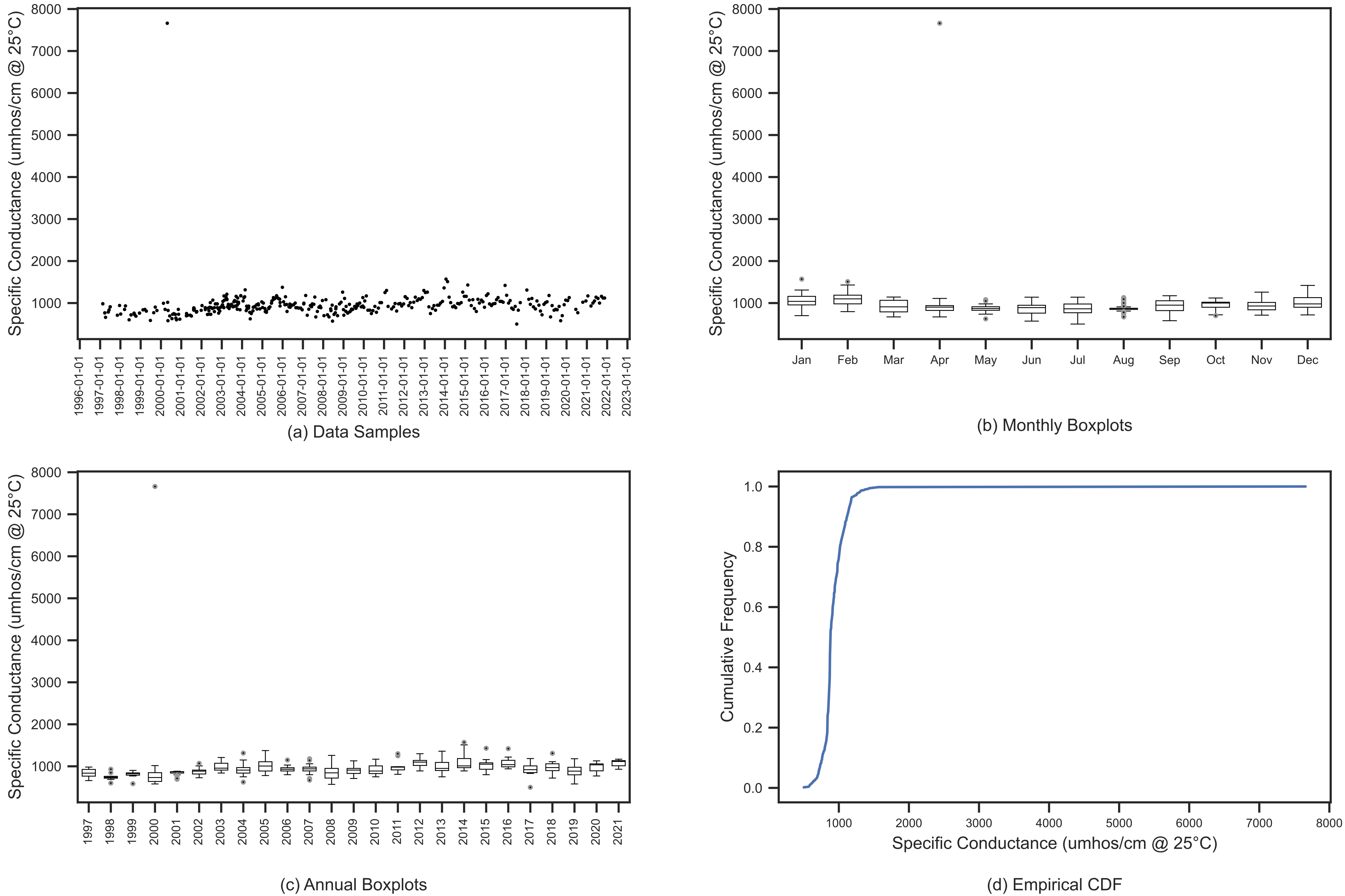
(c) Annual Boxplots

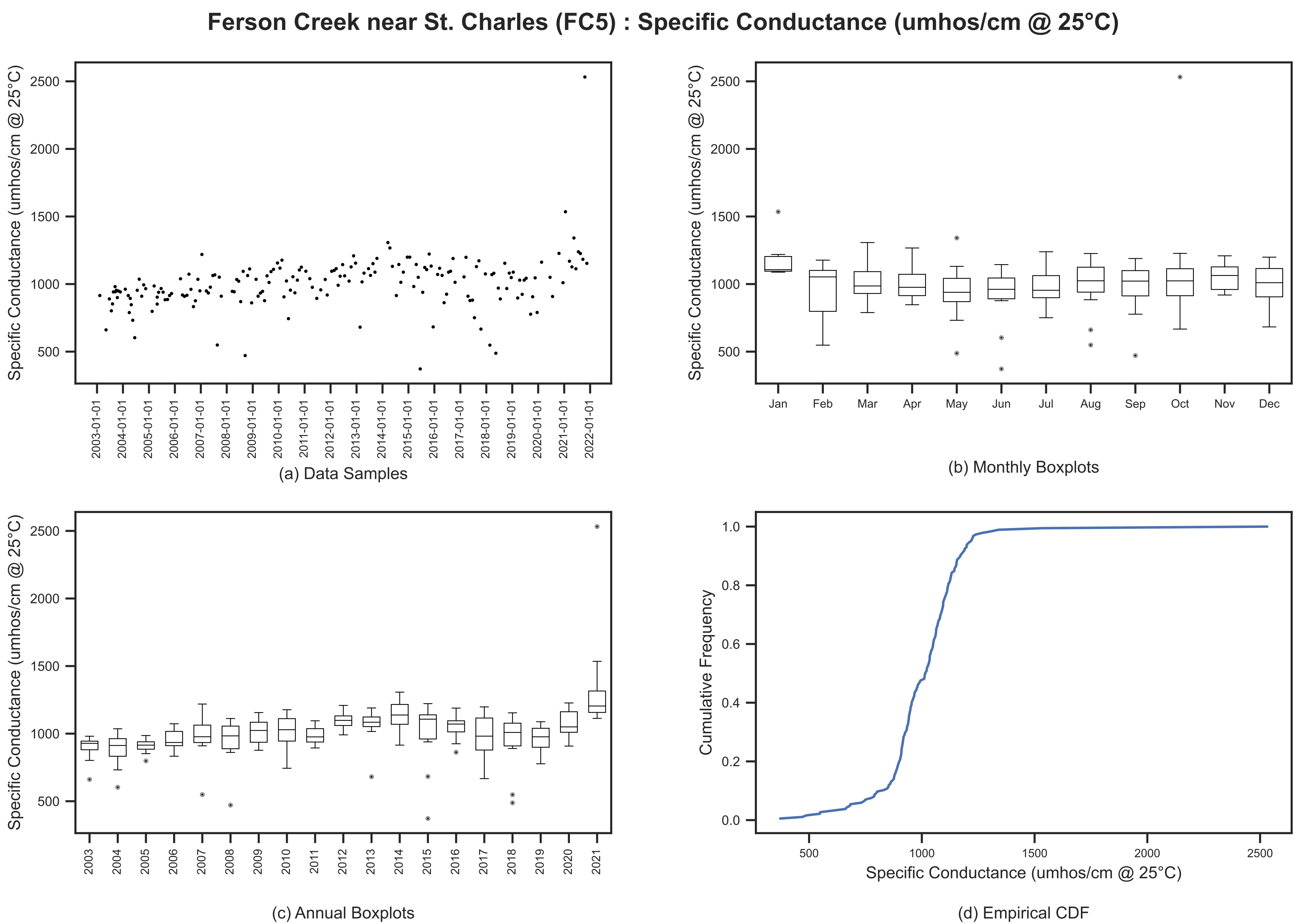
(d) Empirical CDF

Poplar Creek at Elgin (PC1) : Specific Conductance (umhos/cm @ 25°C)



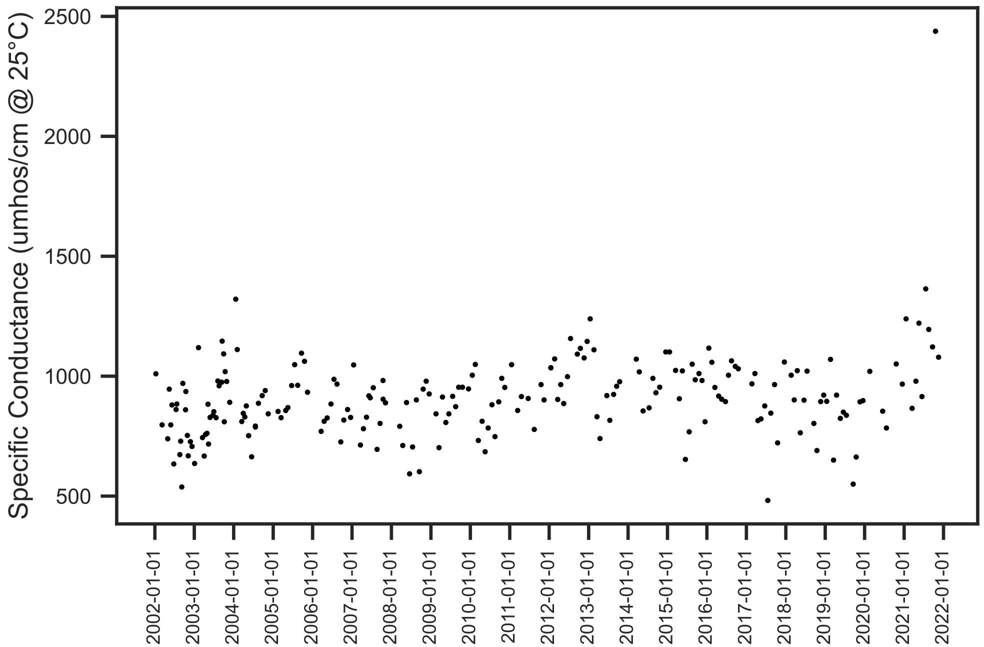
Fox River at South Elgin (FR6) : Specific Conductance (umhos/cm @ 25°C)



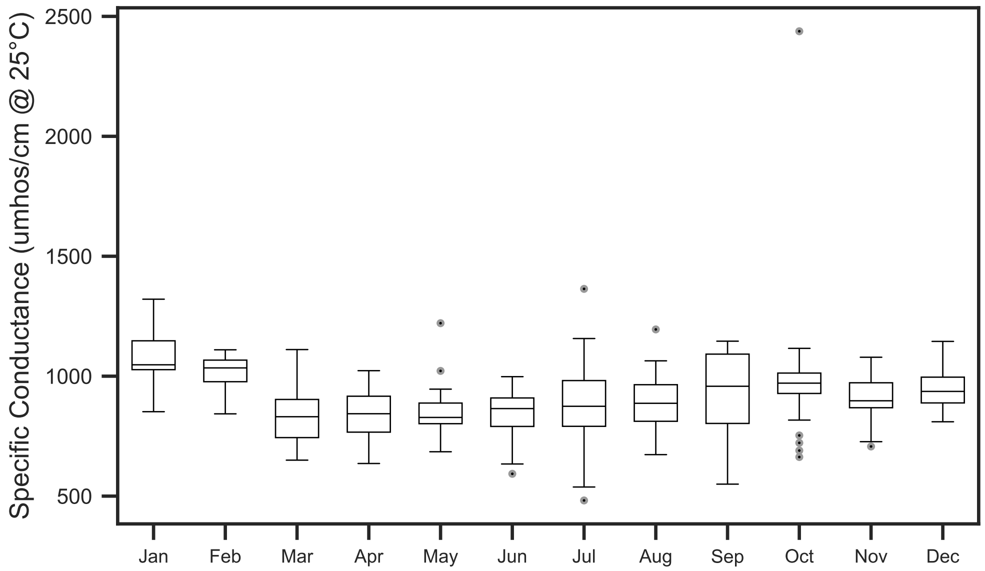


Ferson Creek near St. Charles (FC5) : Specific Conductance (umhos/cm @ 25°C)
Specific Conductance (umhos/cm @ 25°C)
2500
2000
1500
1000
500
2003-01-01
2004-01-01
2005-01-01
2006-01-01
2007-01-01
2008-01-01
2009-01-01
2010-01-01
2011-01-01
2012-01-01
2013-01-01
2014-01-01
2015-01-01
2016-01-01
2017-01-01
2018-01-01
2019-01-01
2020-01-01
2021-01-01
2022-01-01
(a) Data Samples
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(b) Monthly Boxplots
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
(c) Annual Boxplots
Cumulative Frequency
0.0
0.2
0.4
0.6
0.8
1.0
(d) Empirical CDF

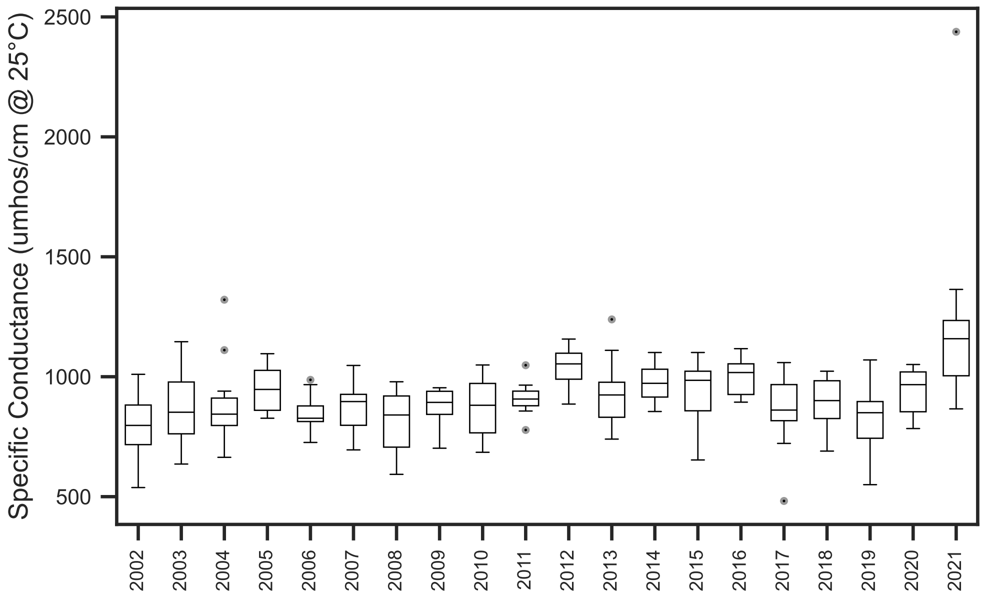
Fox River at Fabyan Pk-Geneva (FR7) : Specific Conductance (umhos/cm @ 25°C)



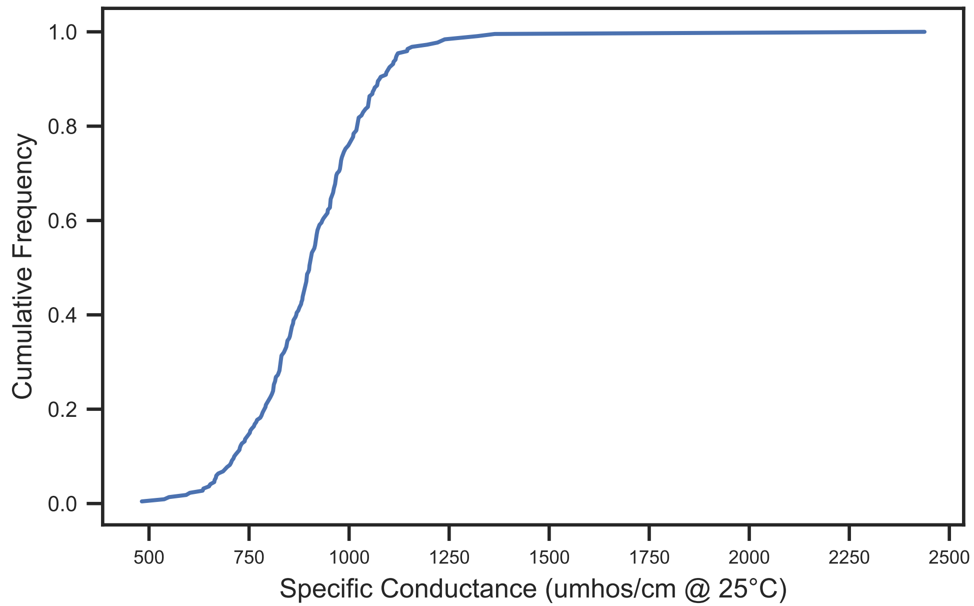
(a) Data Samples



(b) Monthly Boxplots

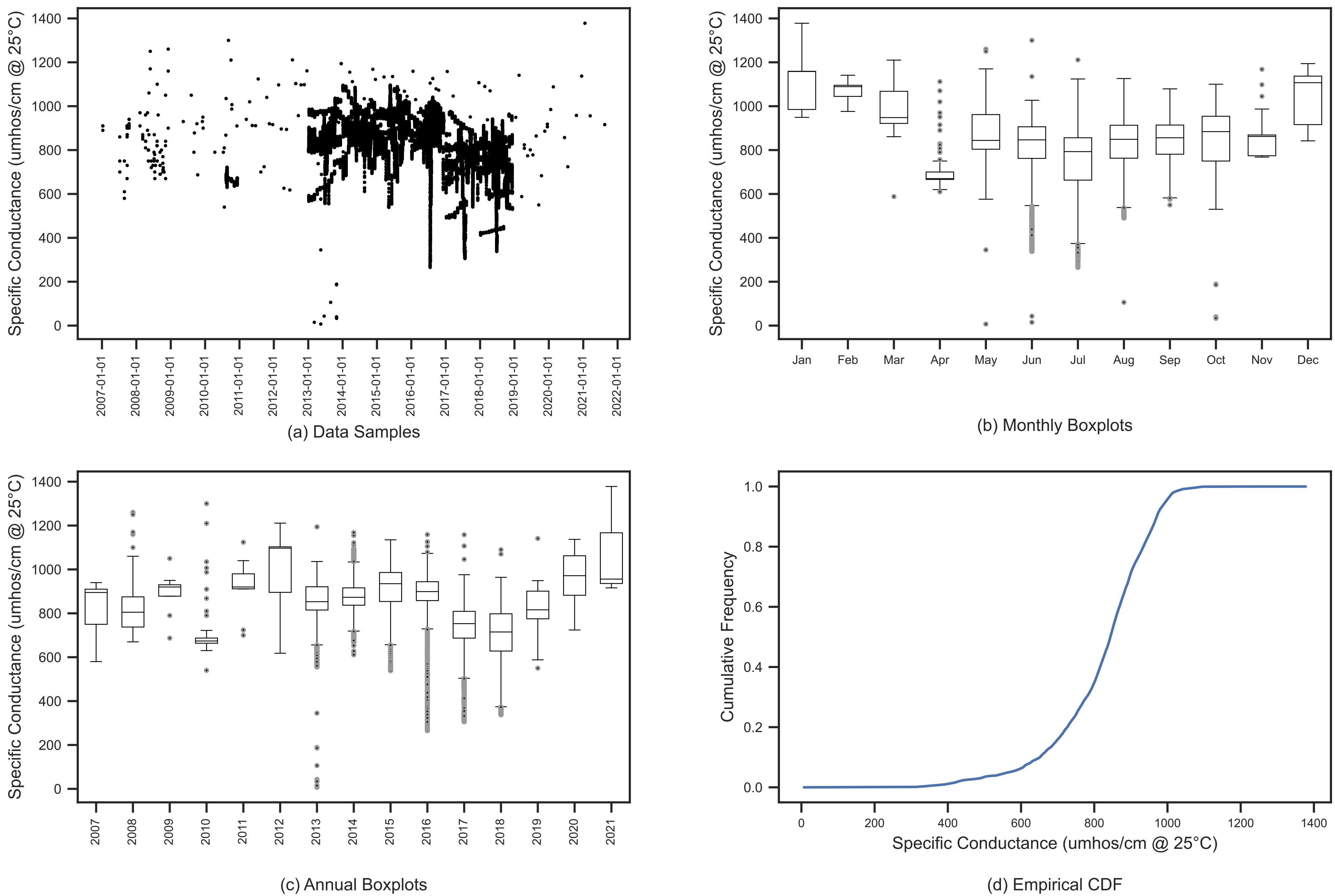


(c) Annual Boxplots

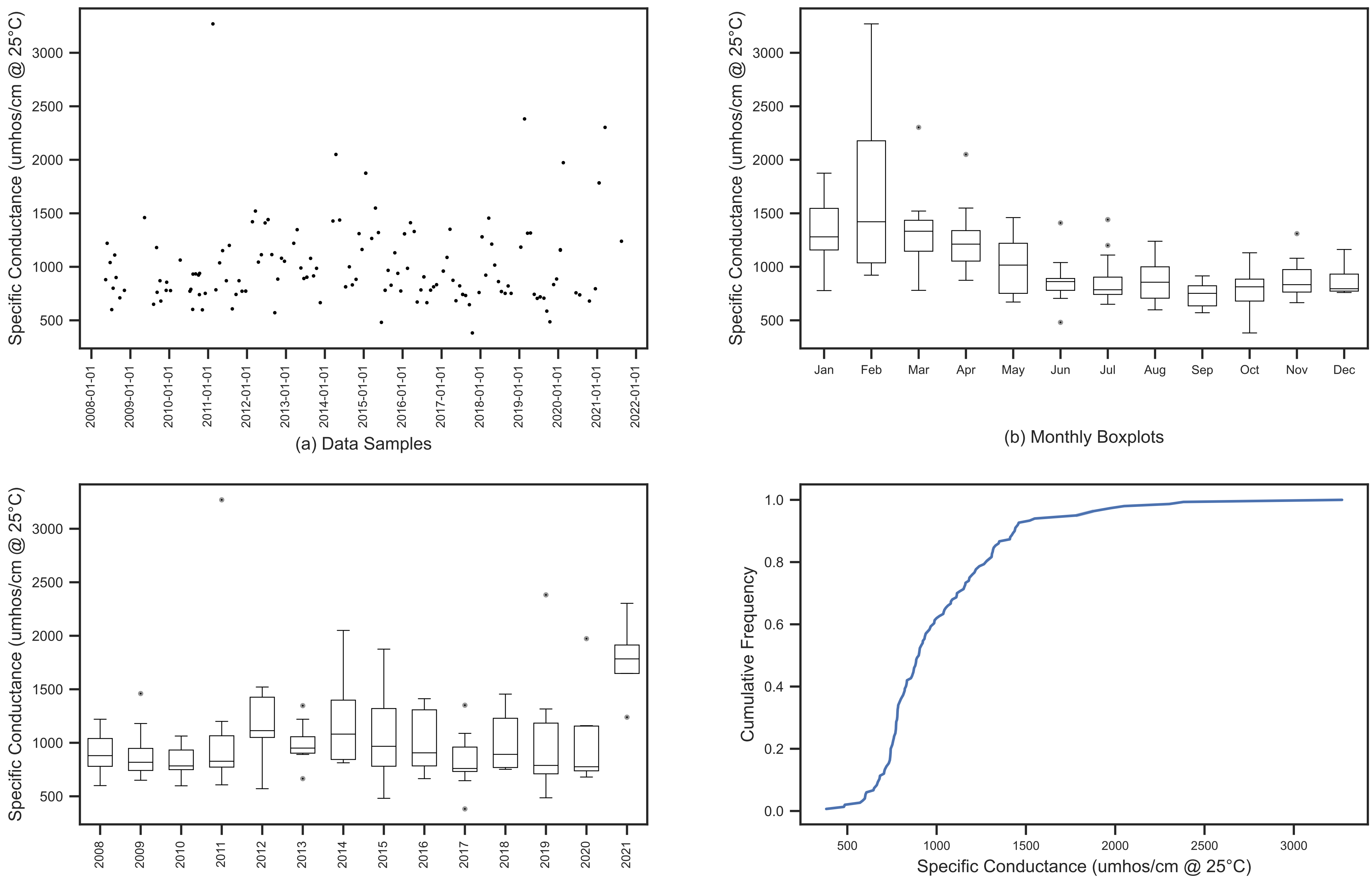


(d) Empirical CDF

Fox River at Sullivan Br. (FR8) : Specific Conductance (umhos/cm @ 25°C)



Indian Creek at Reckinger Rd. (IC1) : Specific Conductance (umhos/cm @ 25°C)



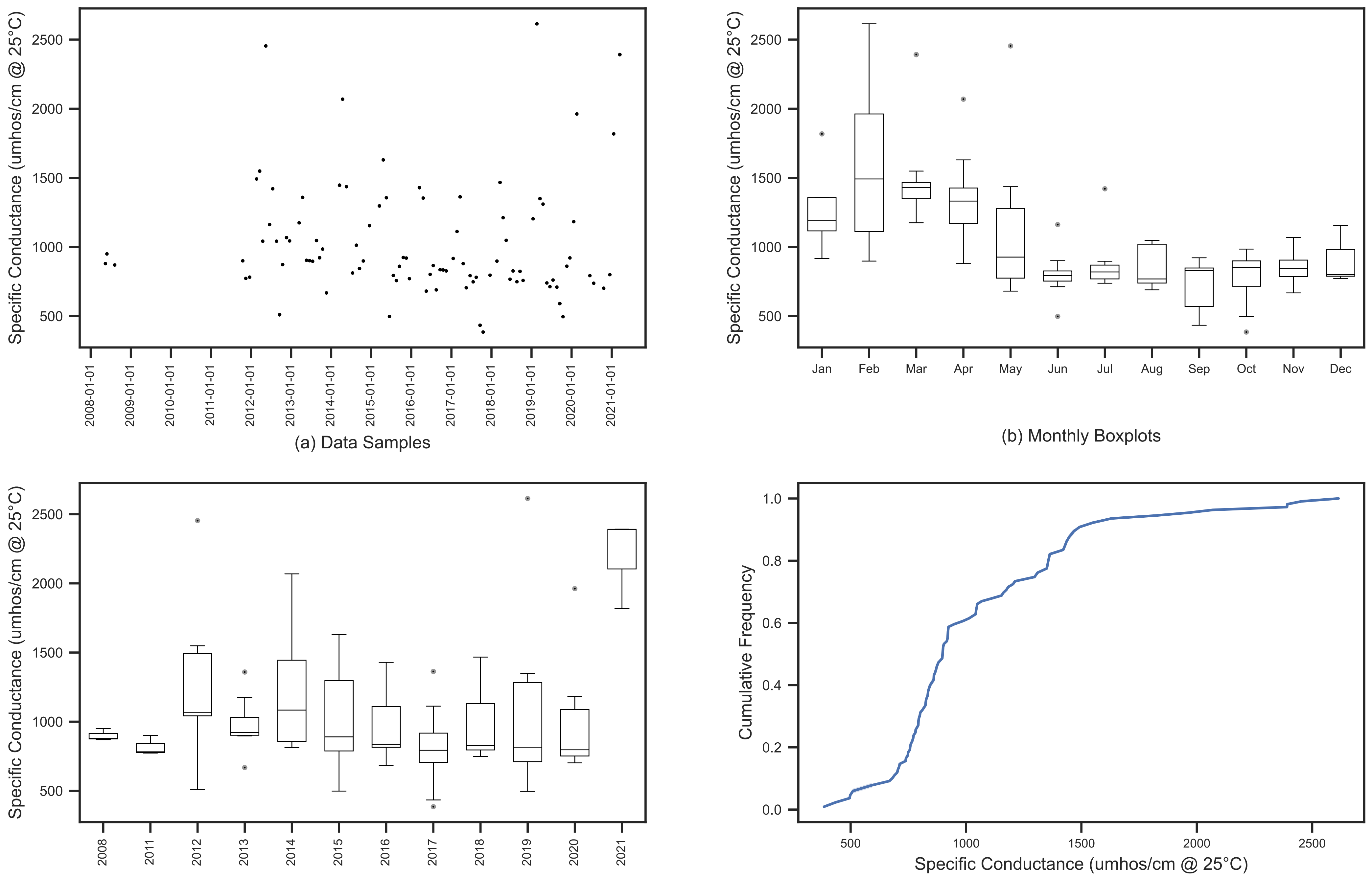
(a) Data Samples

(b) Monthly Boxplots

(c) Annual Boxplots

(d) Empirical CDF

Indian Creek ups Outfall (IC2) : Specific Conductance (umhos/cm @ 25°C)



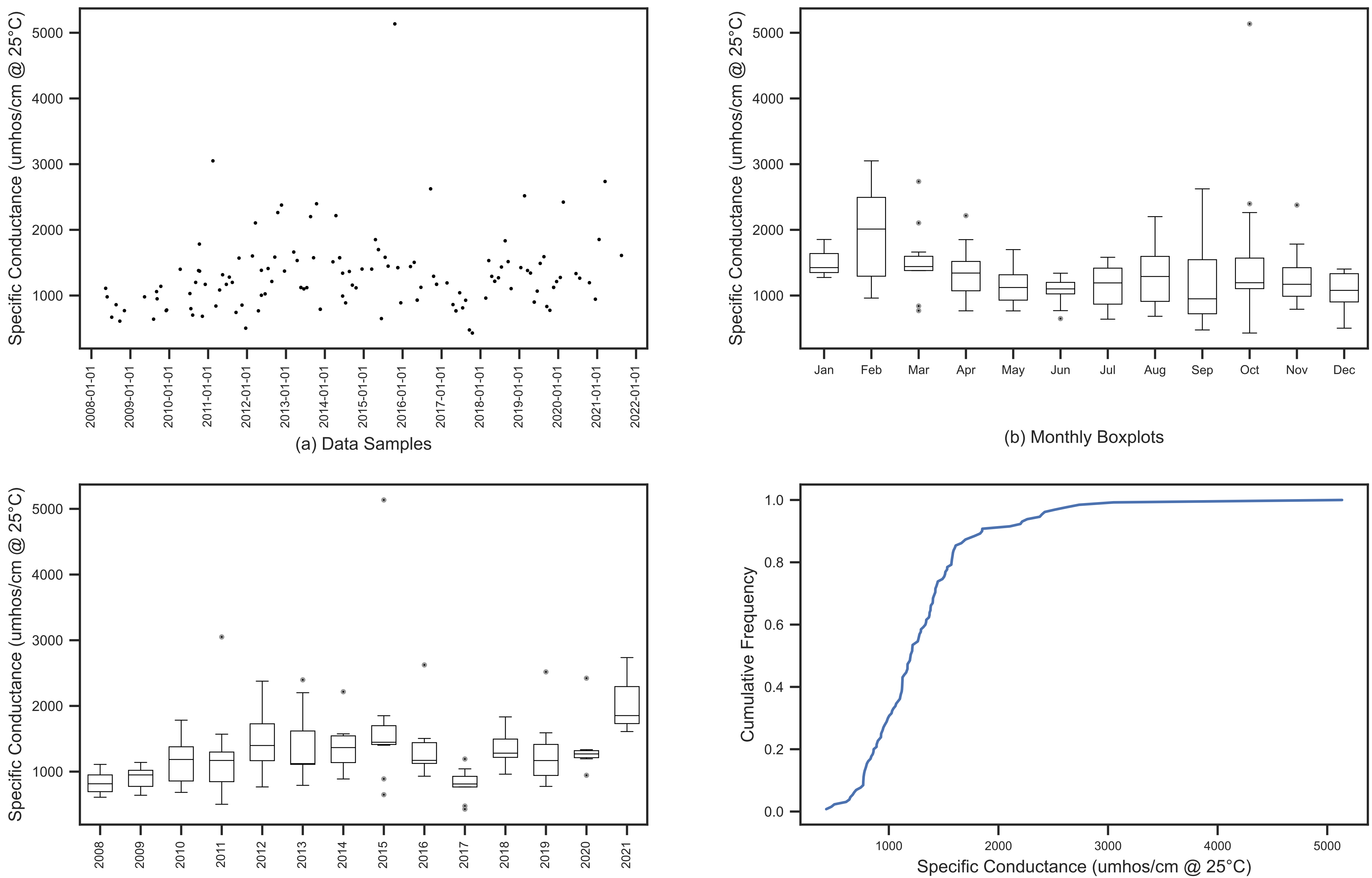
(a) Data Samples

(b) Monthly Boxplots

(c) Annual Boxplots

(d) Empirical CDF

Indian Creek dns Outfall (IC3) : Specific Conductance (umhos/cm @ 25°C)



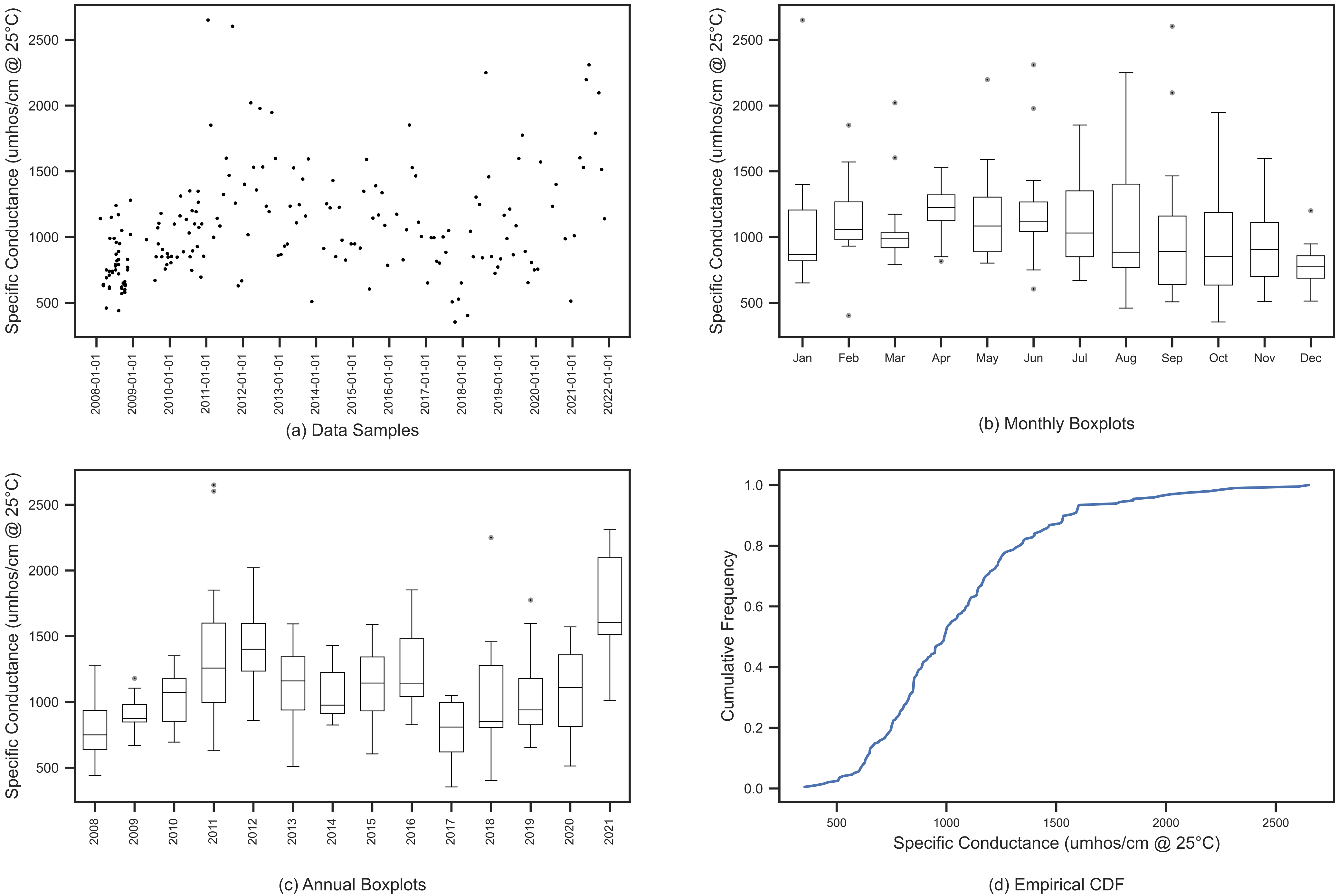
(a) Data Samples

(b) Monthly Boxplots

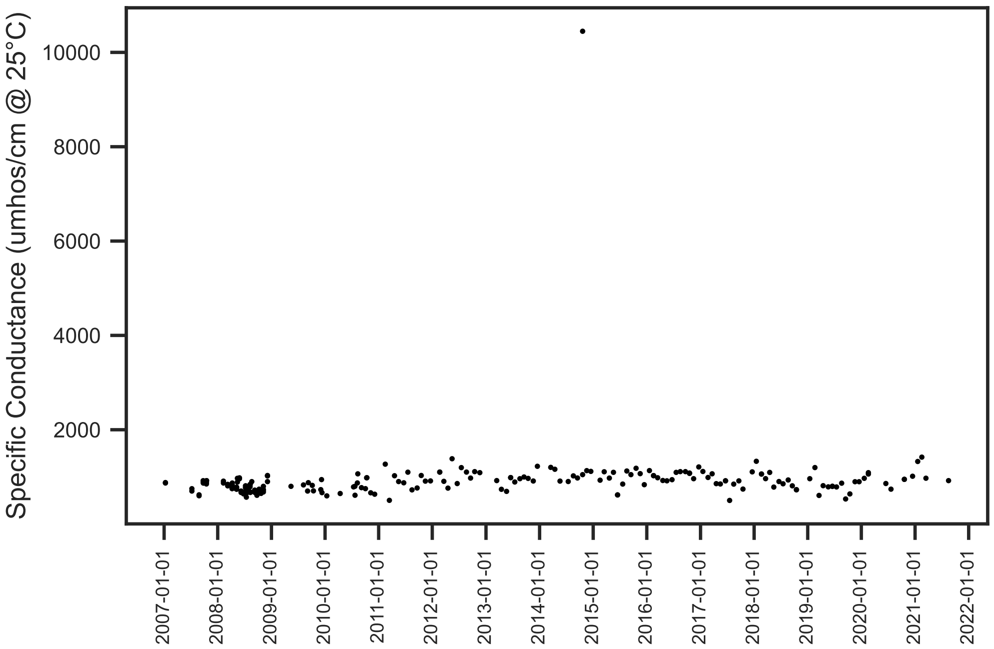
(c) Annual Boxplots

(d) Empirical CDF

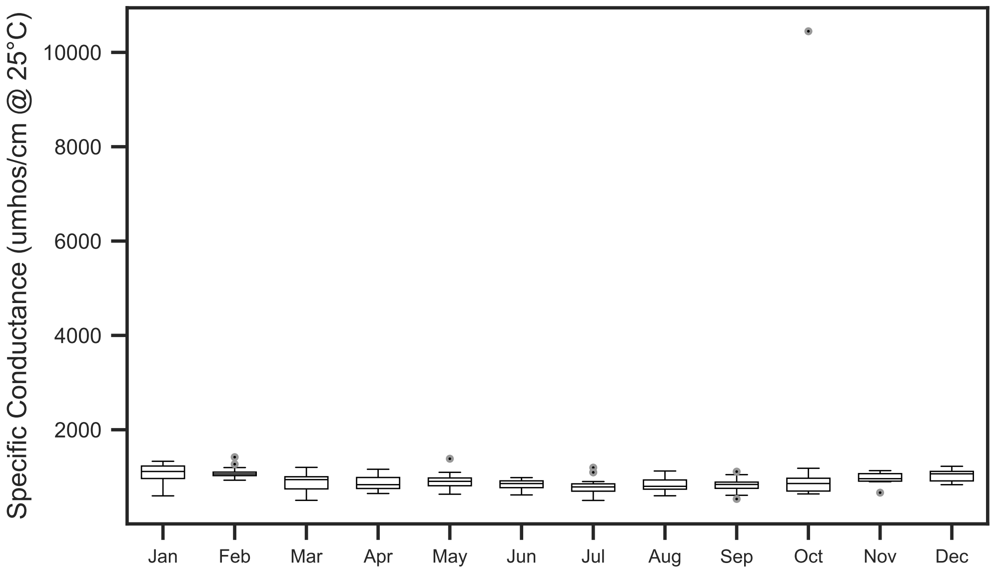
Indian Creek u/s Rt. 25 (IC4) : Specific Conductance (umhos/cm @ 25°C)



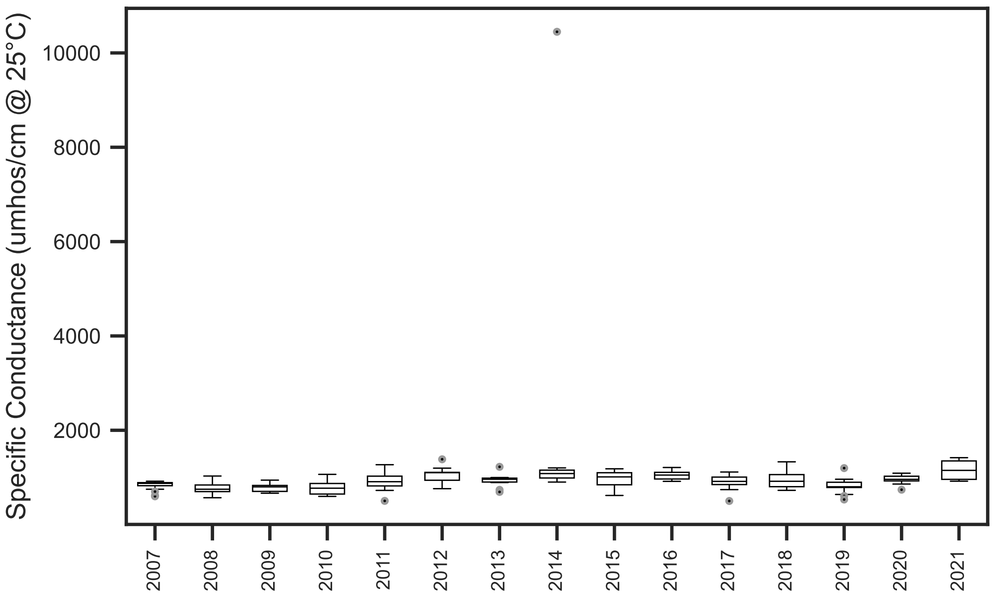
Fox River at North Ave. Br. (FR9) : Specific Conductance (umhos/cm @ 25°C)



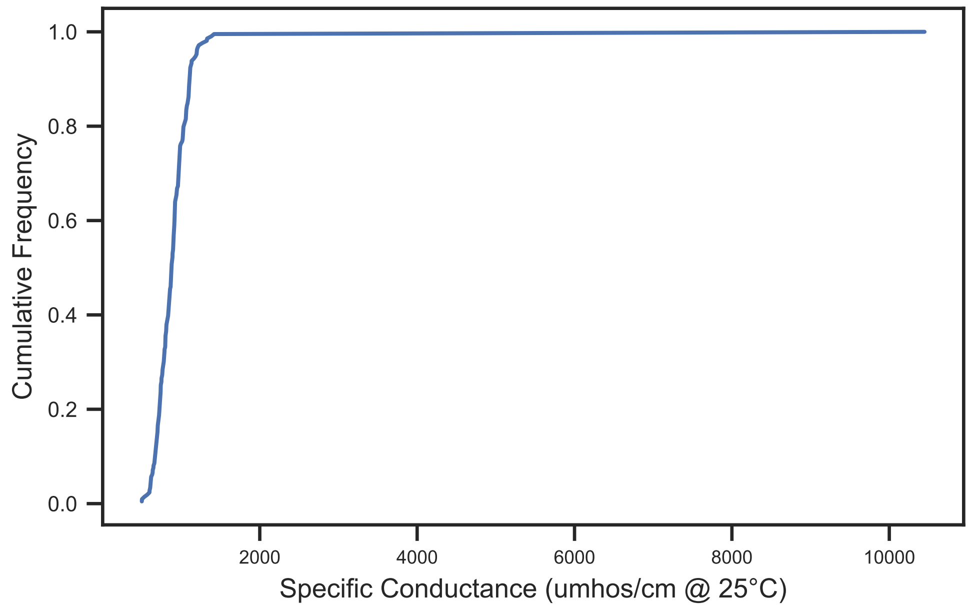
(a) Data Samples



(b) Monthly Boxplots

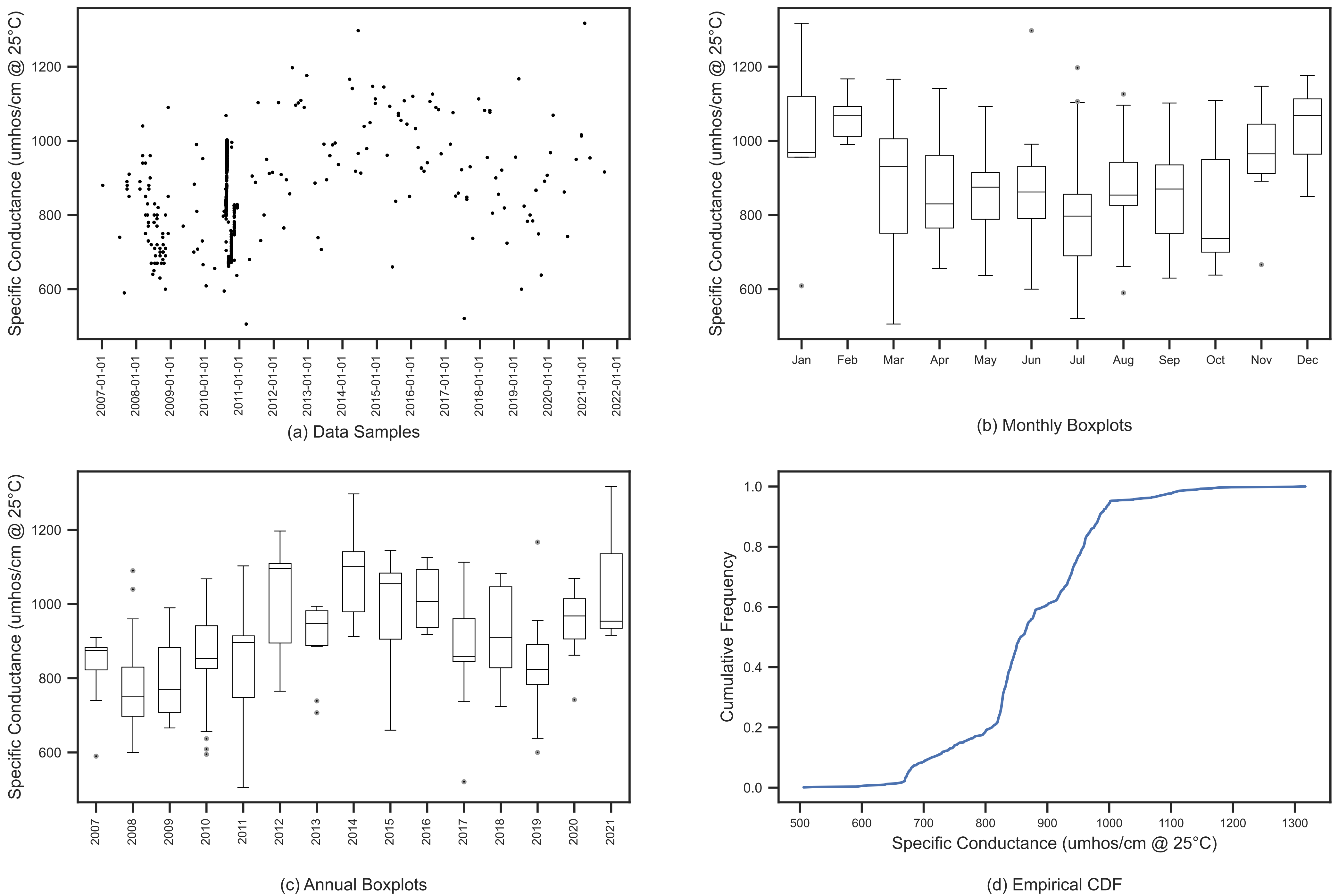


(c) Annual Boxplots

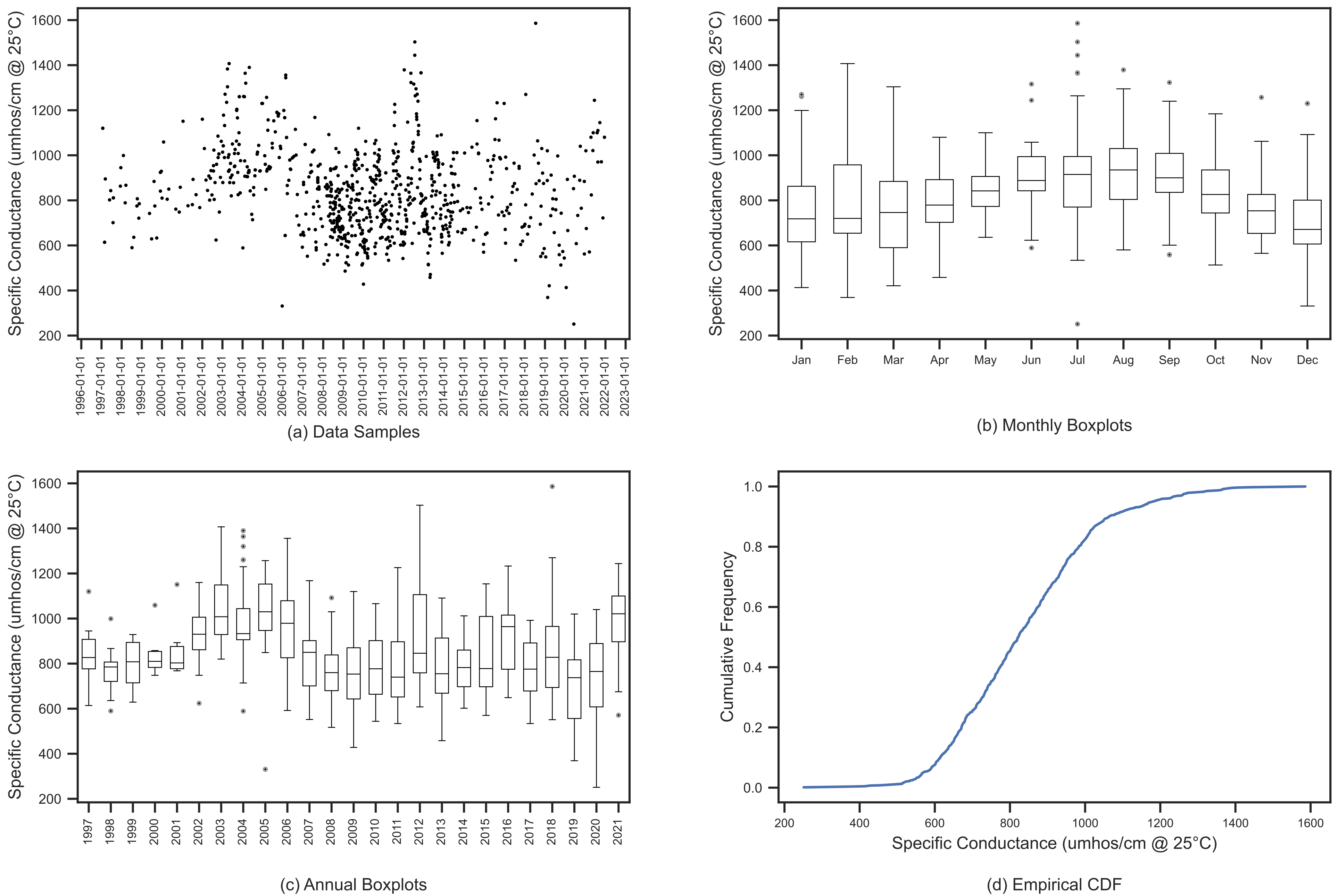


(d) Empirical CDF

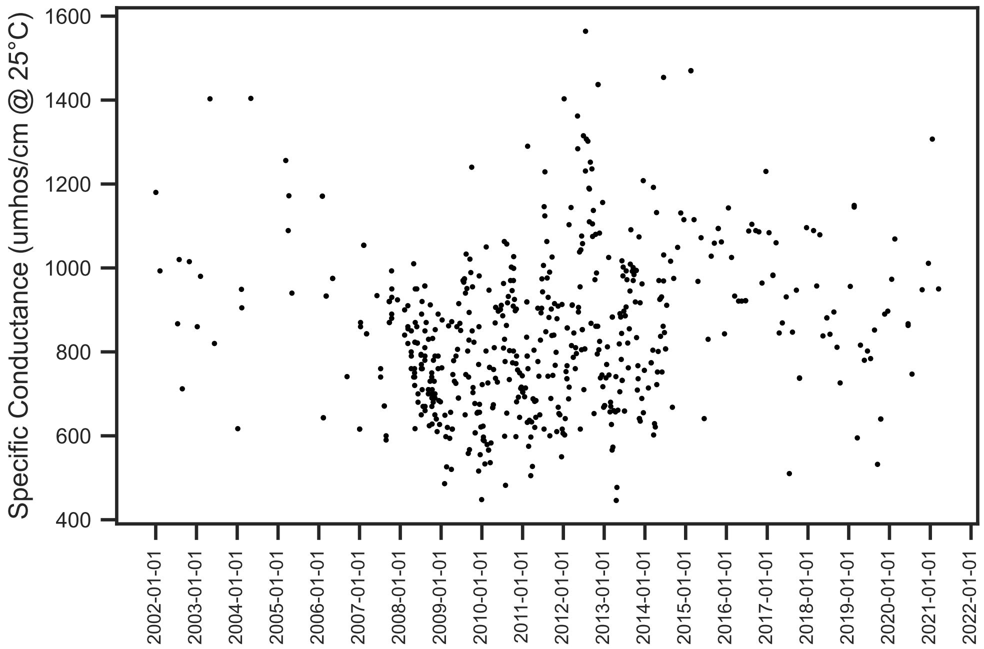
Fox River at Ashland Ave. (FR10) : Specific Conductance (umhos/cm @ 25°C)



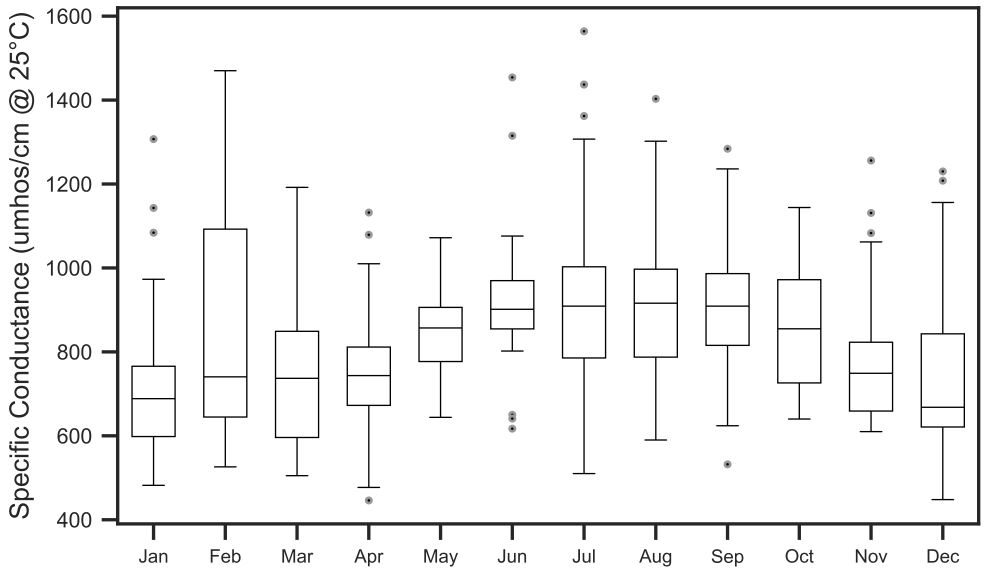
Fox River at Montgomery (FR11) : Specific Conductance (umhos/cm @ 25°C)



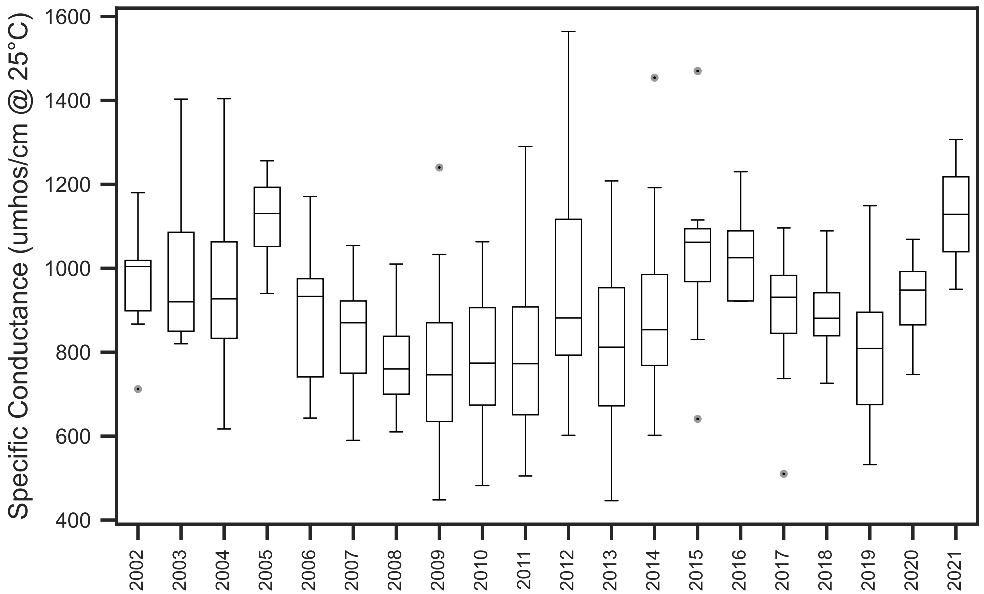
Fox River at Rt. 34, Oswego (FR12) : Specific Conductance (umhos/cm @ 25°C)



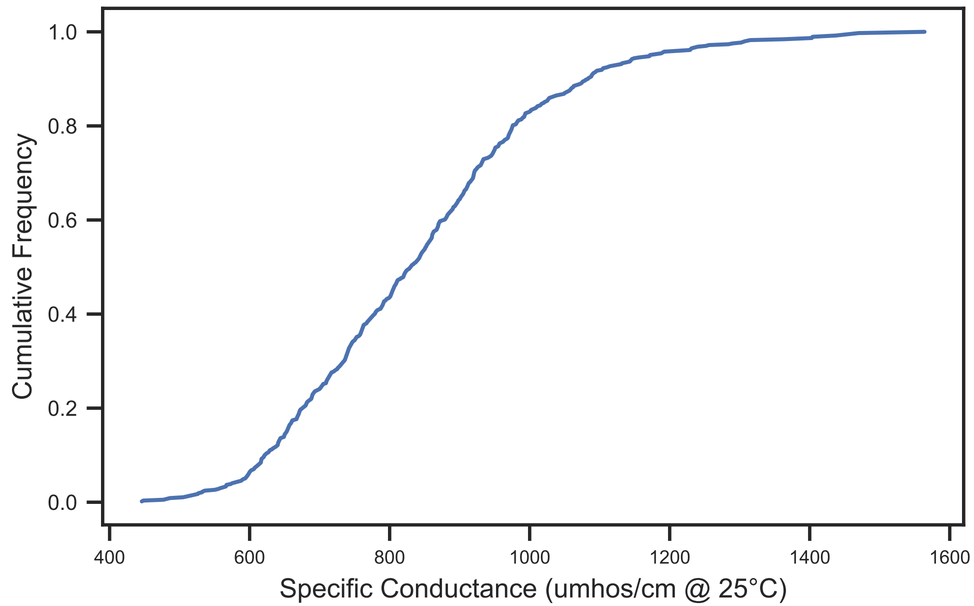
(a) Data Samples



(b) Monthly Boxplots

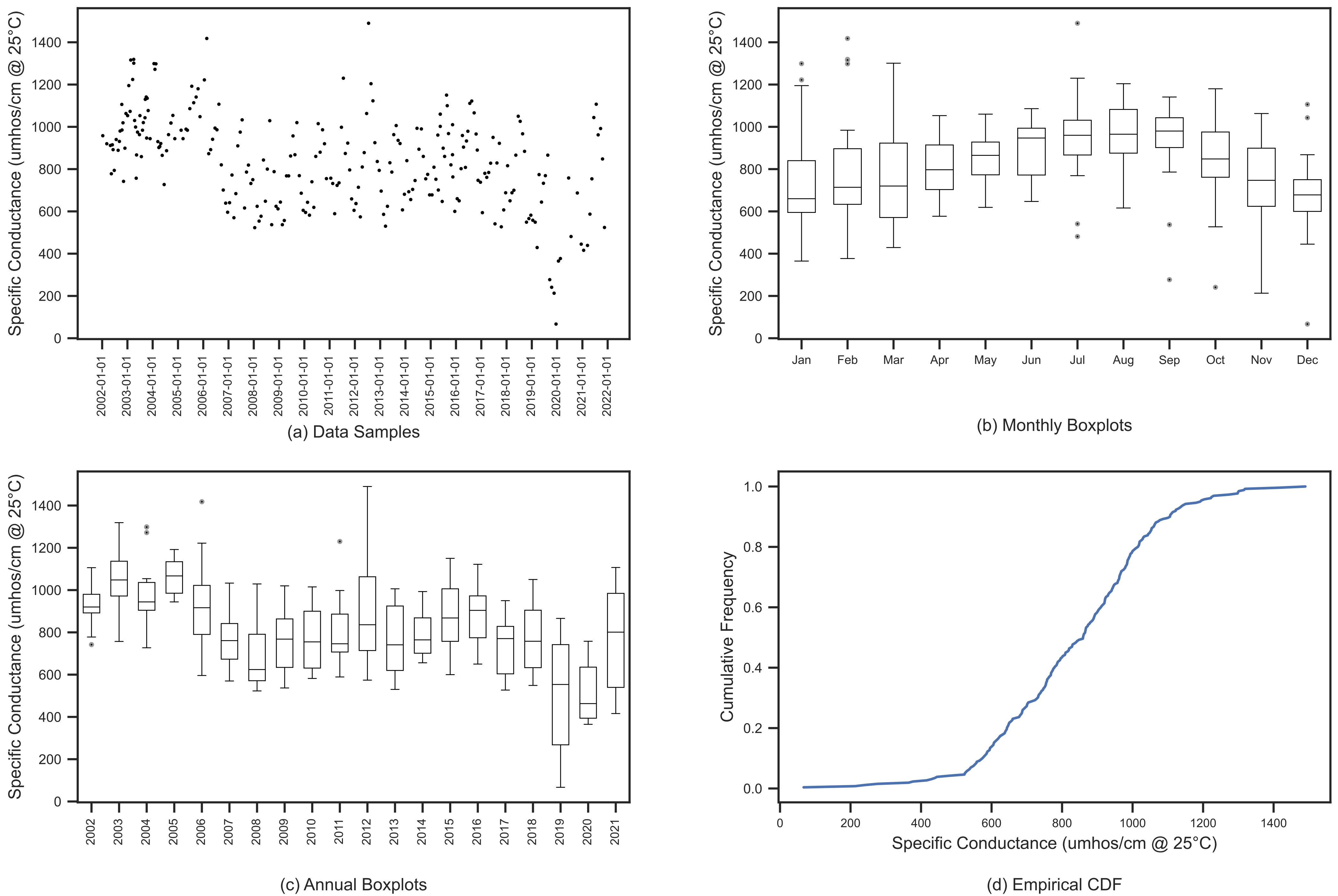


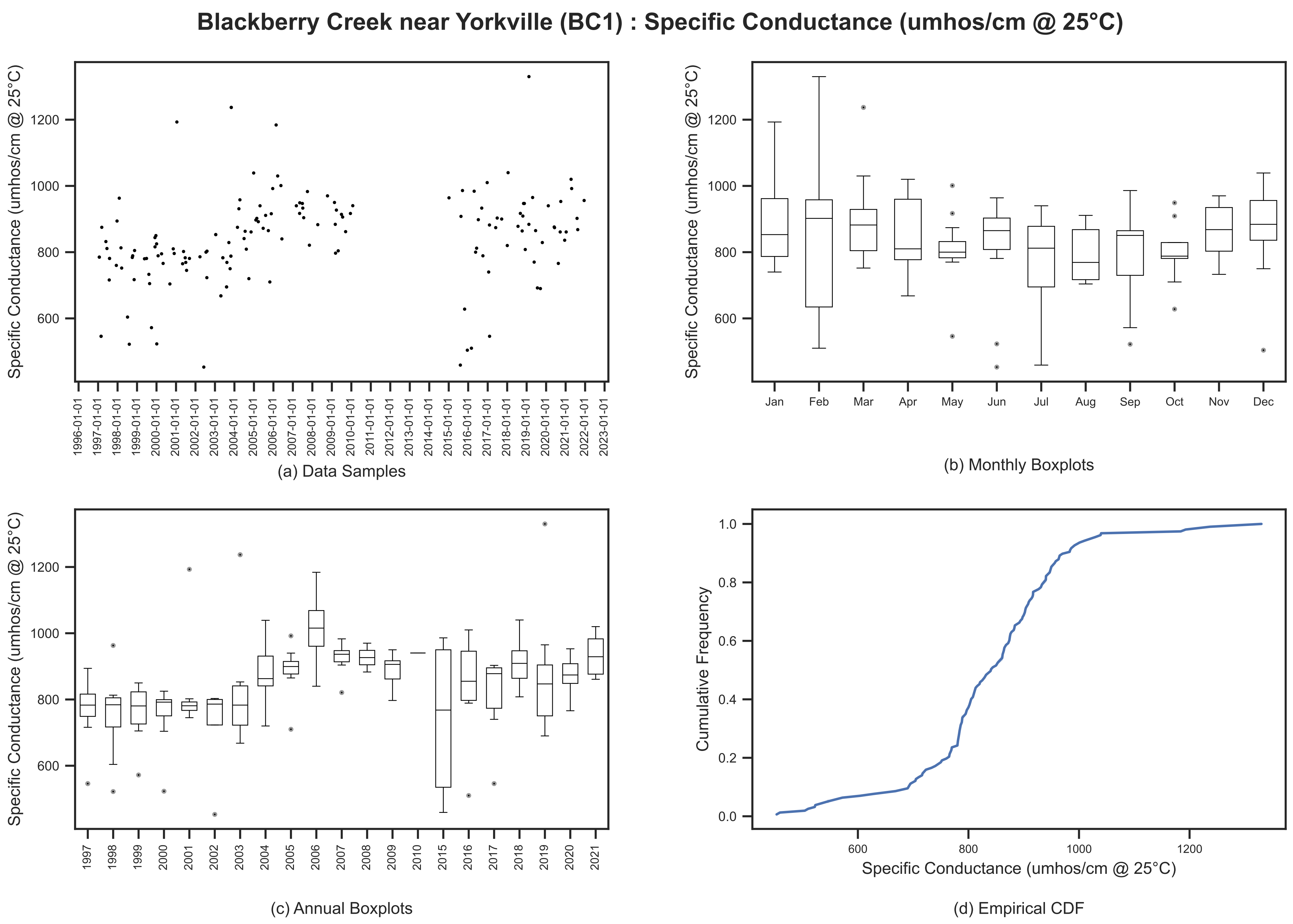
(c) Annual Boxplots

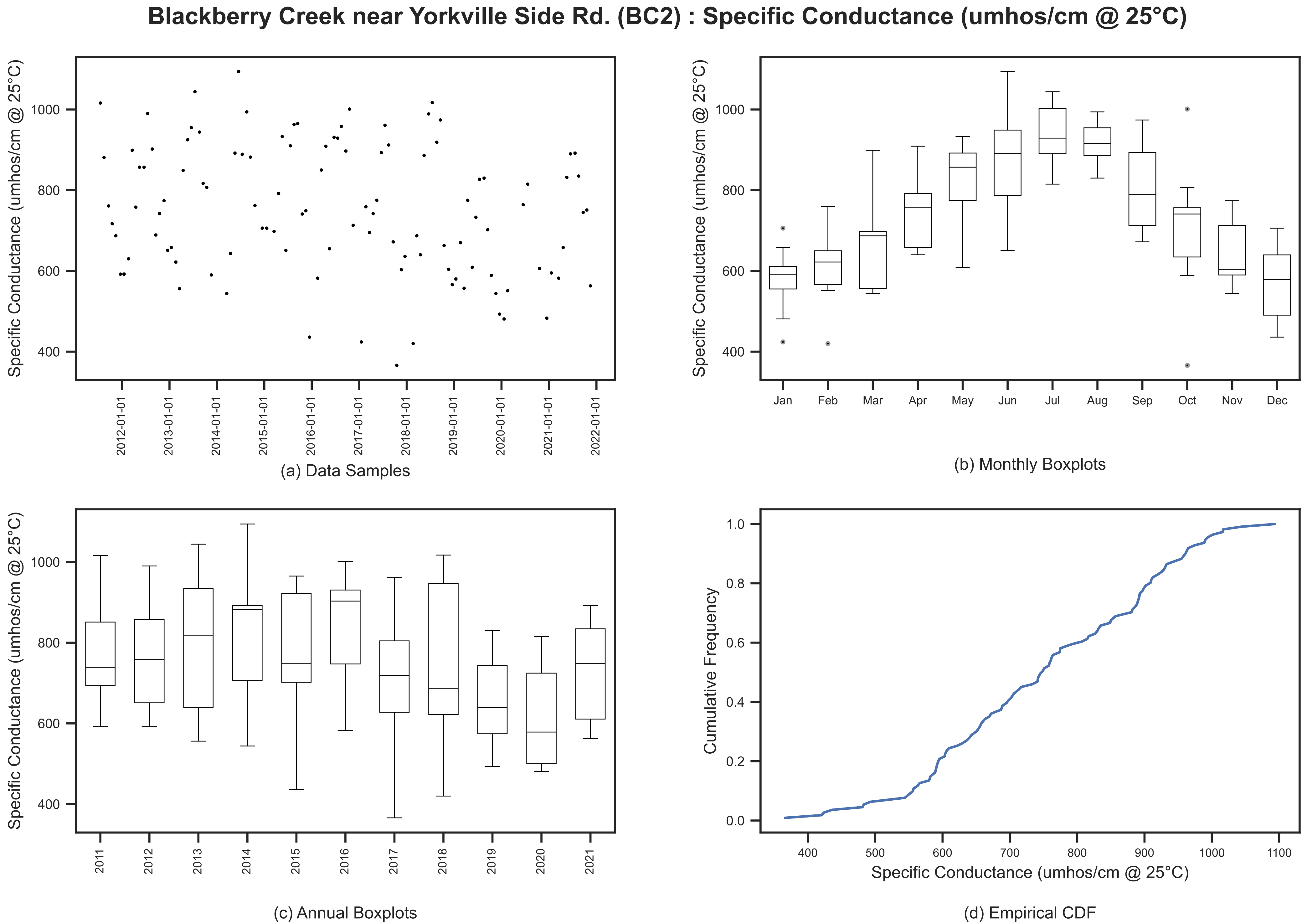


(d) Empirical CDF

Fox River at Yorkville (FR13) : Specific Conductance (umhos/cm @ 25°C)




Blackberry Creek near Yorkville (BC1) : Specific Conductance (umhos/cm @ 25°C)
Specific Conductance (umhos/cm @ 25°C)
(a) Data Samples
(b) Monthly Boxplots
(c) Annual Boxplots
Cumulative Frequency
Specific Conductance (umhos/cm @ 25°C)
(d) Empirical CDF



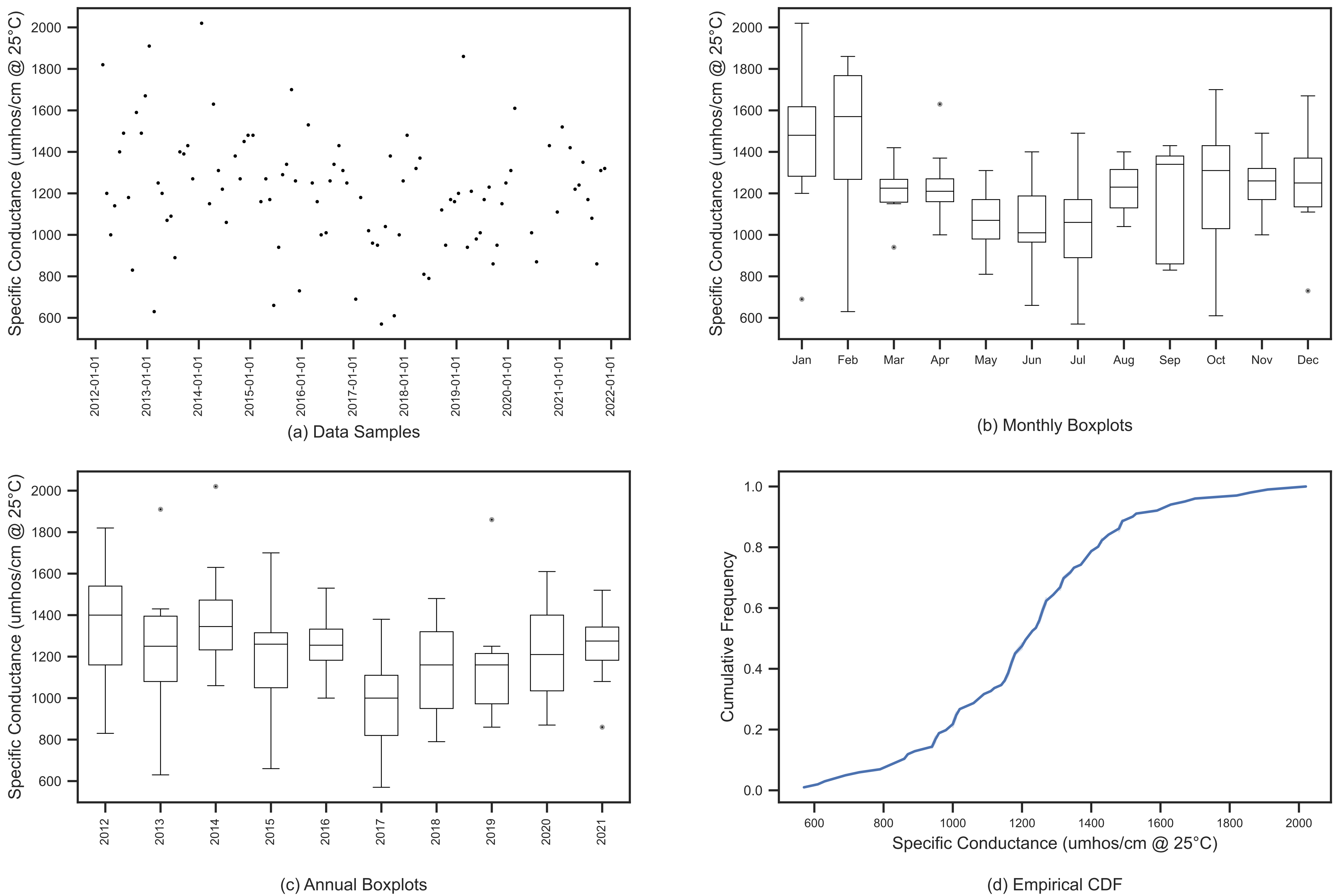
(a) Data Samples

(b) Monthly Boxplots

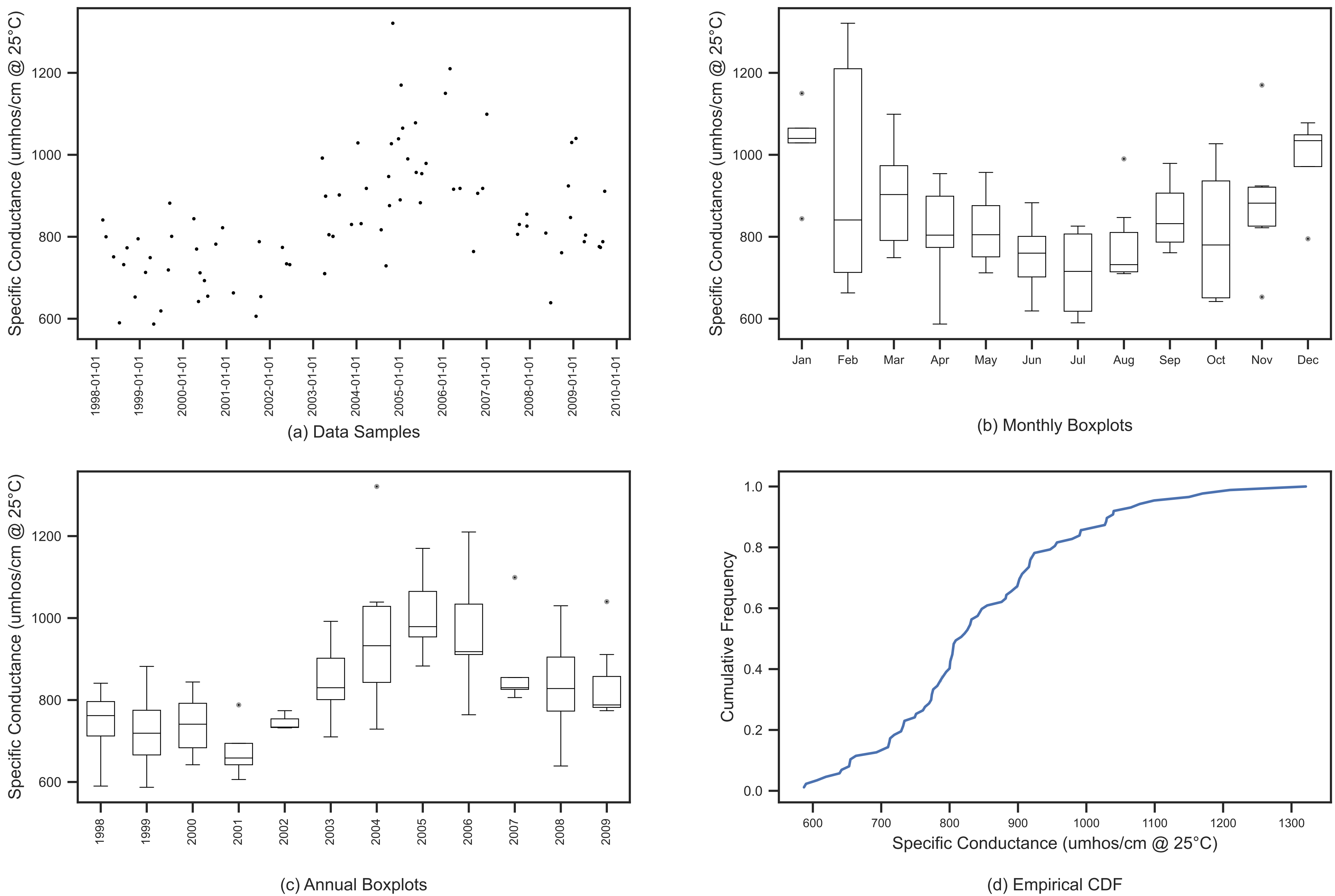
(c) Annual Boxplots

(d) Empirical CDF

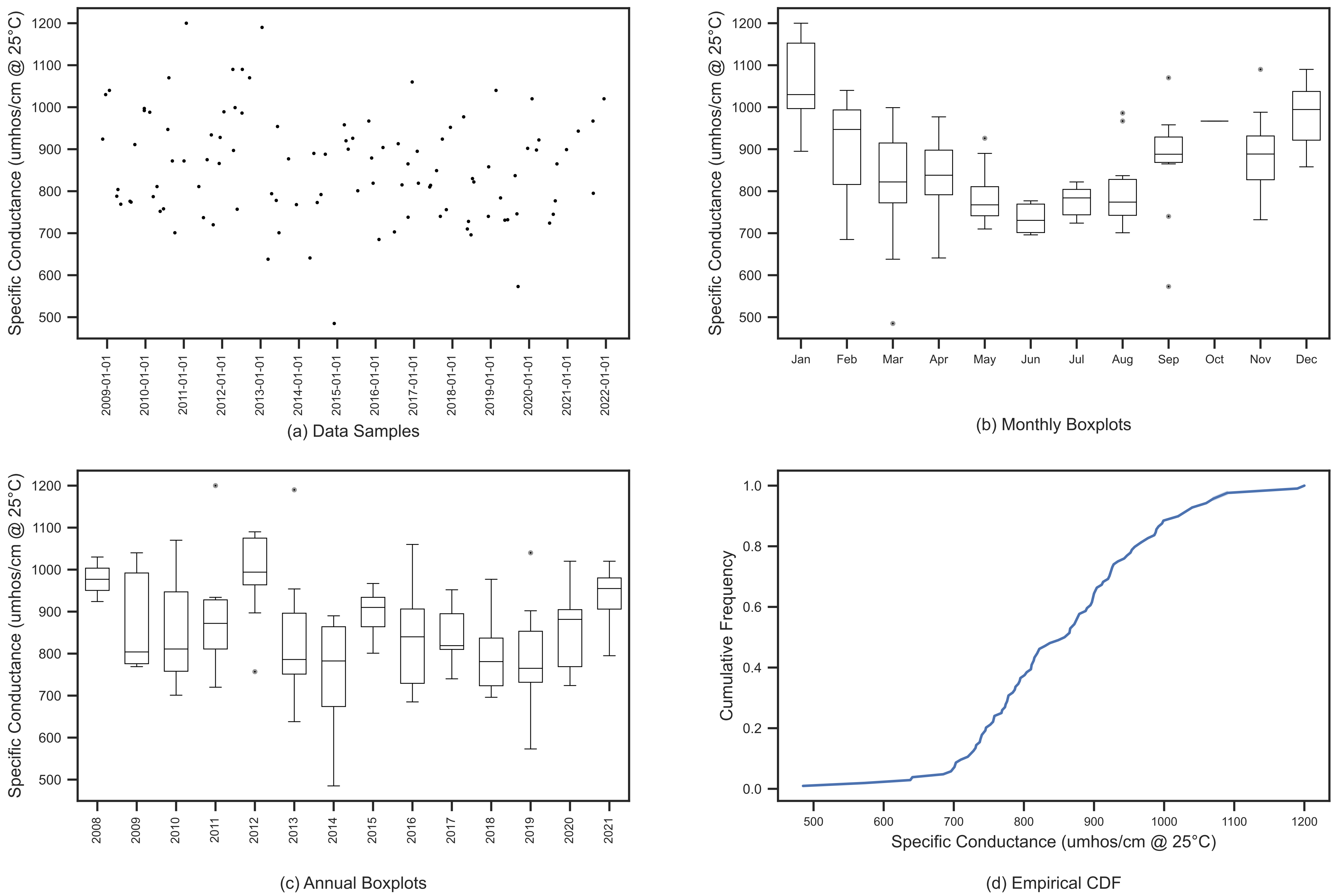
Little Indian Creek at dns Unversity Rd. Br. (LC1) : Specific Conductance (umhos/cm @ 25°C)



Fox River at Rt. 71 (FR14) : Specific Conductance (umhos/cm @ 25°C)



Fox River at Ottawa (FR15) : Specific Conductance (umhos/cm @ 25°C)



(a) Data Samples

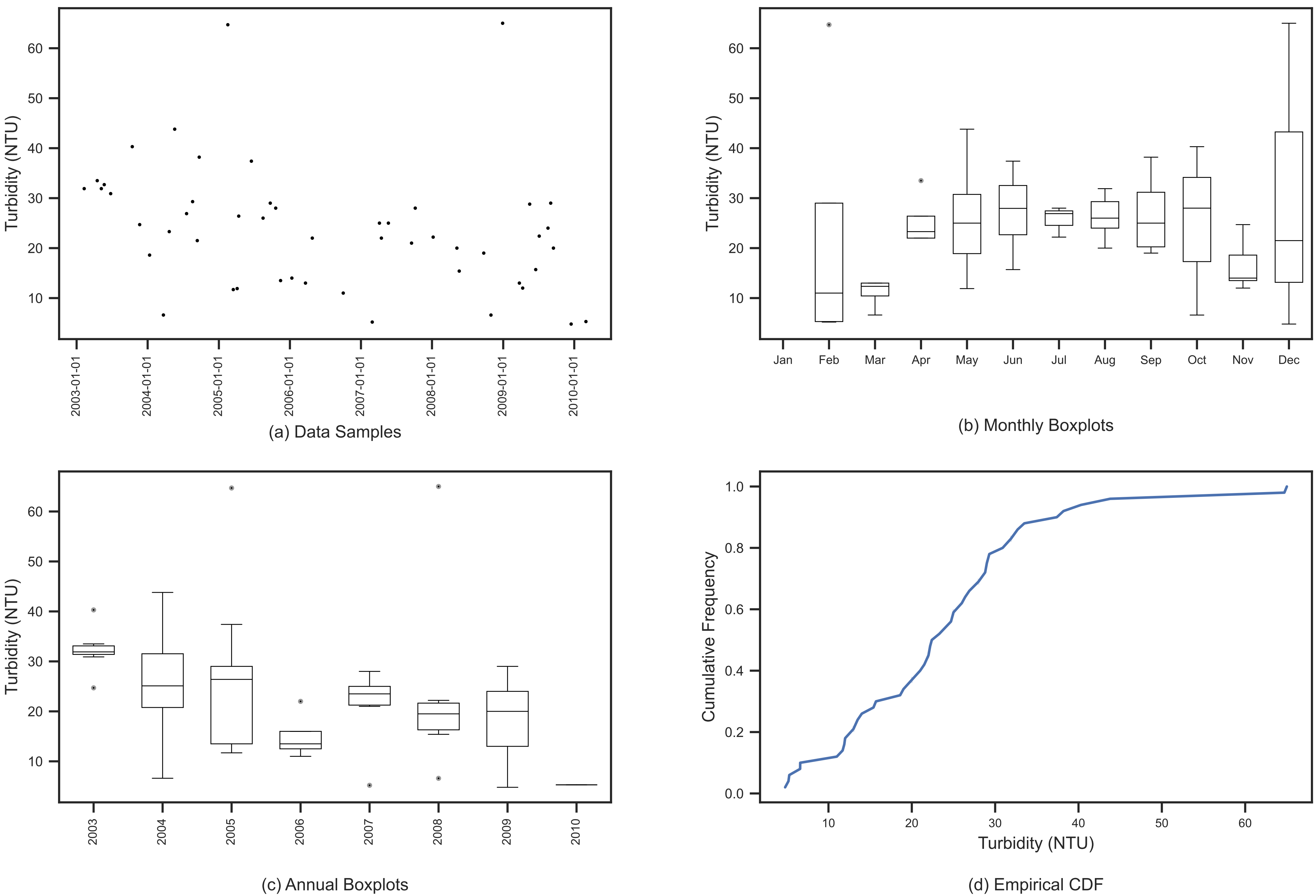
(b) Monthly Boxplots

(c) Annual Boxplots

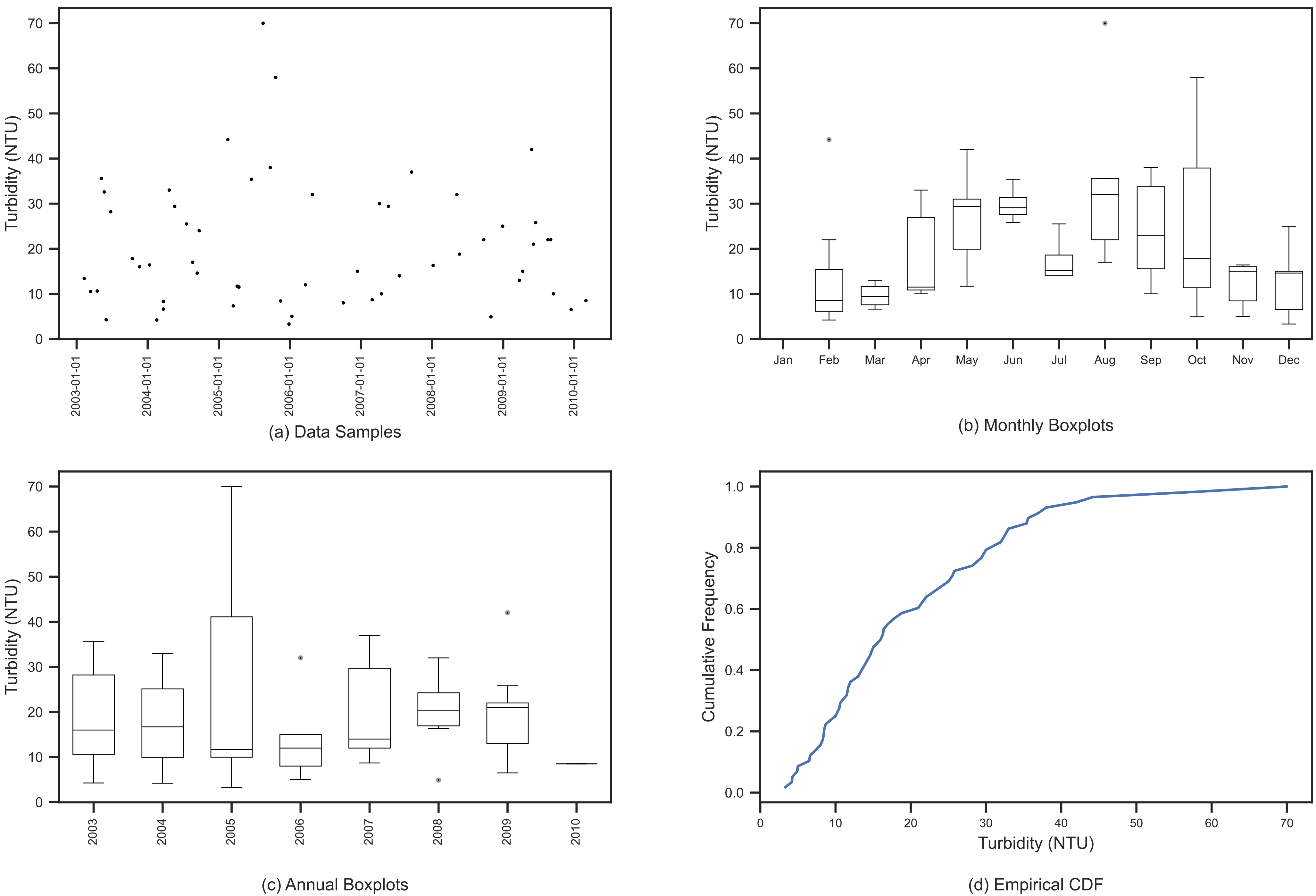
(d) Empirical CDF

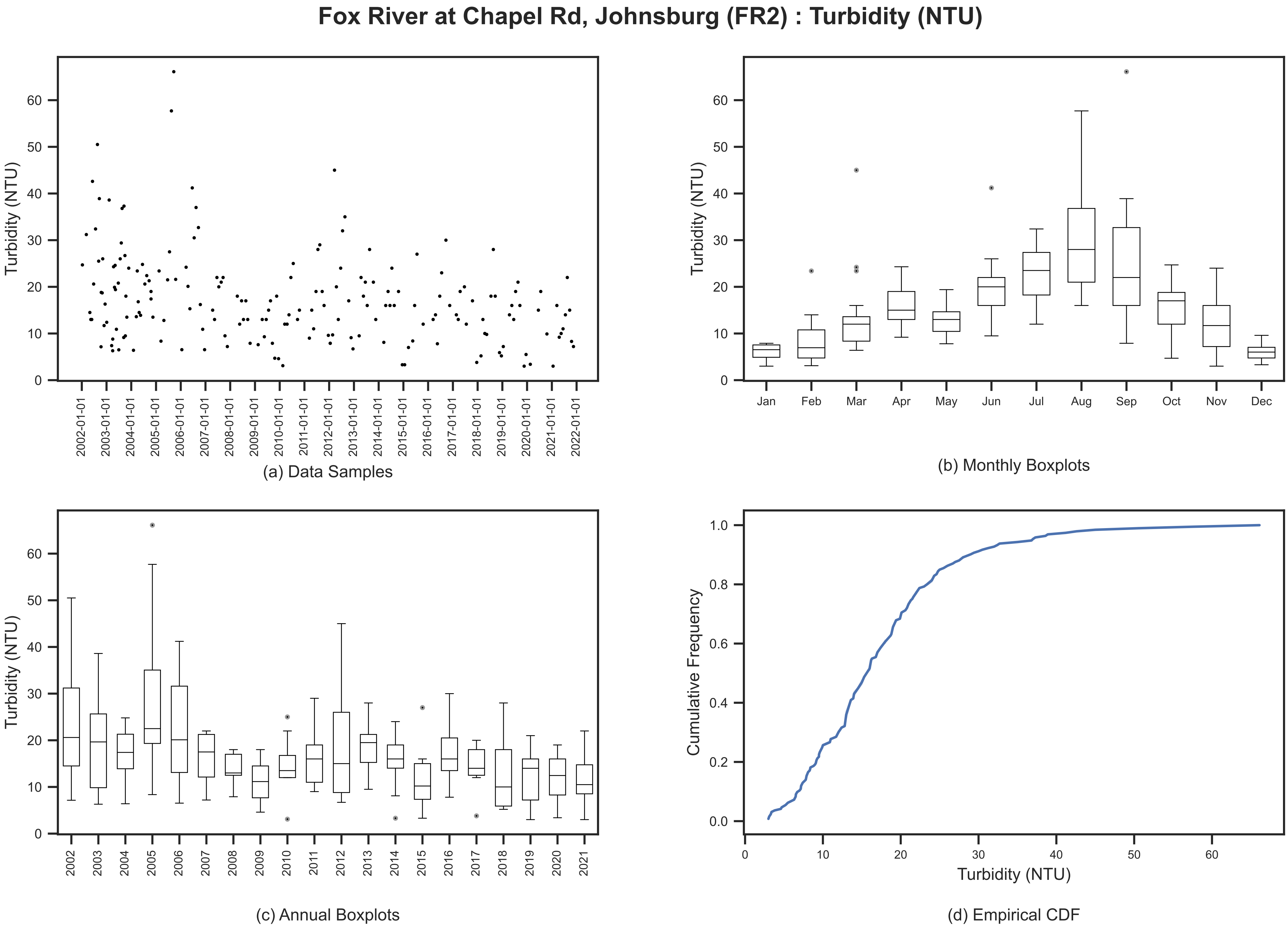
EDA Outputs for Turbidity (NTU)

Fox River at Rt. 173 near Channel Lake (FR1) : Turbidity (NTU)

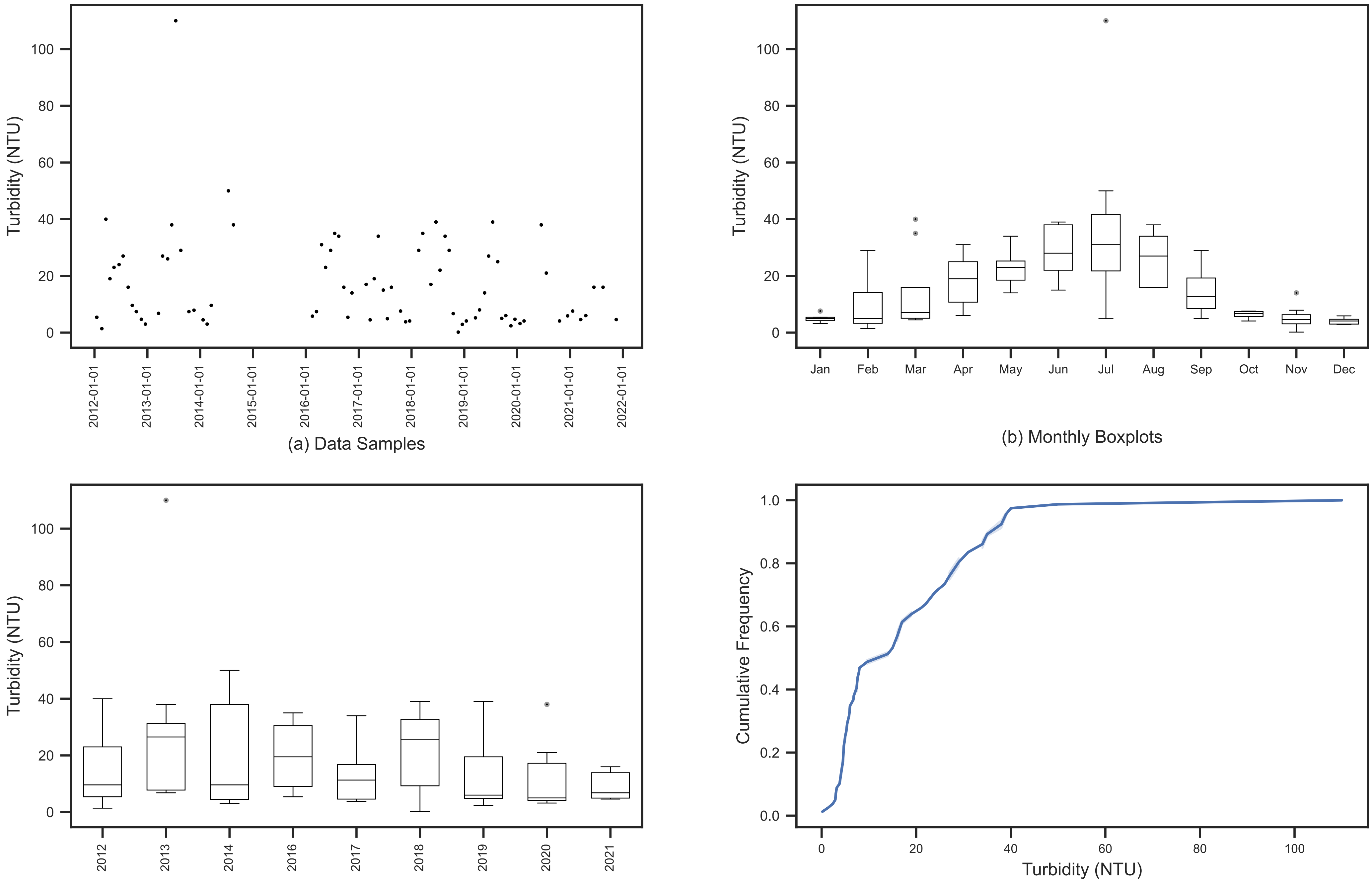


Nippersink Creek near Spring Grove (NC1) : Turbidity (NTU)




Fox River at Chapel Rd, Johnsburg (FR2) : Turbidity (NTU)
Turbidity (NTU)
(a) Data Samples
(b) Monthly Boxplots
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(c) Annual Boxplots
Cumulative Frequency
(d) Empirical CDF

Sleepy Hollow Creek at Stilling Ln. (SH1) : Turbidity (NTU)



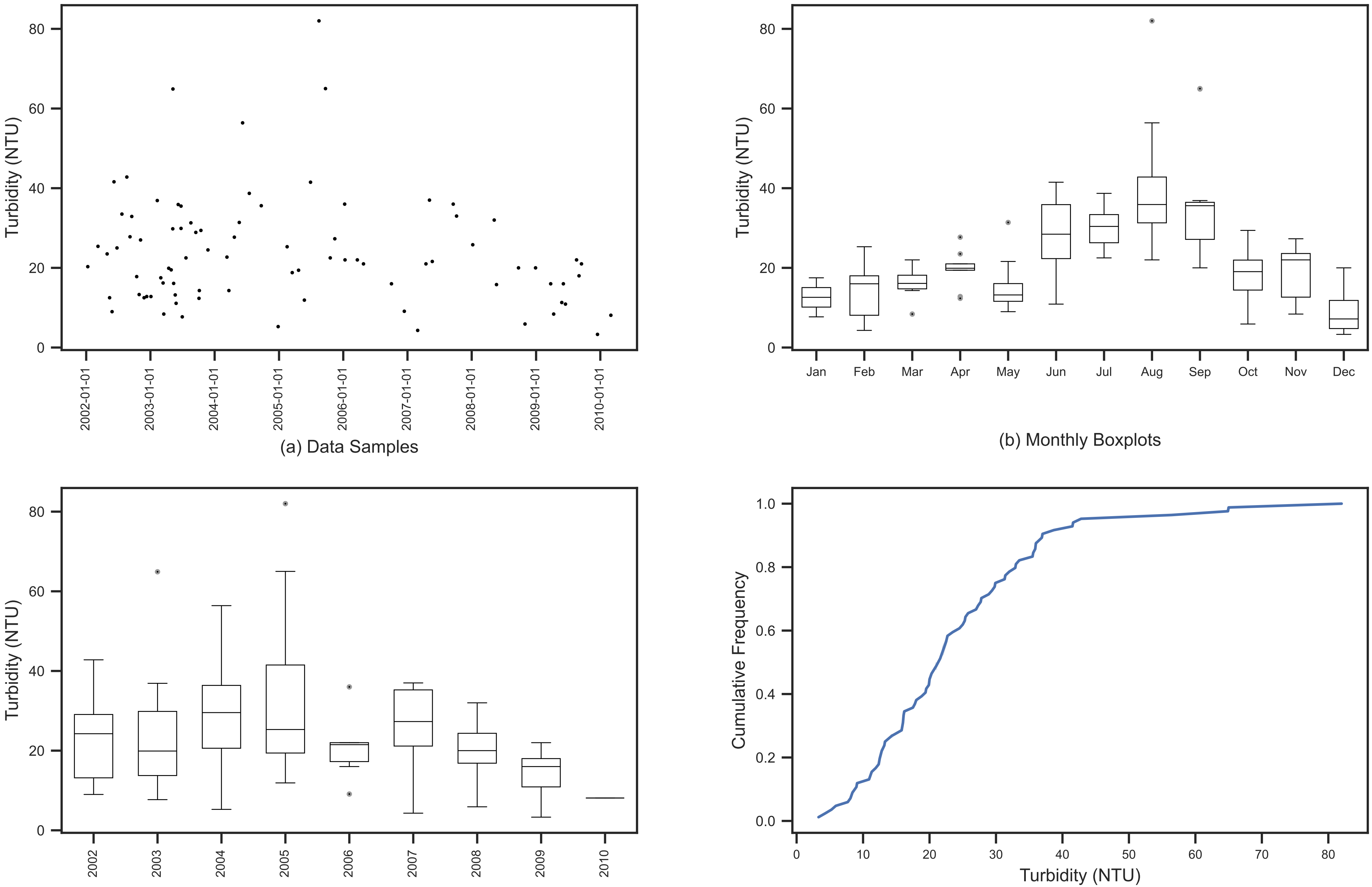
(a) Data Samples

(b) Monthly Boxplots

(c) Annual Boxplots

(d) Empirical CDF

Fox River at Burtons Br. (FR3) : Turbidity (NTU)



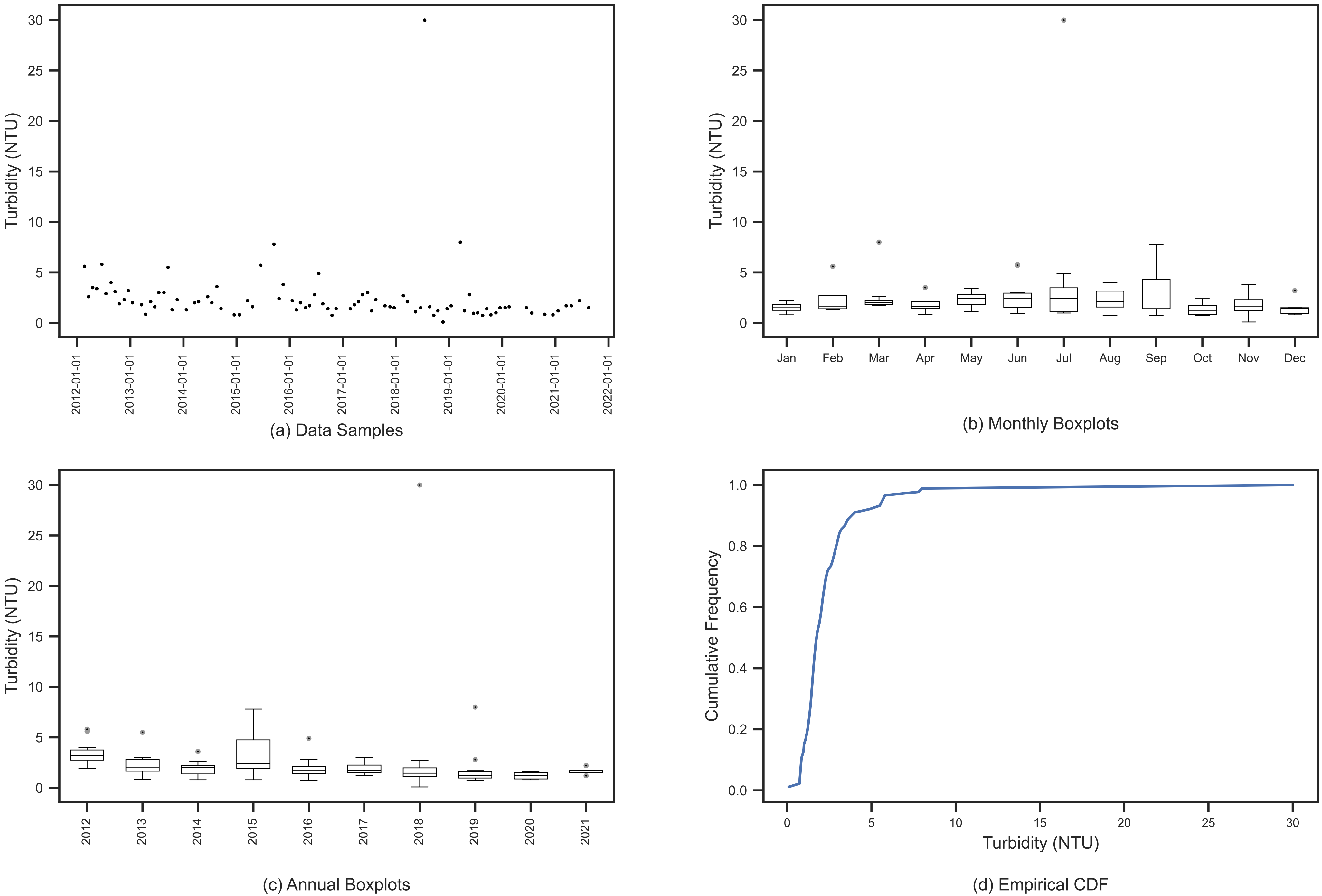
(a) Data Samples

(b) Monthly Boxplots

(c) Annual Boxplots

(d) Empirical CDF

Silver Creek at Lk shore Dr. & E. Park Ln. (SC1) : Turbidity (NTU)



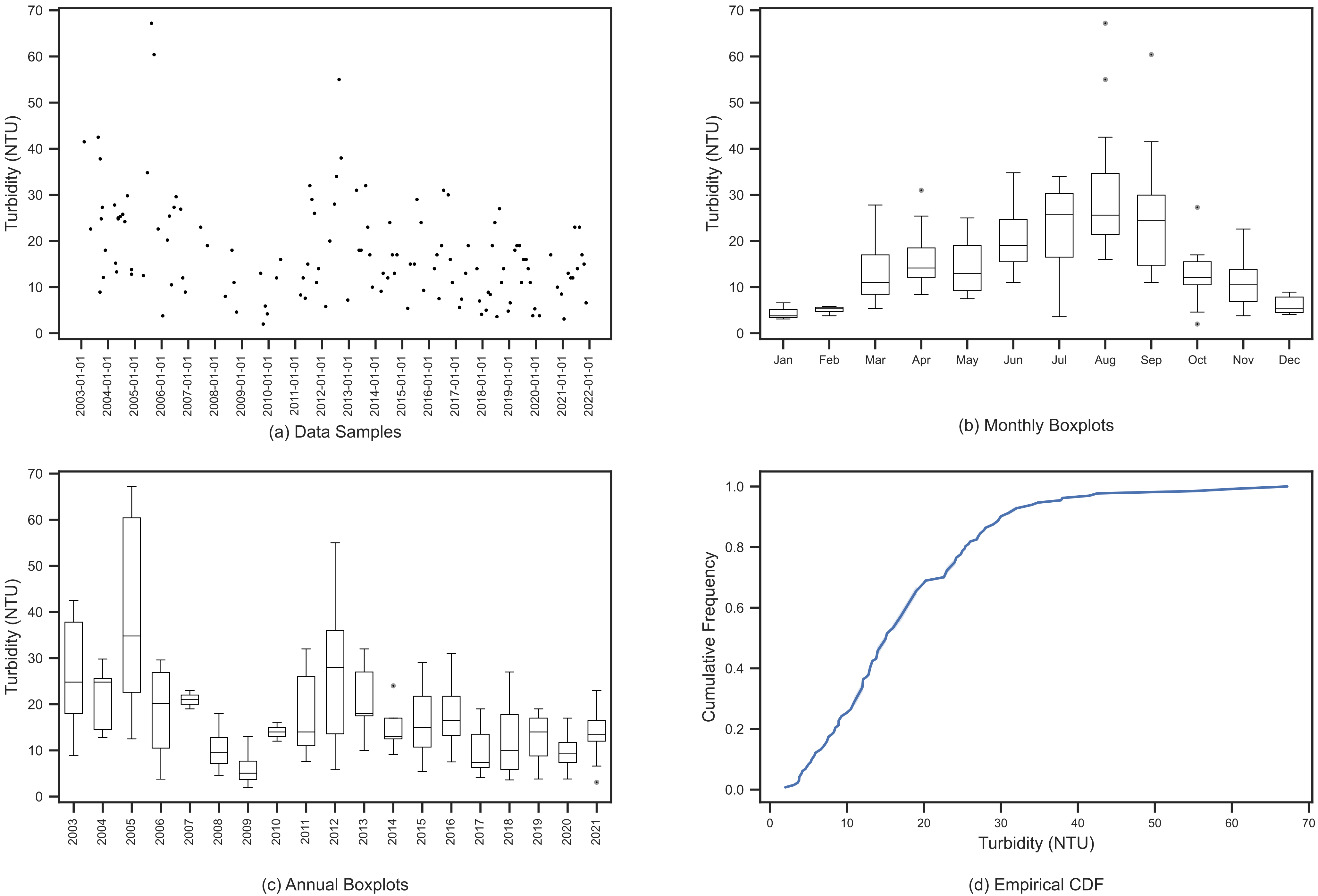
(a) Data Samples

(b) Monthly Boxplots

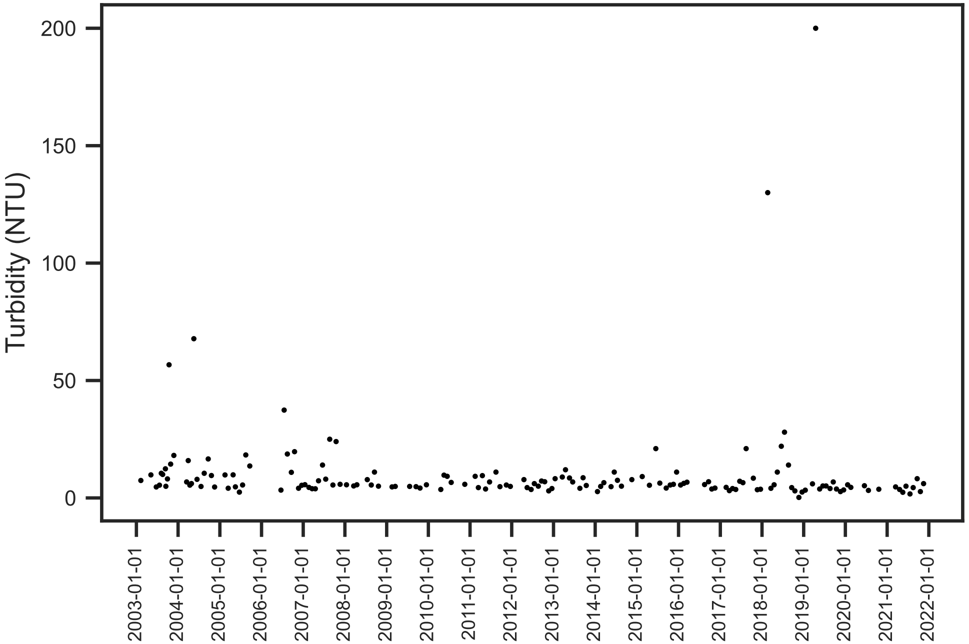
(c) Annual Boxplots

(d) Empirical CDF

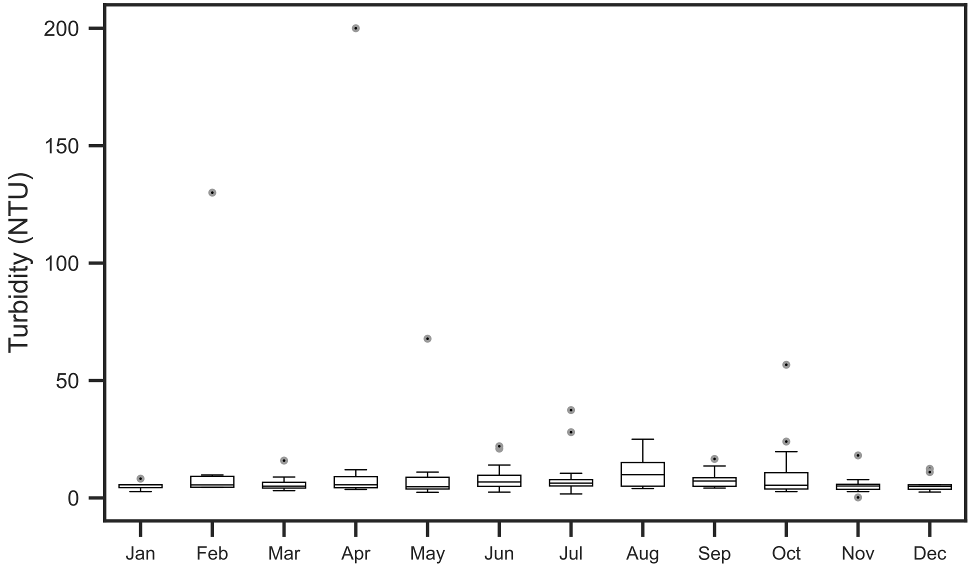
Fox River at Rawson Rd., E Oakwood Hills (FR4) : Turbidity (NTU)



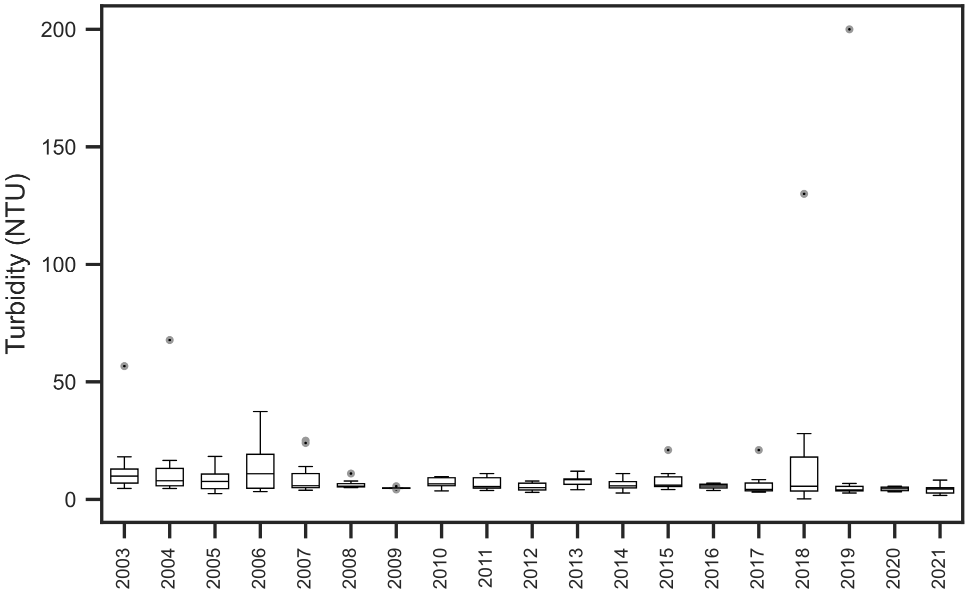
Crystal Lk Outlet-Rt 31, Algonquin (CL1) : Turbidity (NTU)



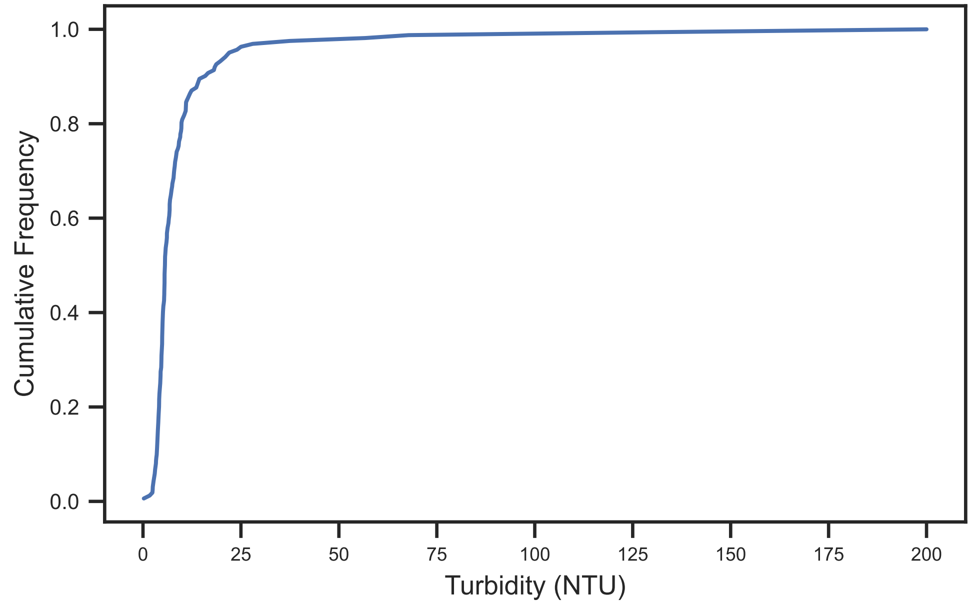
(a) Data Samples



(b) Monthly Boxplots

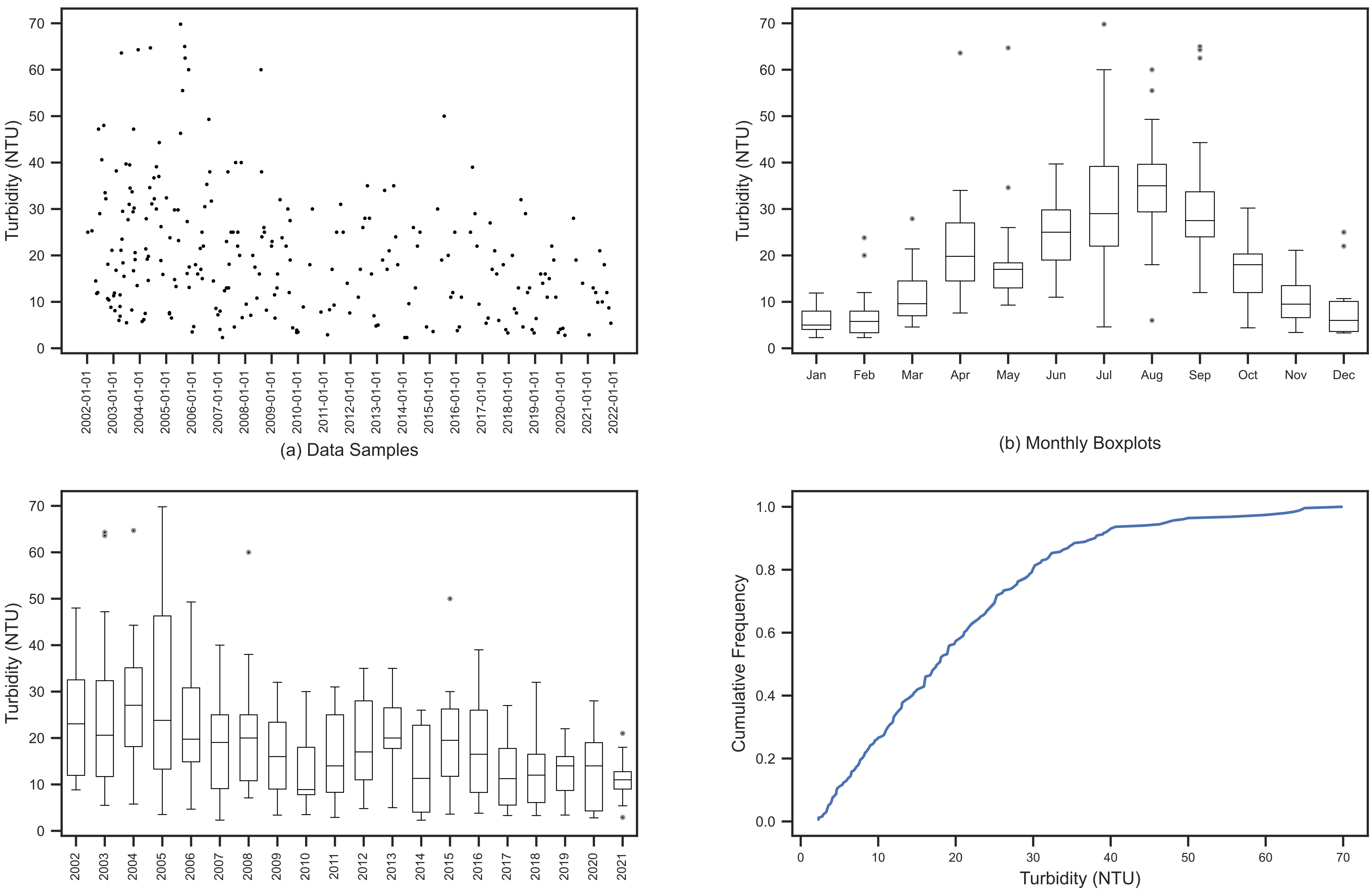


(c) Annual Boxplots



(d) Empirical CDF

Fox River at Algonquin (FR5) : Turbidity (NTU)



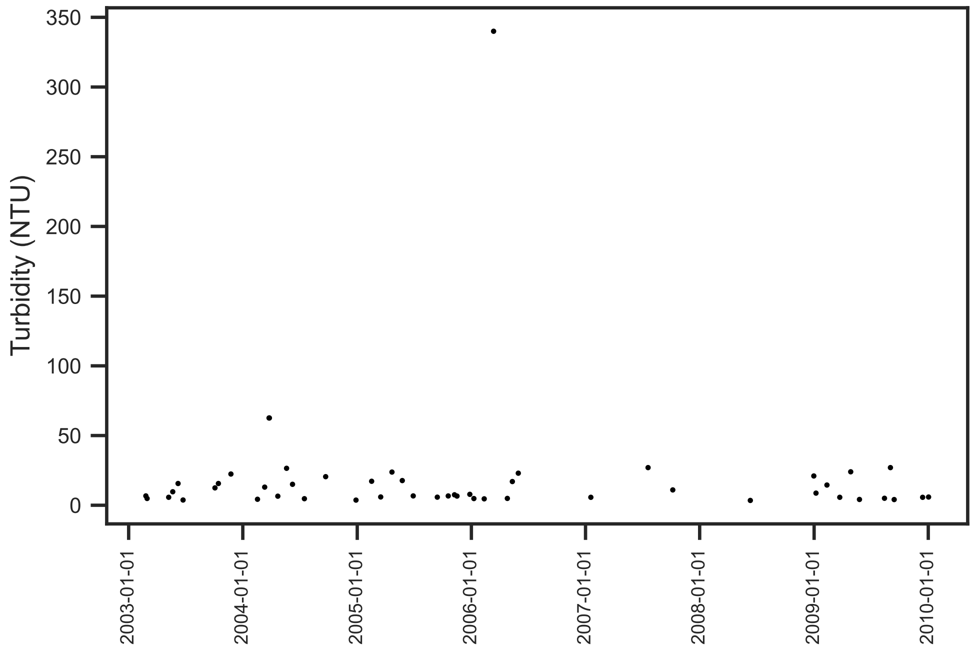
(a) Data Samples

(b) Monthly Boxplots

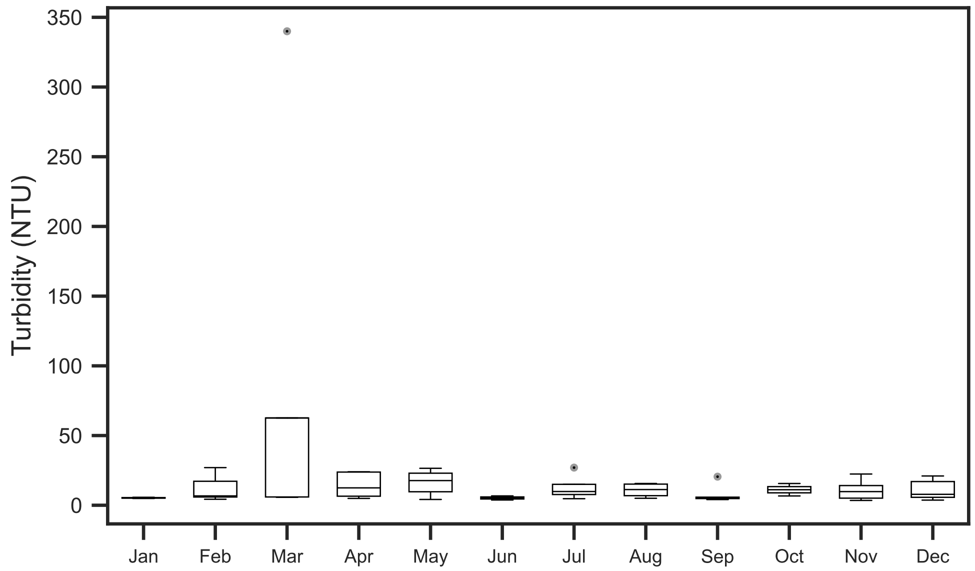
(c) Annual Boxplots

(d) Empirical CDF

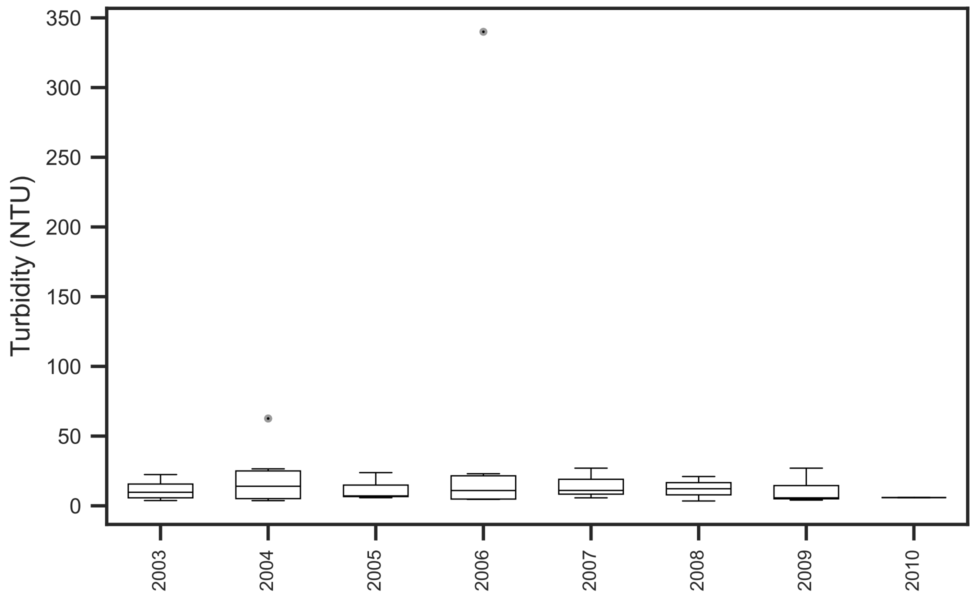
Poplar Creek at Elgin (PC1) : Turbidity (NTU)



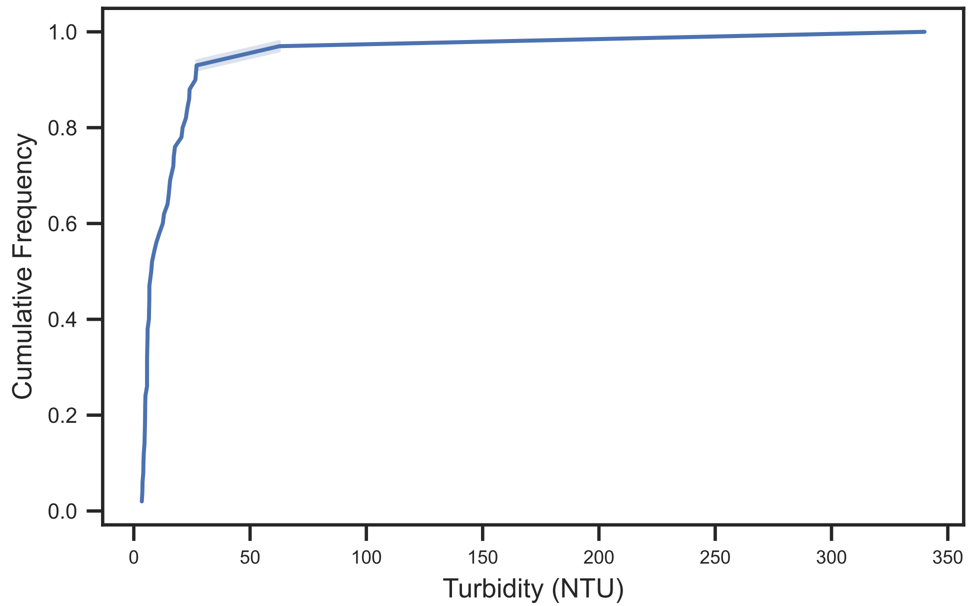
(a) Data Samples



(b) Monthly Boxplots

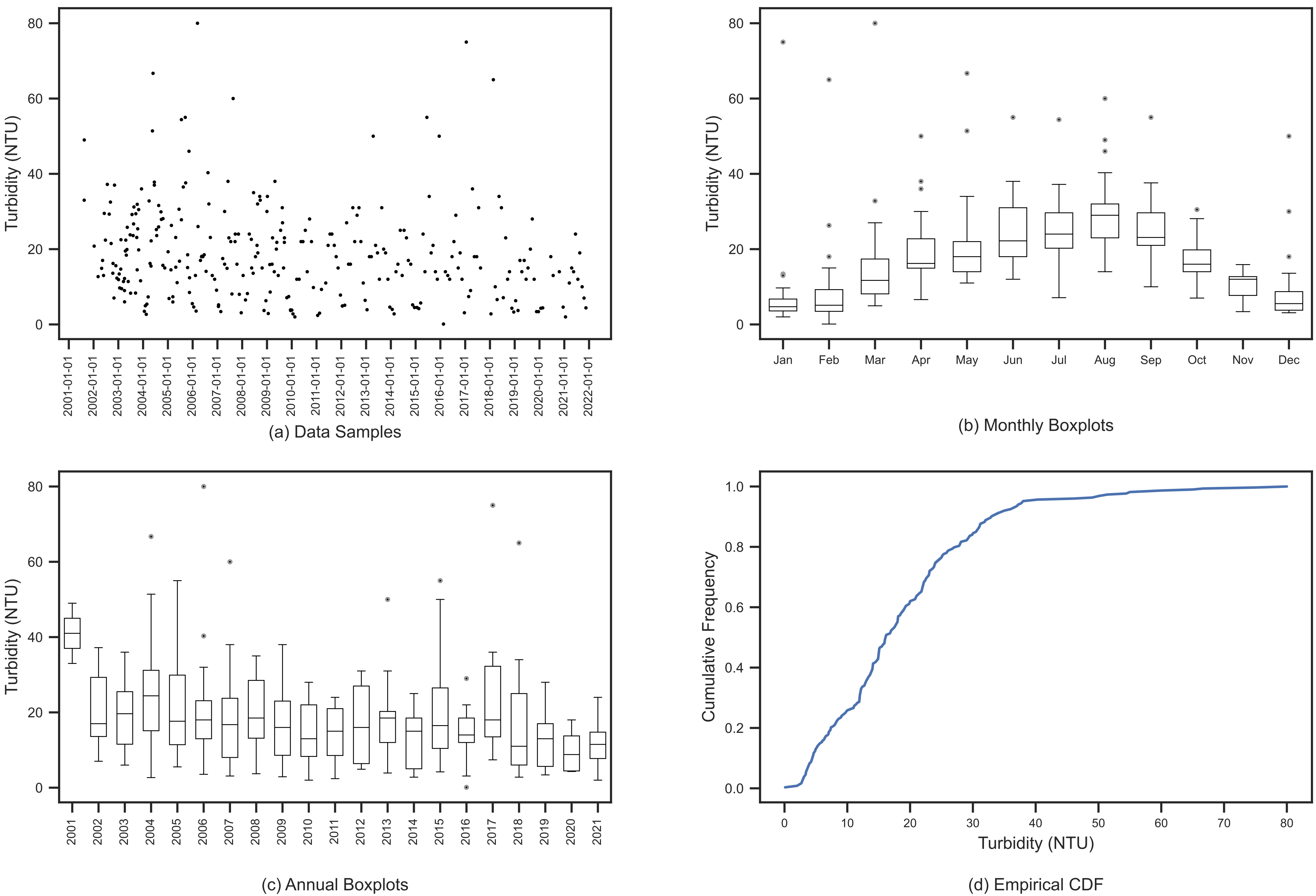


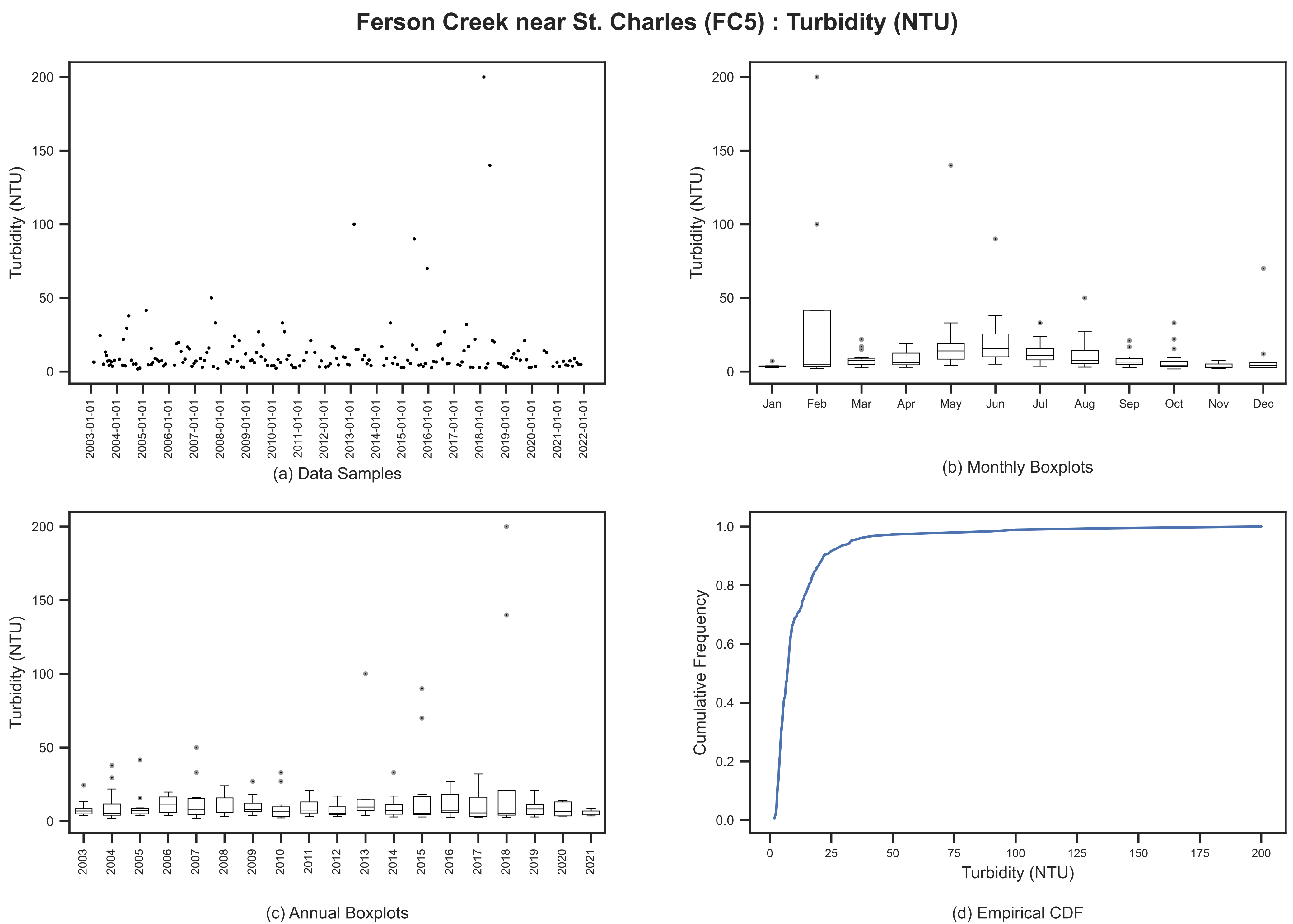
(c) Annual Boxplots



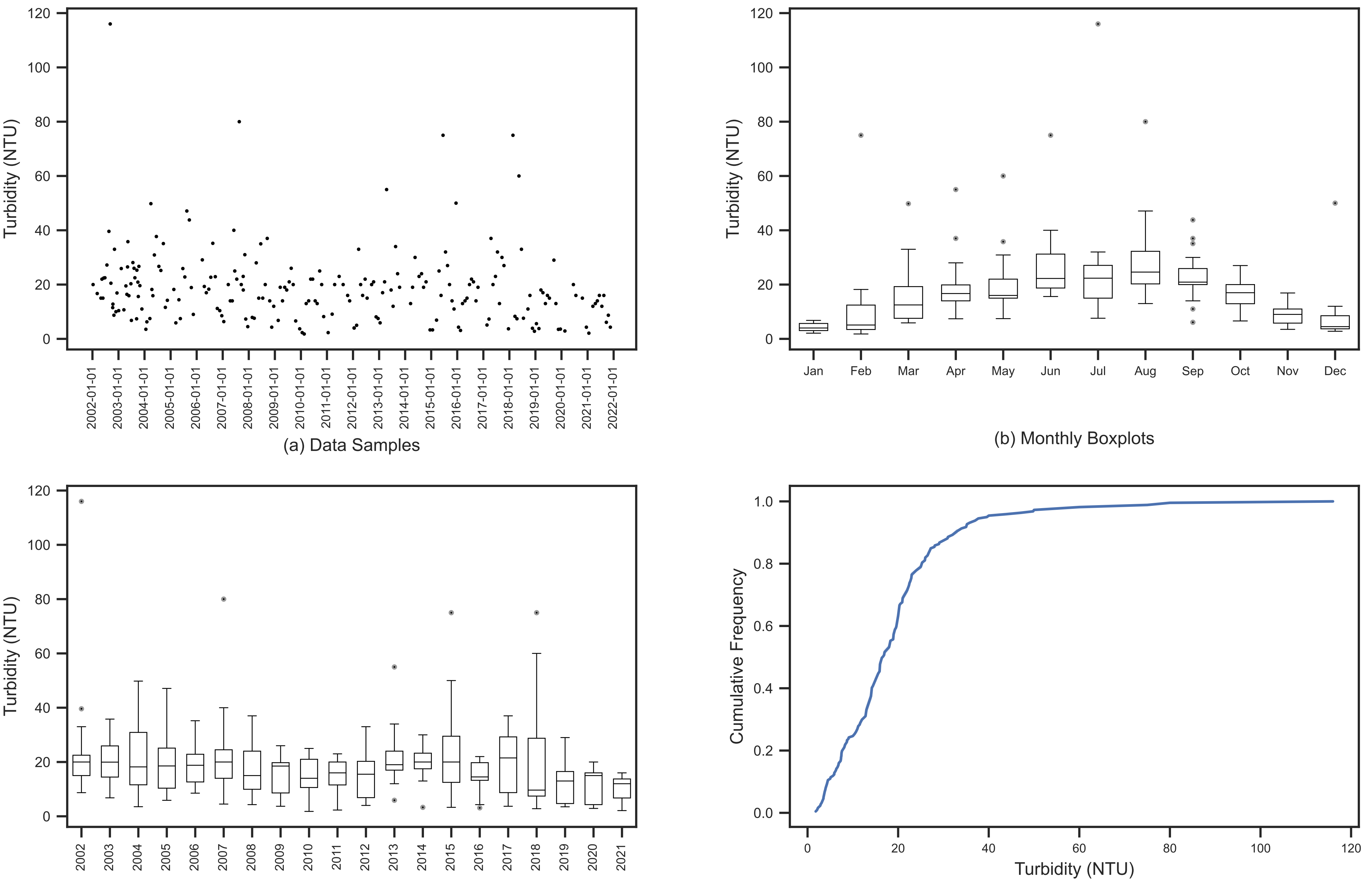
(d) Empirical CDF

Fox River at South Elgin (FR6) : Turbidity (NTU)




Ferson Creek near St. Charles (FC5) : Turbidity (NTU)
Turbidity (NTU)
0
50
100
150
200
2003-01-01
2004-01-01
2005-01-01
2006-01-01
2007-01-01
2008-01-01
2009-01-01
2010-01-01
2011-01-01
2012-01-01
2013-01-01
2014-01-01
2015-01-01
2016-01-01
2017-01-01
2018-01-01
2019-01-01
2020-01-01
2021-01-01
2022-01-01
(a) Data Samples
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(b) Monthly Boxplots
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
(c) Annual Boxplots
Cumulative Frequency
0.0
0.2
0.4
0.6
0.8
1.0
0
25
50
75
100
125
150
175
200
Turbidity (NTU)
(d) Empirical CDF

Fox River at Fabyan Pk-Geneva (FR7) : Turbidity (NTU)

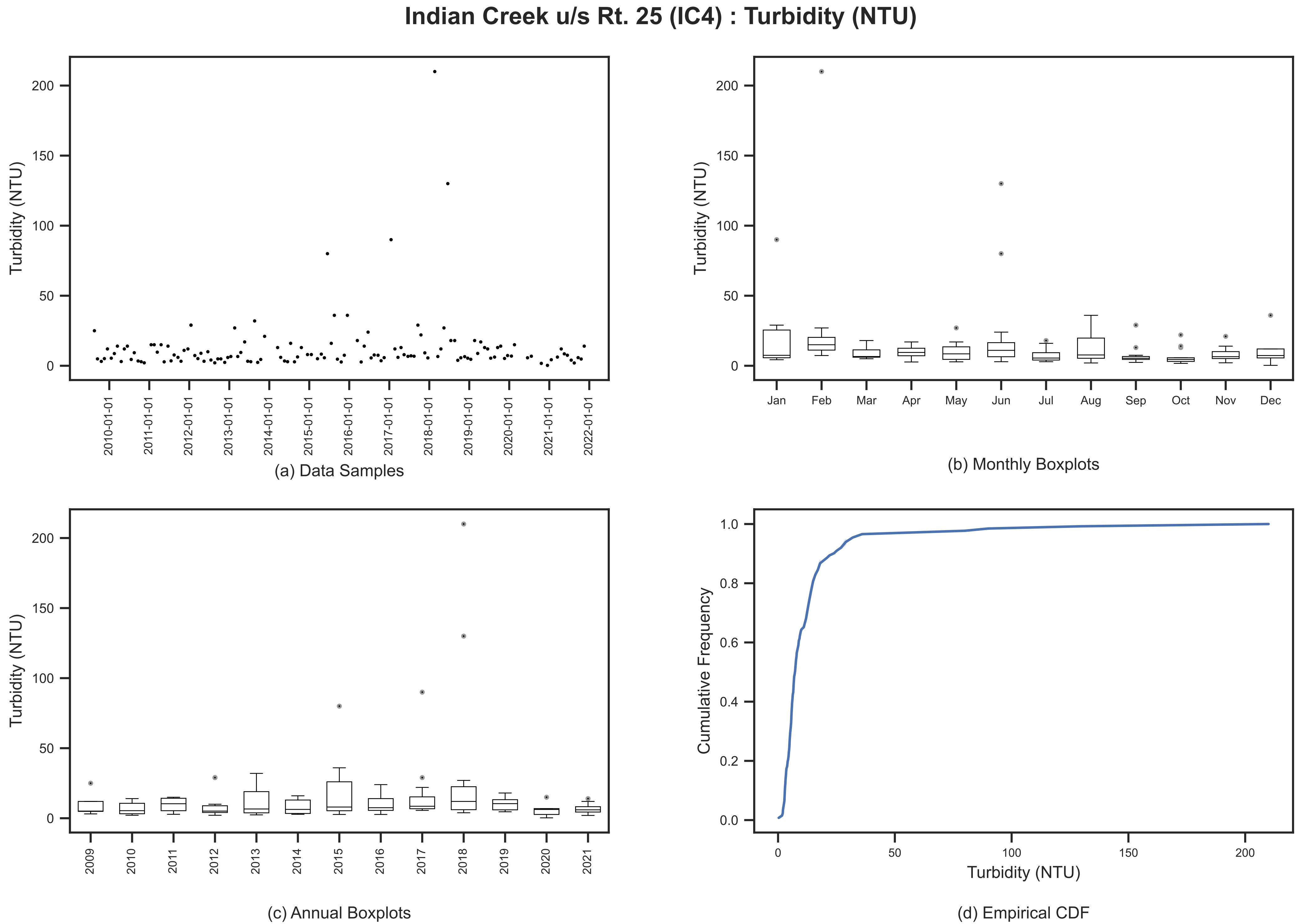


(a) Data Samples

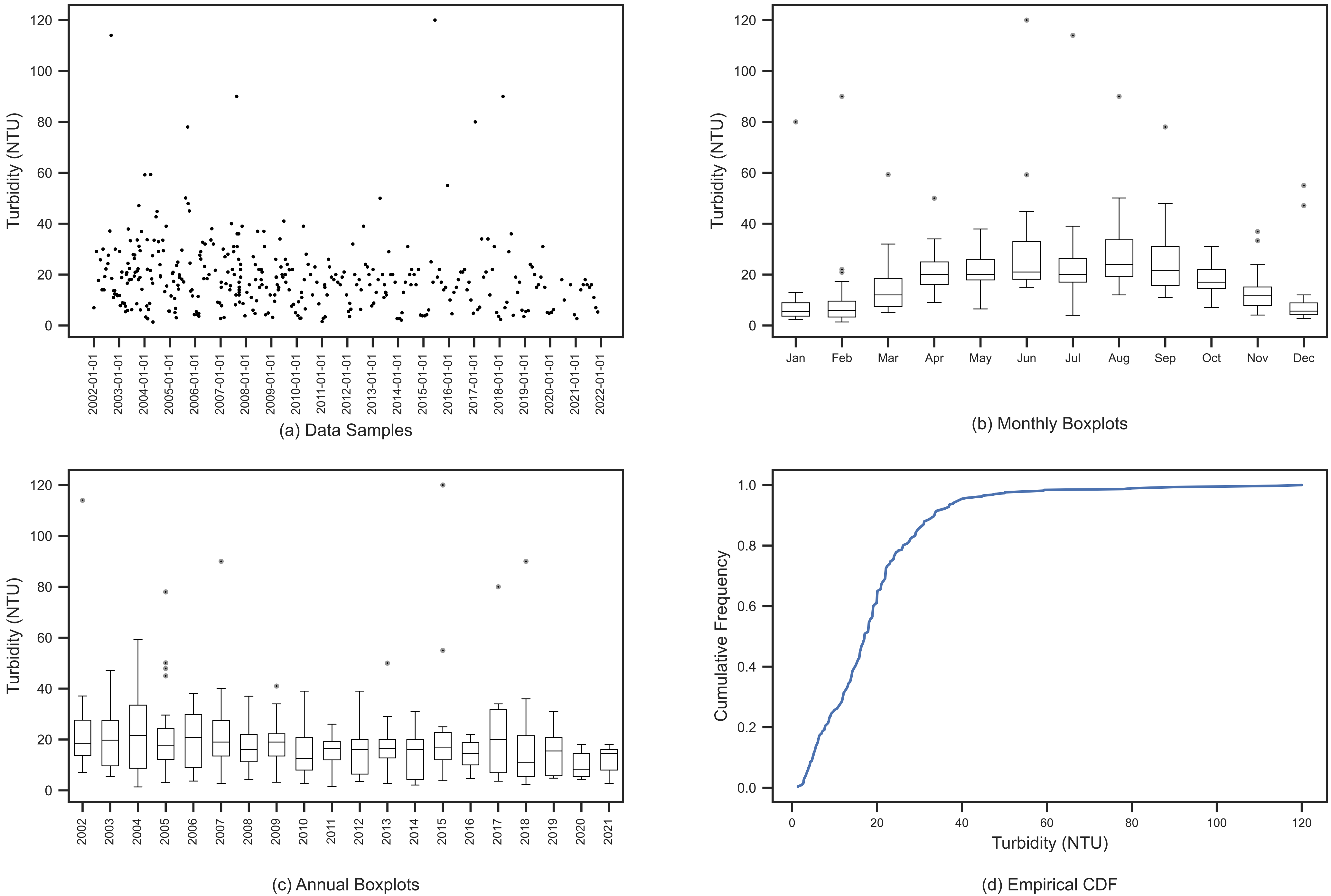
(b) Monthly Boxplots

(c) Annual Boxplots

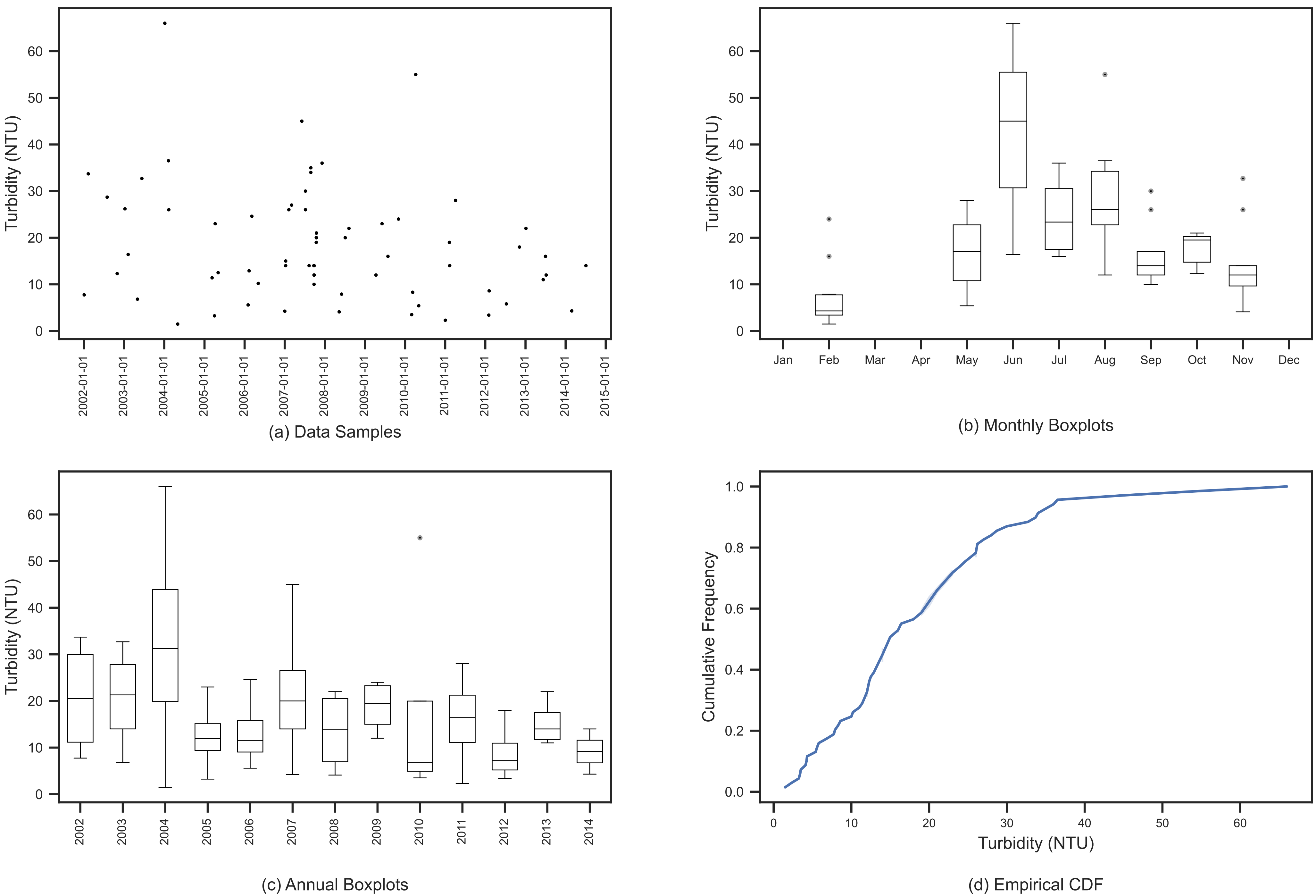
(d) Empirical CDF


Indian Creek u/s Rt. 25 (IC4) : Turbidity (NTU)
Turbidity (NTU)
0
50
100
150
200
2010-01-01
2011-01-01
2012-01-01
2013-01-01
2014-01-01
2015-01-01
2016-01-01
2017-01-01
2018-01-01
2019-01-01
2020-01-01
2021-01-01
2022-01-01
(a) Data Samples
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(b) Monthly Boxplots
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
(c) Annual Boxplots
Cumulative Frequency
0.0
0.2
0.4
0.6
0.8
1.0
Turbidity (NTU)
(d) Empirical CDF

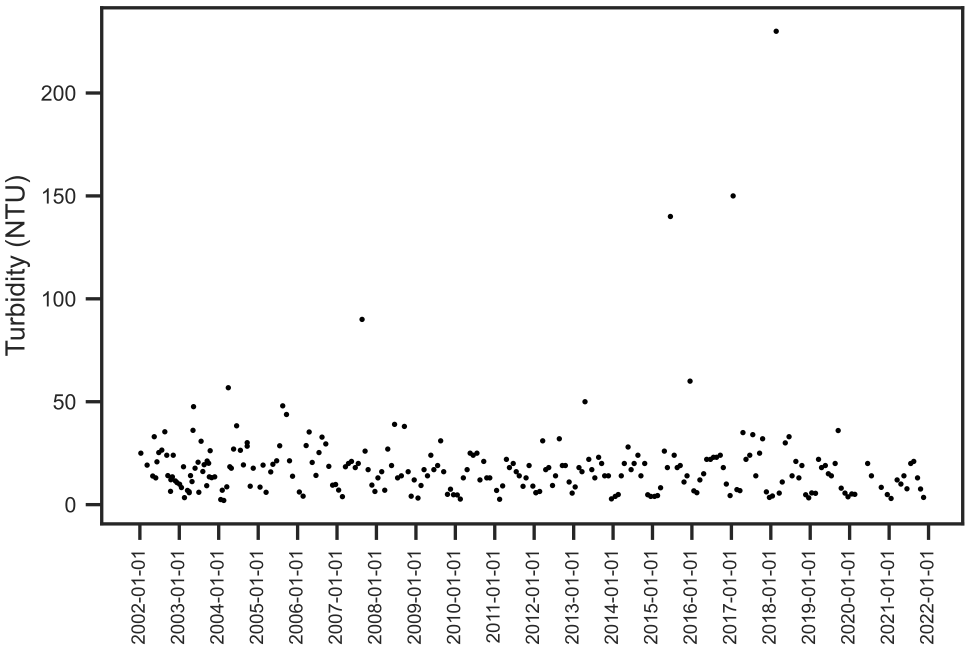
Fox River at Montgomery (FR11) : Turbidity (NTU)



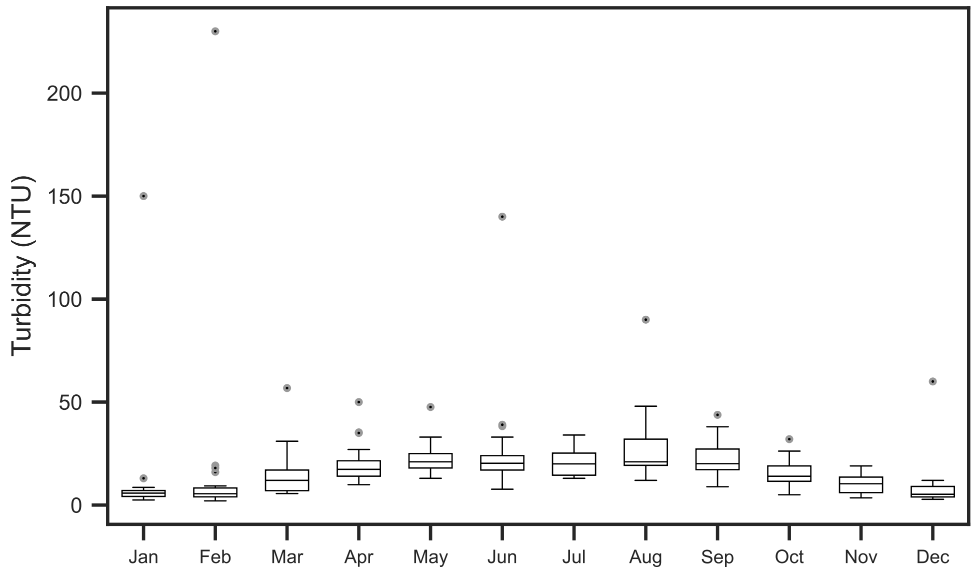
Fox River at Rt. 34, Oswego (FR12) : Turbidity (NTU)



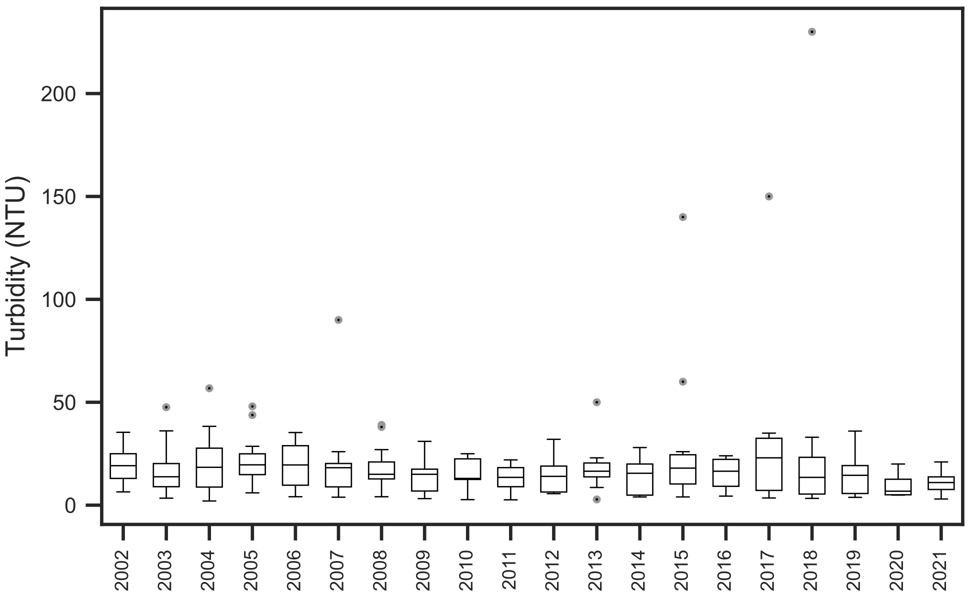
Fox River at Yorkville (FR13) : Turbidity (NTU)



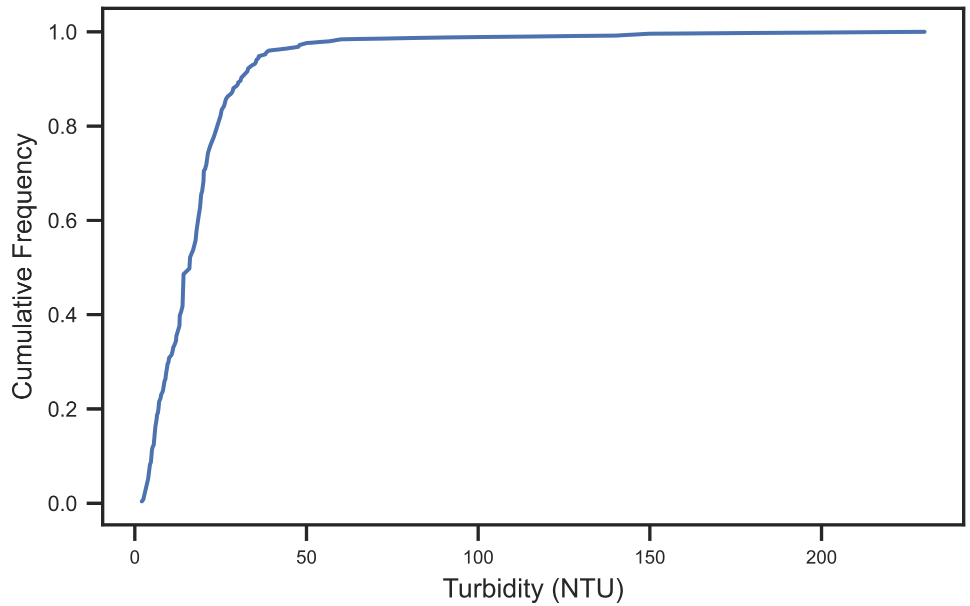
(a) Data Samples



(b) Monthly Boxplots

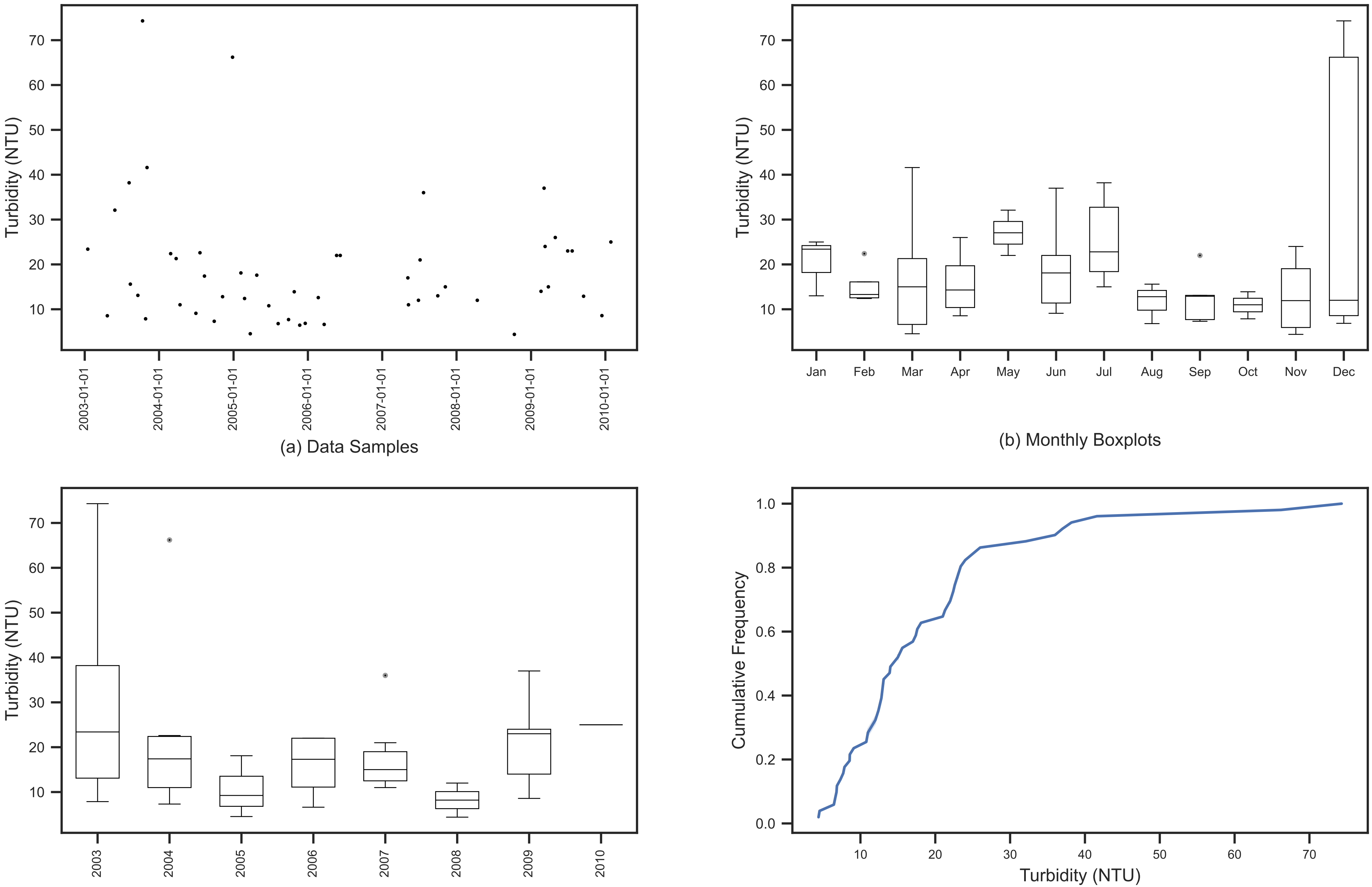


(c) Annual Boxplots



(d) Empirical CDF

Blackberry Creek near Yorkville (BC1) : Turbidity (NTU)



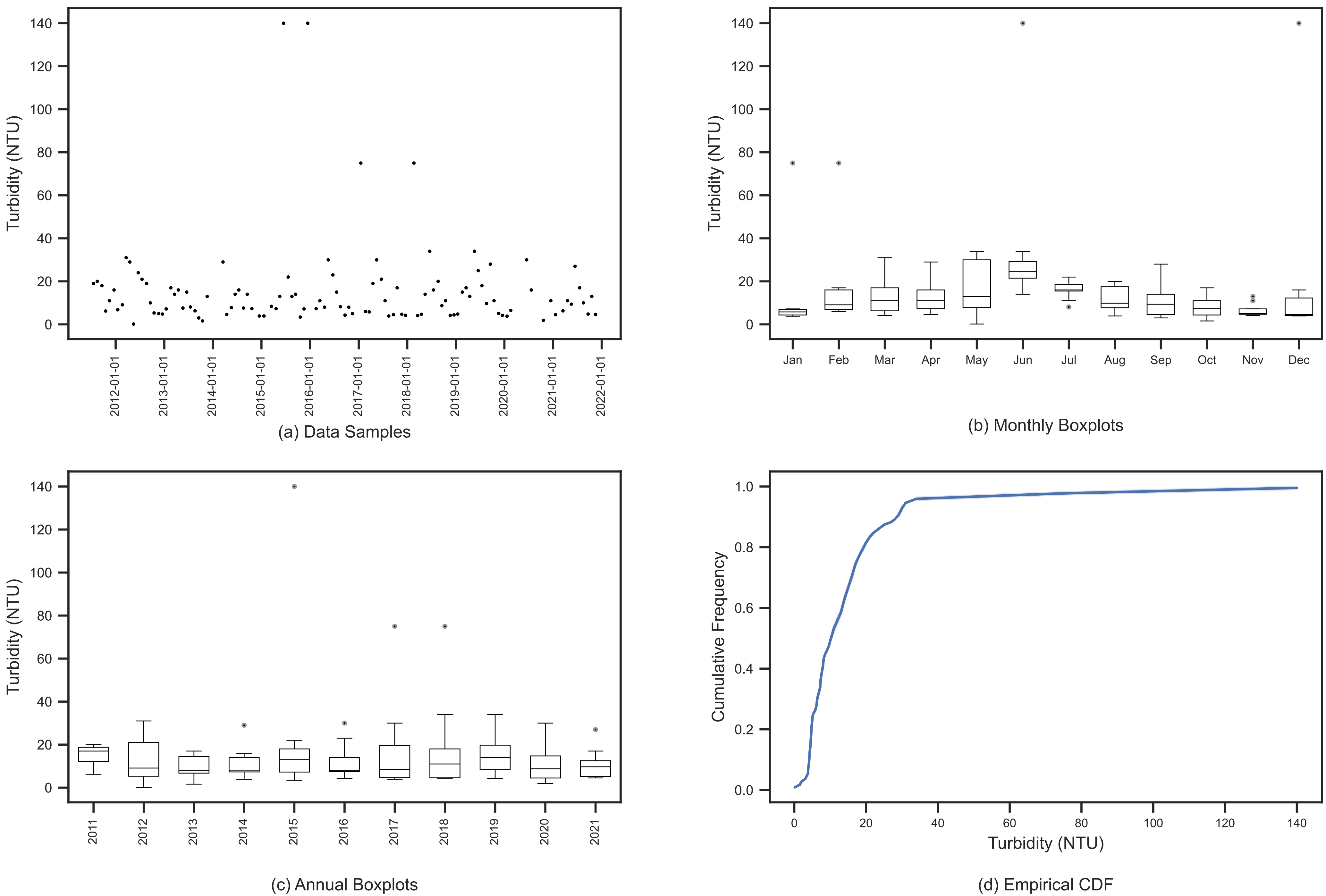
(a) Data Samples

(b) Monthly Boxplots

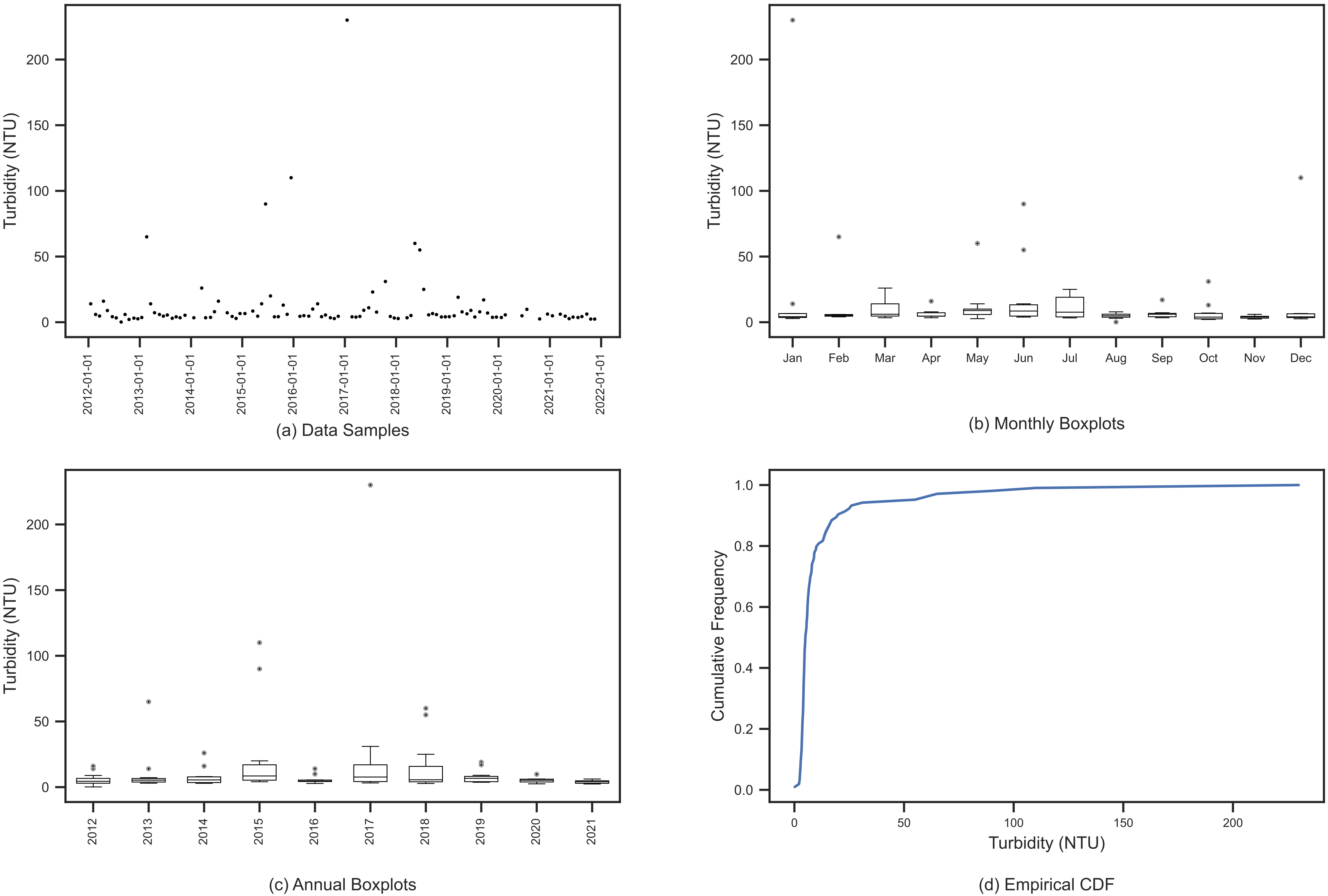
(c) Annual Boxplots

(d) Empirical CDF

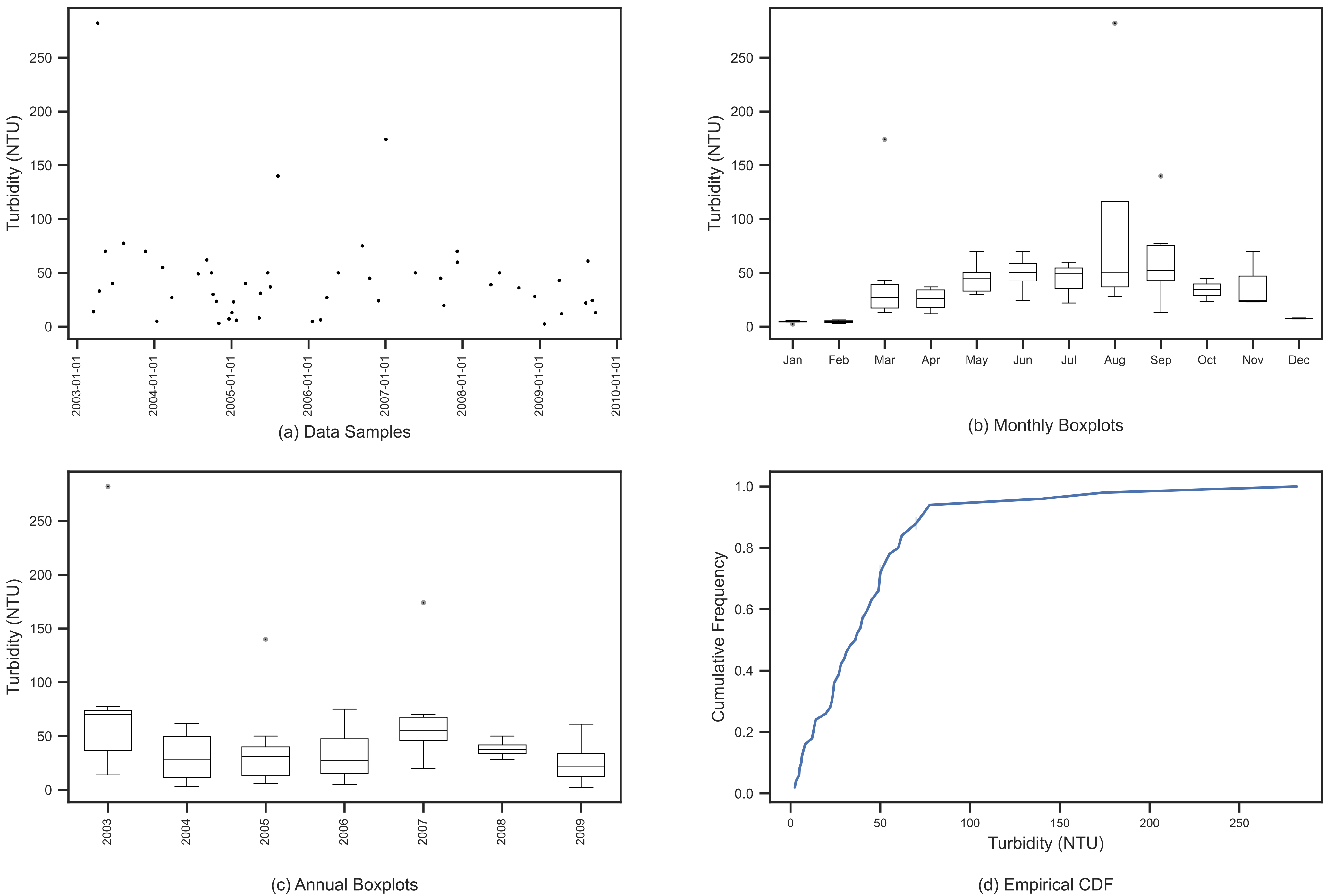
Blackberry Creek near Yorkville Side Rd. (BC2) : Turbidity (NTU)



Little Indian Creek at dns Unversity Rd. Br. (LC1) : Turbidity (NTU)

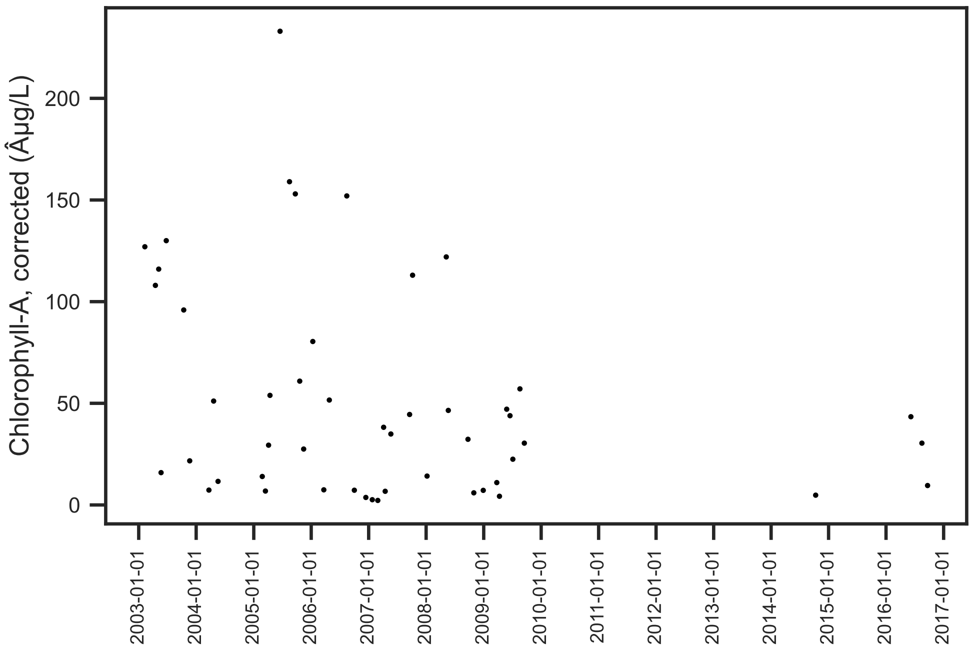


Fox River at Rt. 71 (FR14) : Turbidity (NTU)

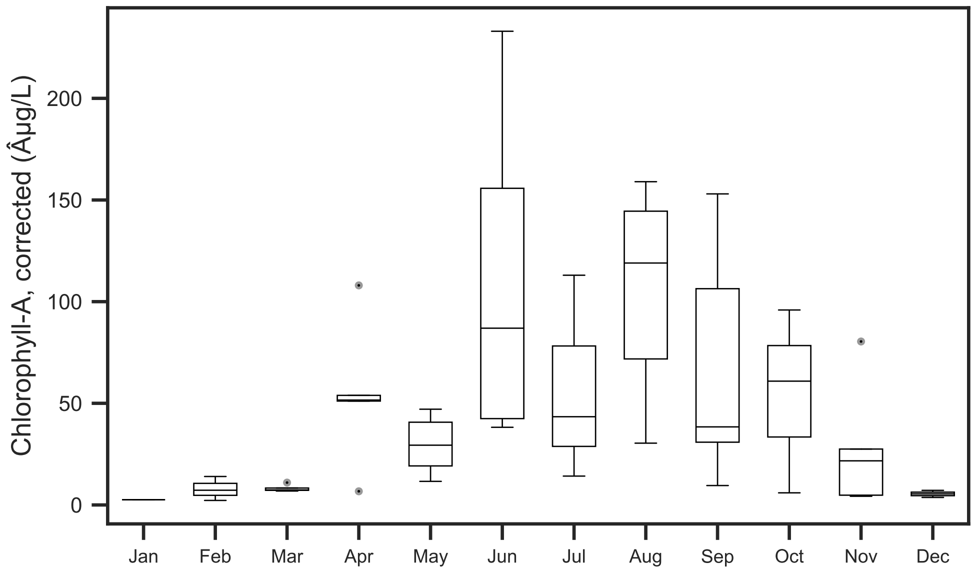


EDA Outputs for Chlorophyll-A, corrected (μg/L)

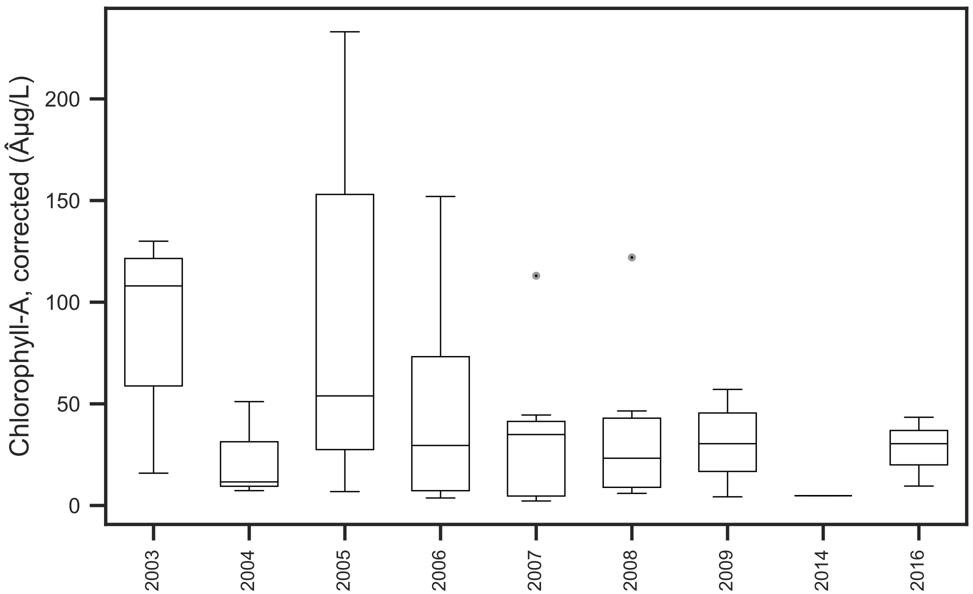
Fox River at Rt. 173 near Channel Lake (FR1) : Chlorophyll-A, corrected (Âµg/L)



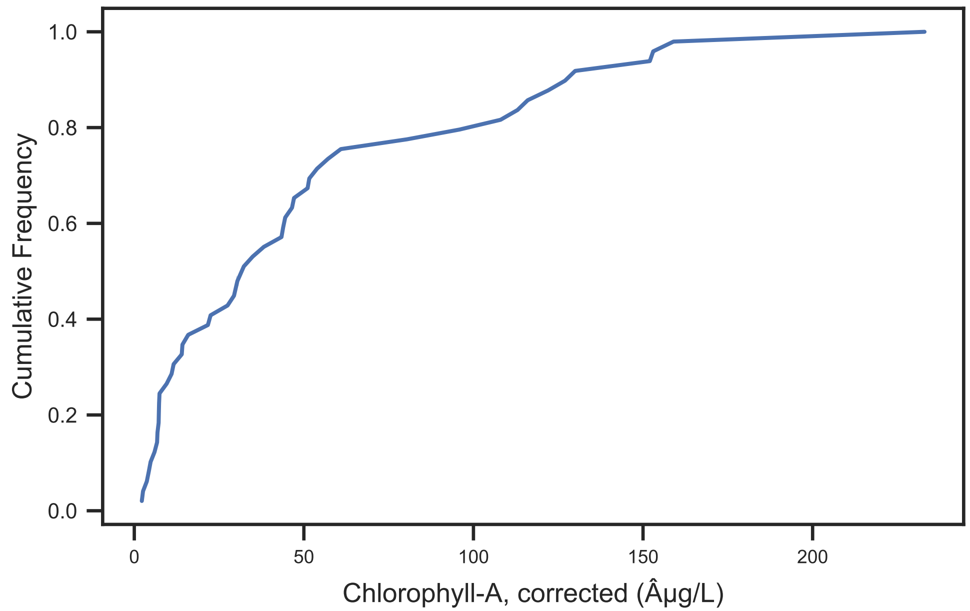
(a) Data Samples



(b) Monthly Boxplots

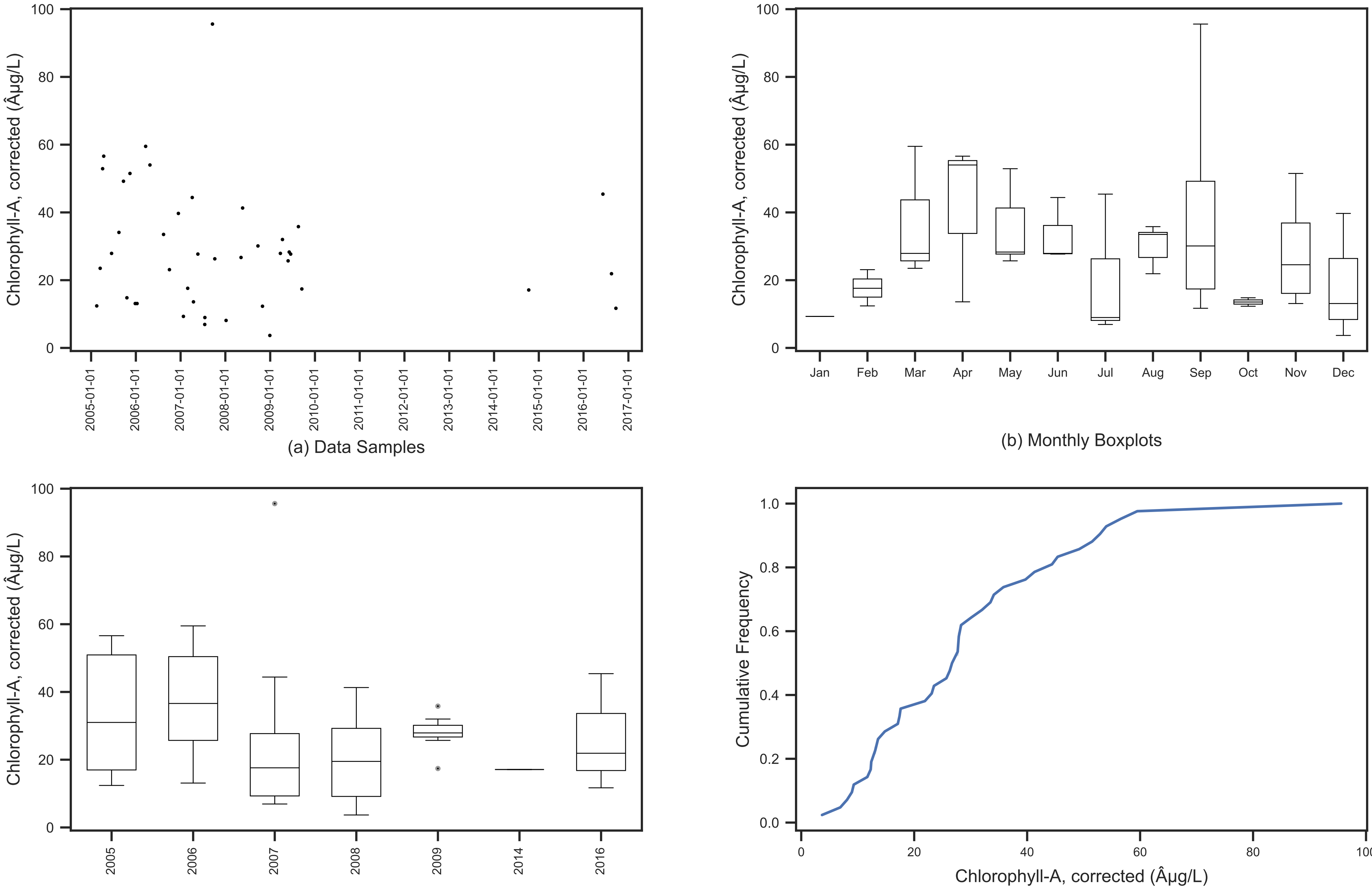


(c) Annual Boxplots



(d) Empirical CDF

Nippersink Creek near Spring Grove (NC1) : Chlorophyll-A, corrected (Âµg/L)



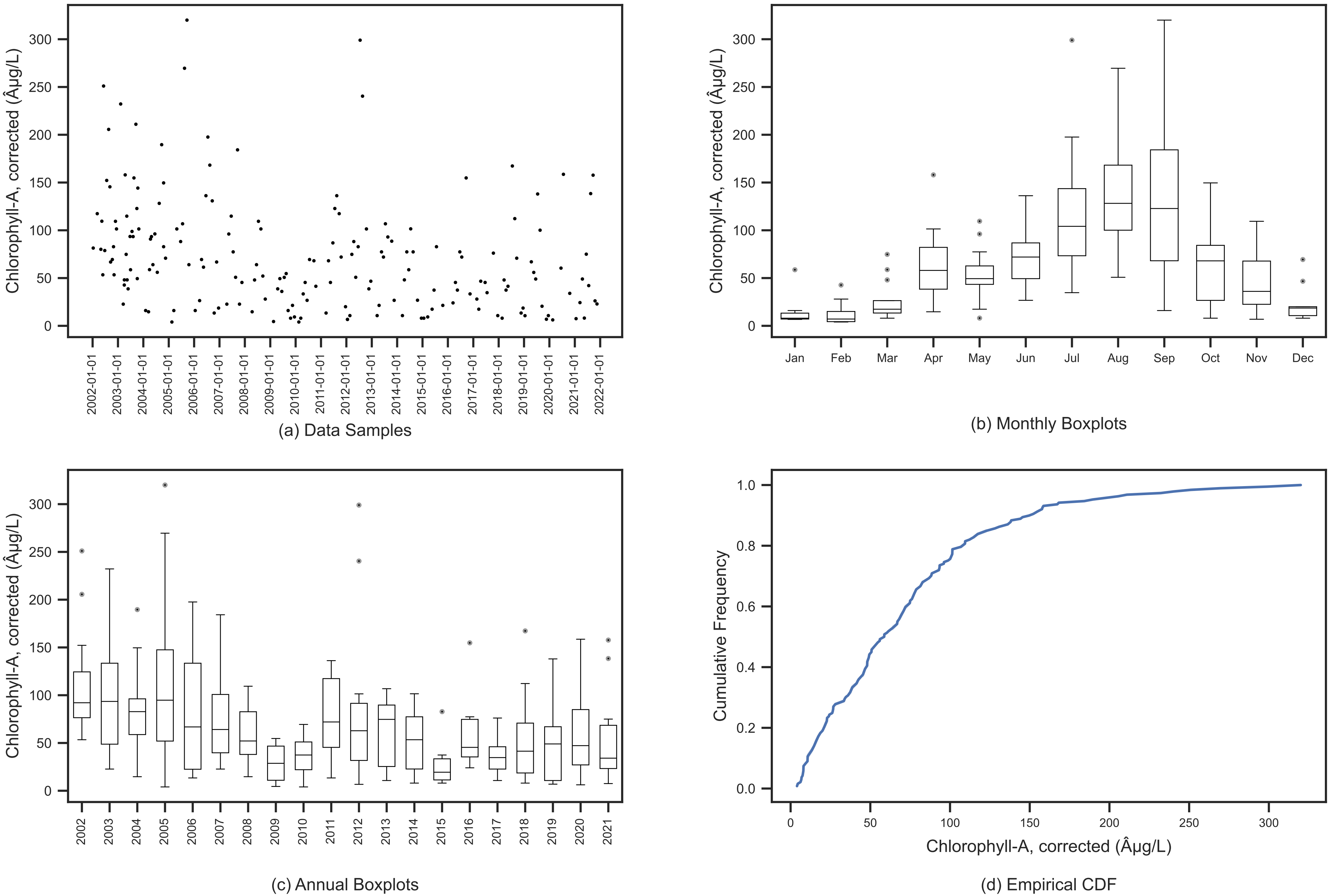
(a) Data Samples

(b) Monthly Boxplots

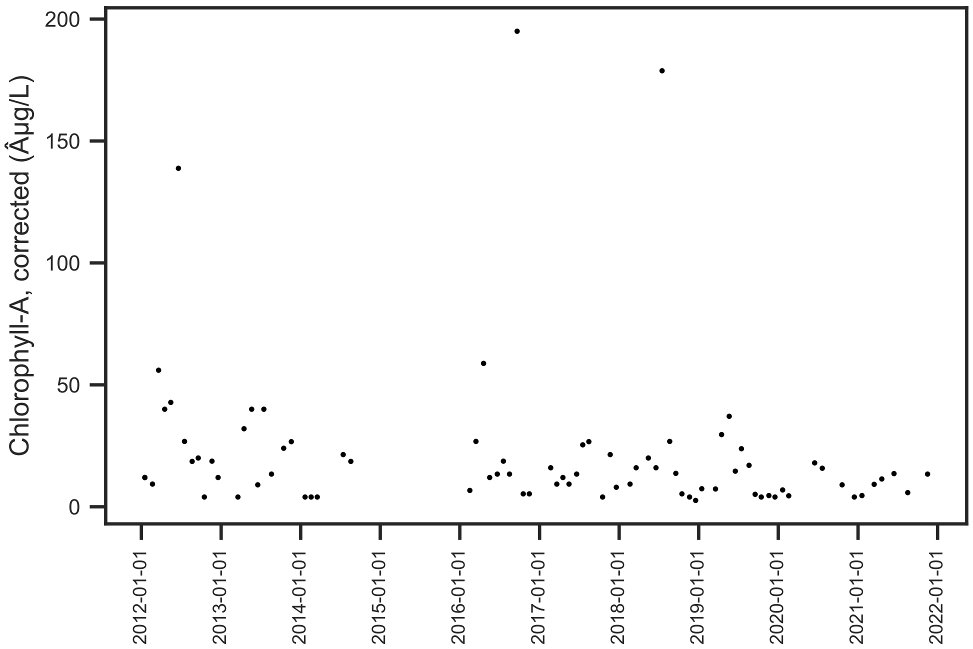
(c) Annual Boxplots

(d) Empirical CDF

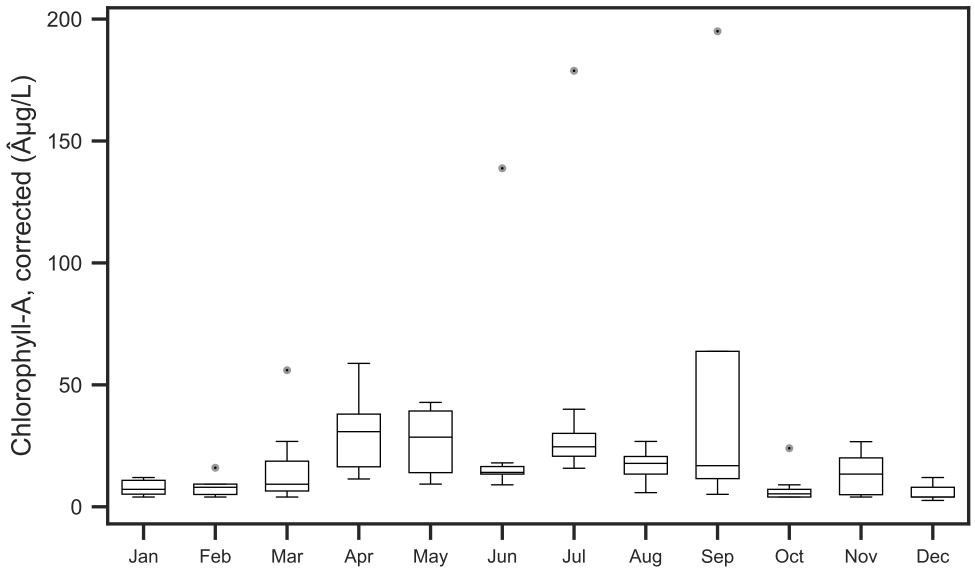
Fox River at Chapel Rd, Johnsburg (FR2) : Chlorophyll-A, corrected (Âµg/L)



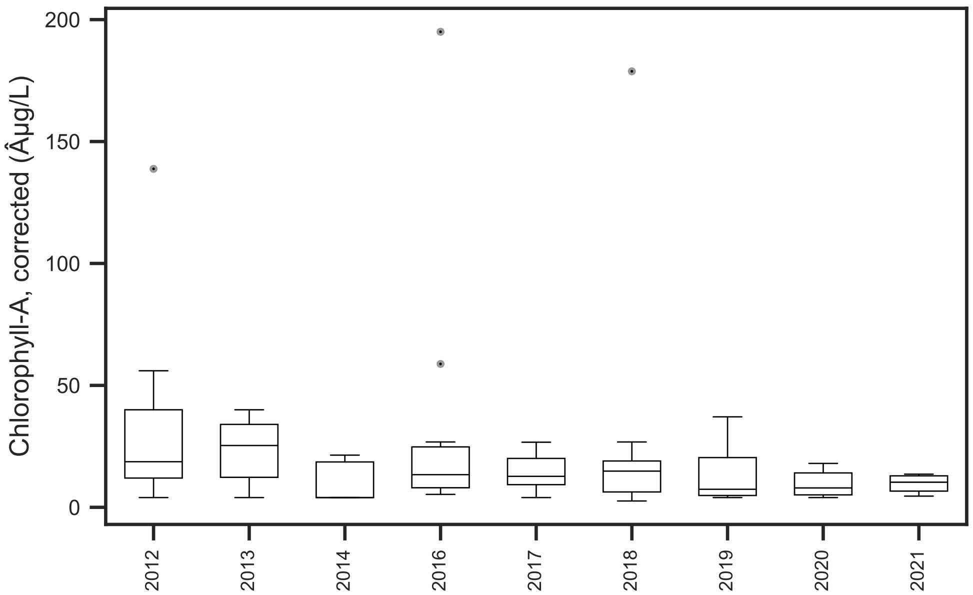
Sleepy Hollow Creek at Stilling Ln. (SH1) : Chlorophyll-A, corrected (Âµg/L)



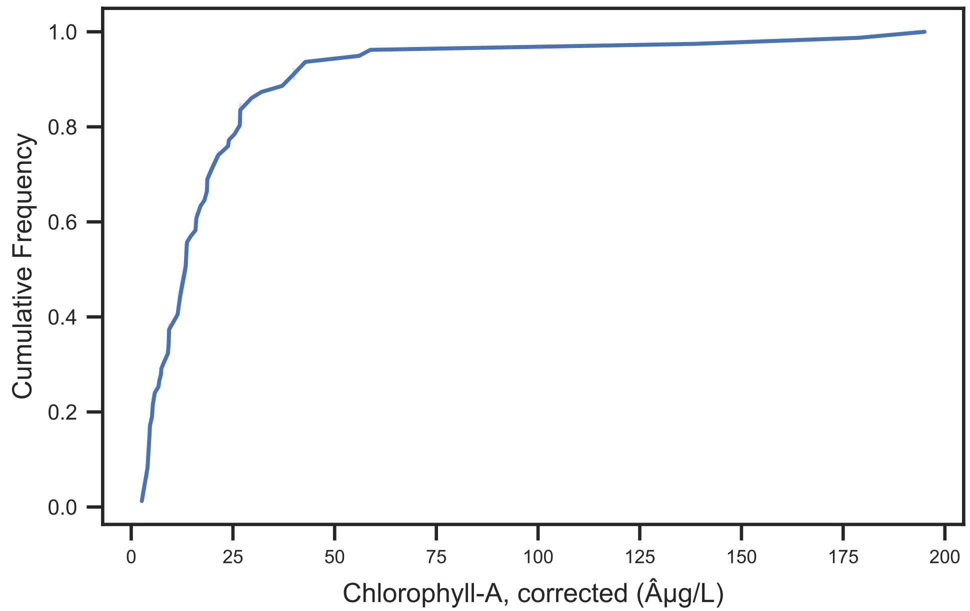
(a) Data Samples



(b) Monthly Boxplots

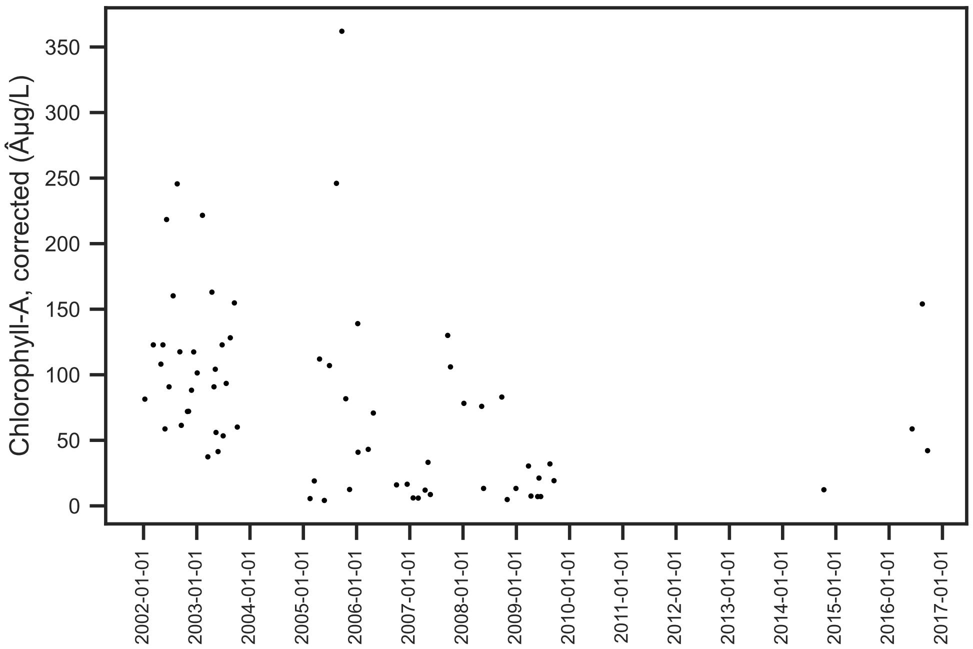


(c) Annual Boxplots

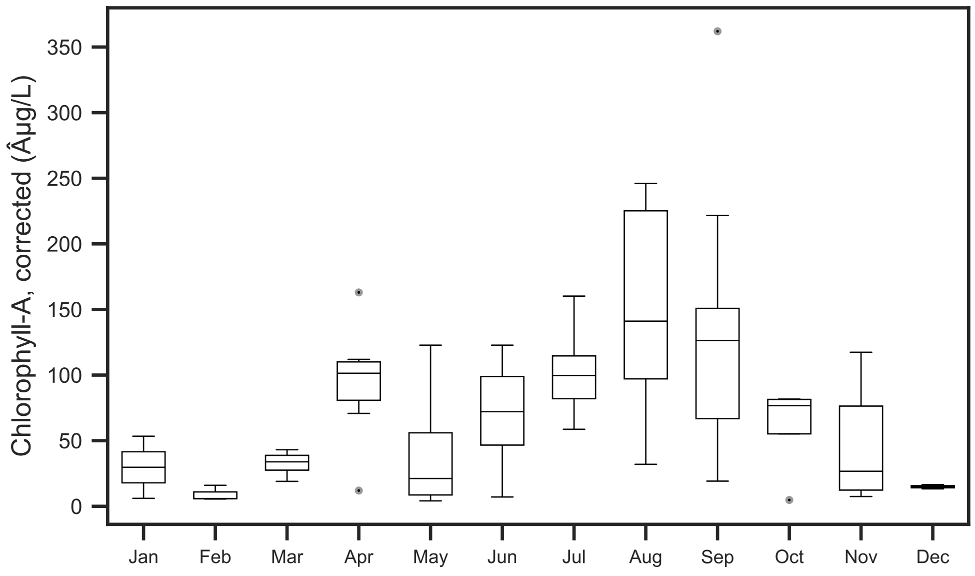


(d) Empirical CDF

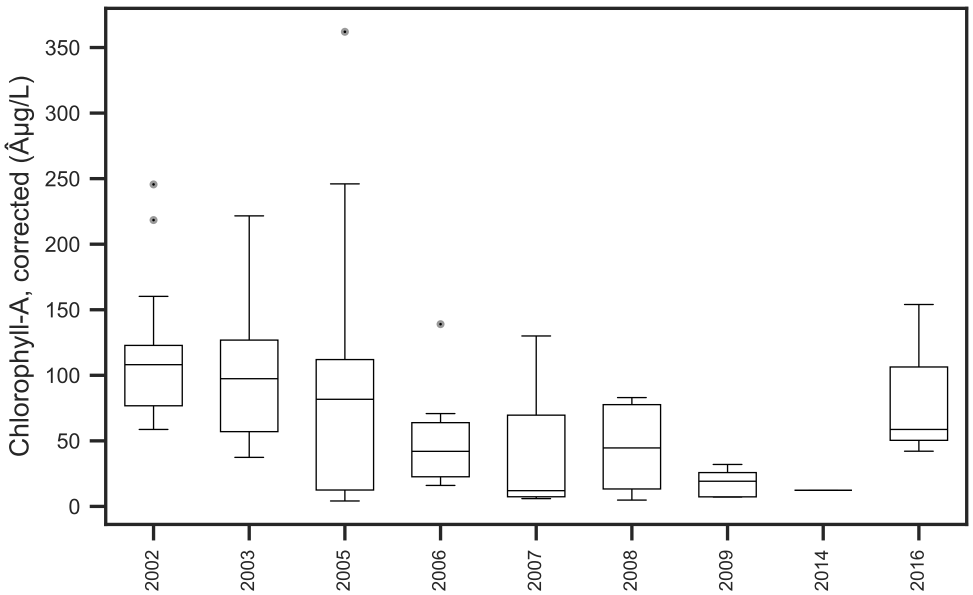
Fox River at Burtons Br. (FR3) : Chlorophyll-A, corrected (Âµg/L)



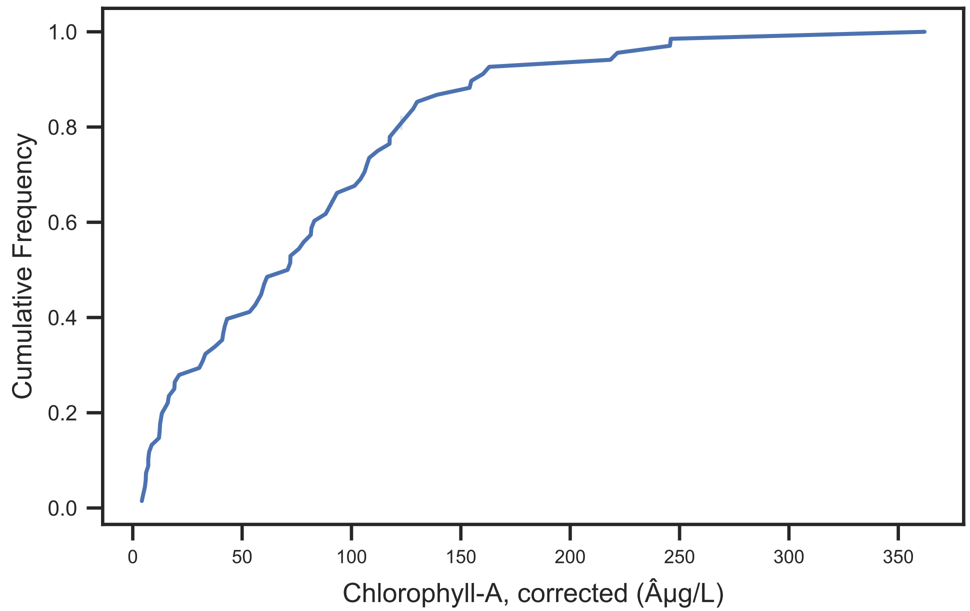
(a) Data Samples



(b) Monthly Boxplots

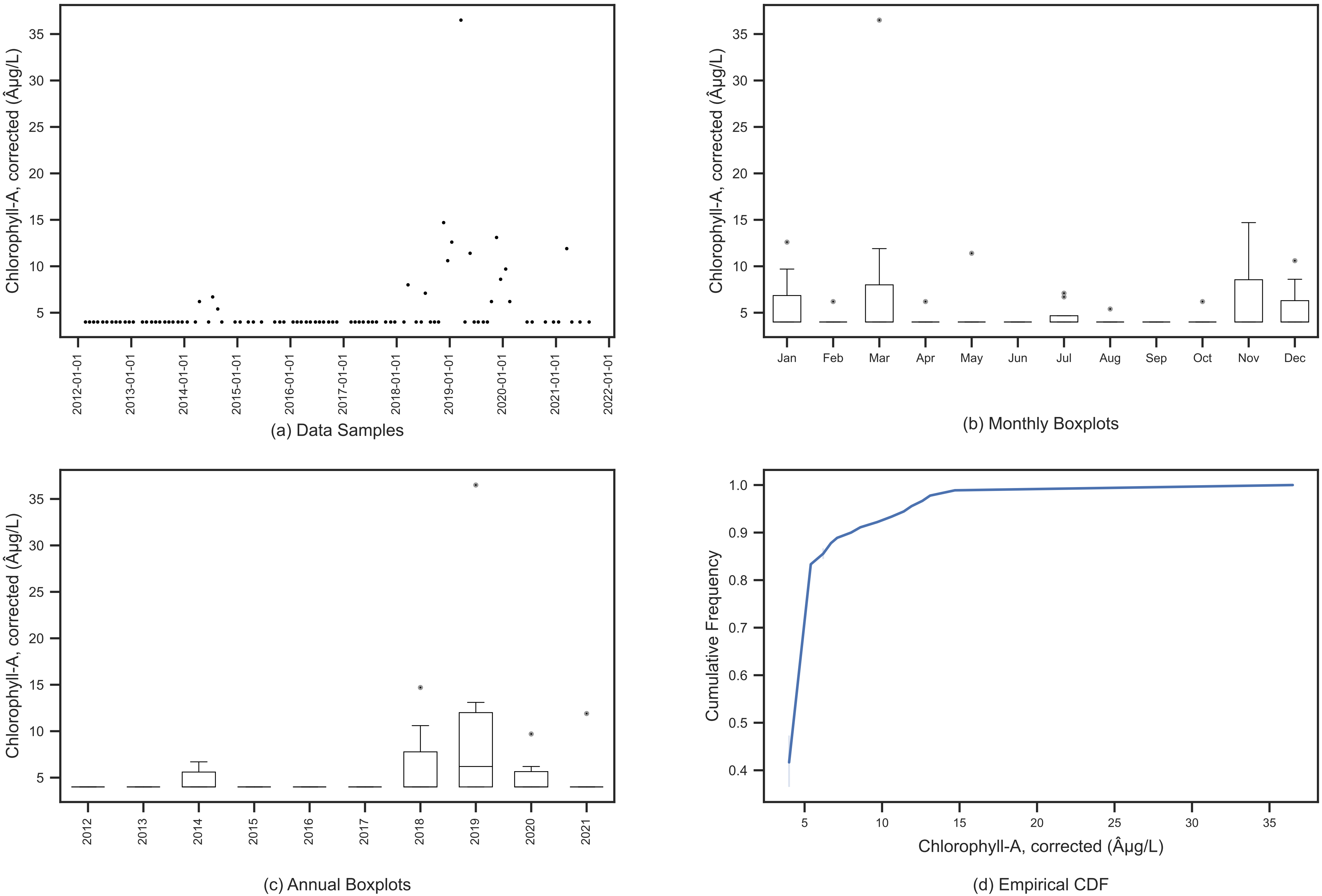


(c) Annual Boxplots

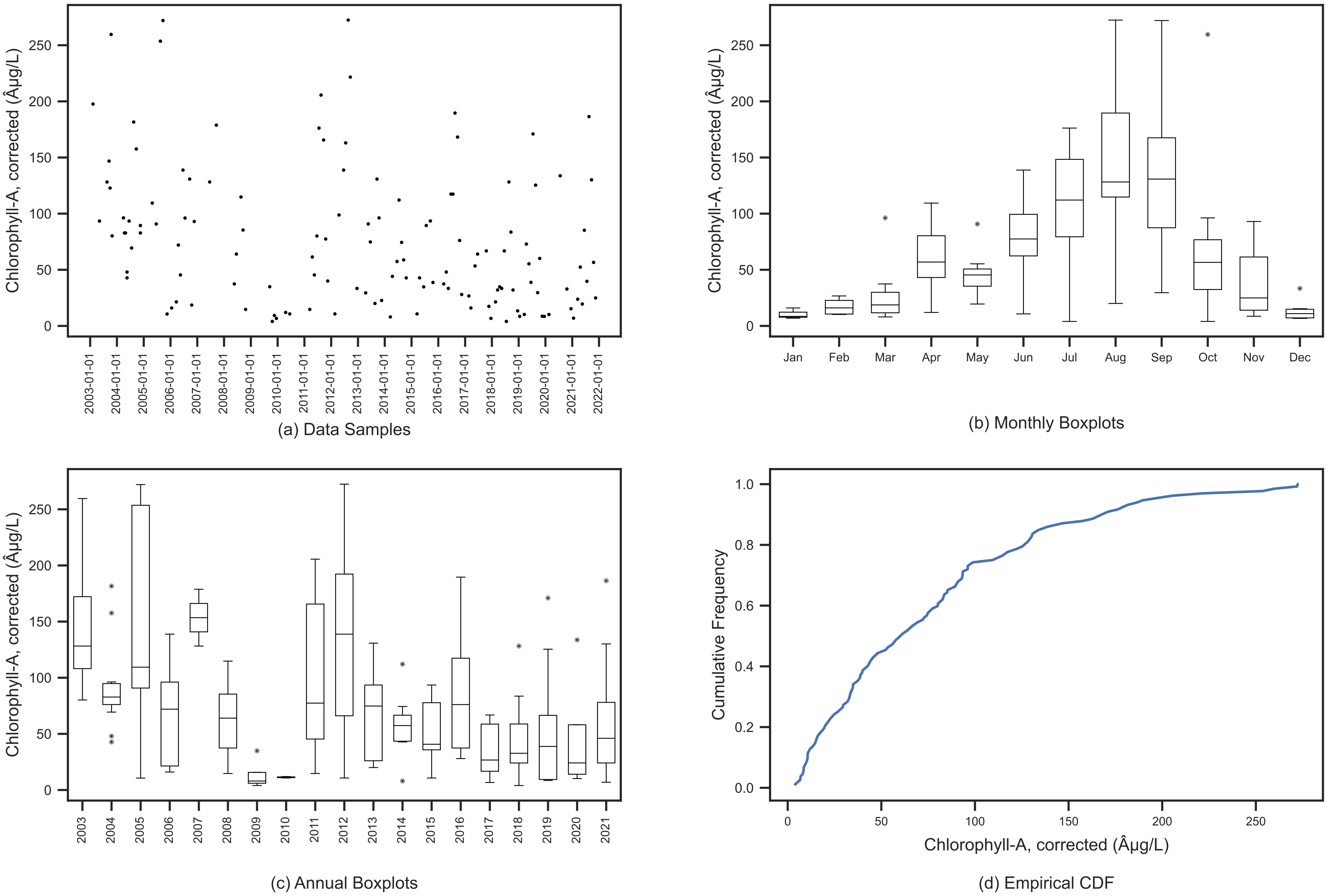


(d) Empirical CDF

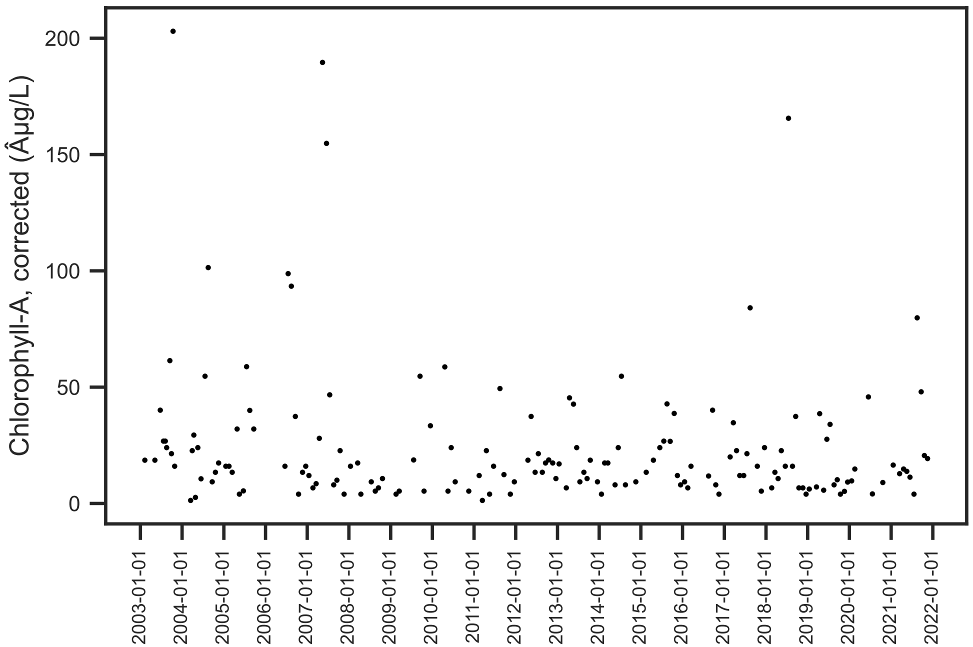
Silver Creek at Lk shore Dr. & E. Park Ln. (SC1) : Chlorophyll-A, corrected (Âµg/L)



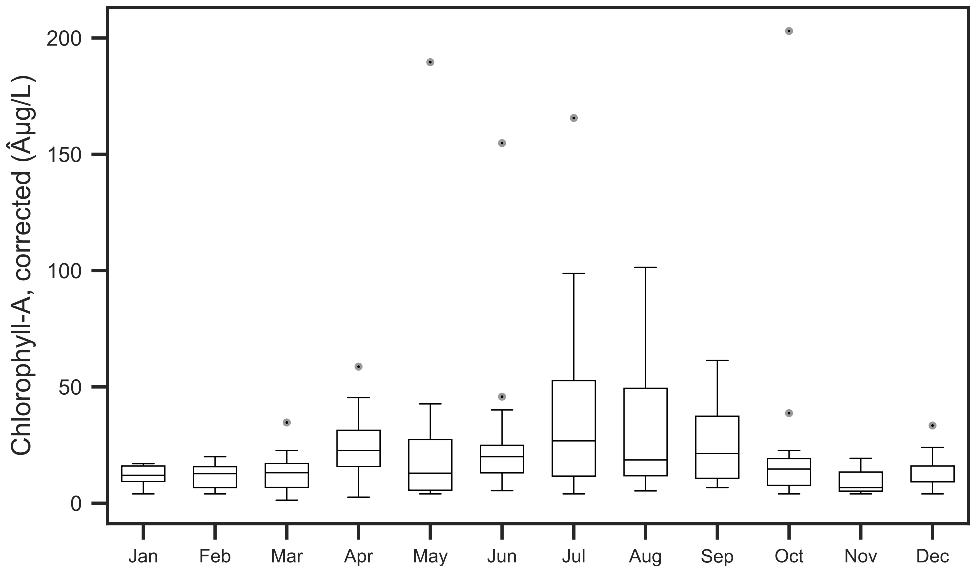
Fox River at Rawson Rd., E Oakwood Hills (FR4) : Chlorophyll-A, corrected (Âµg/L)



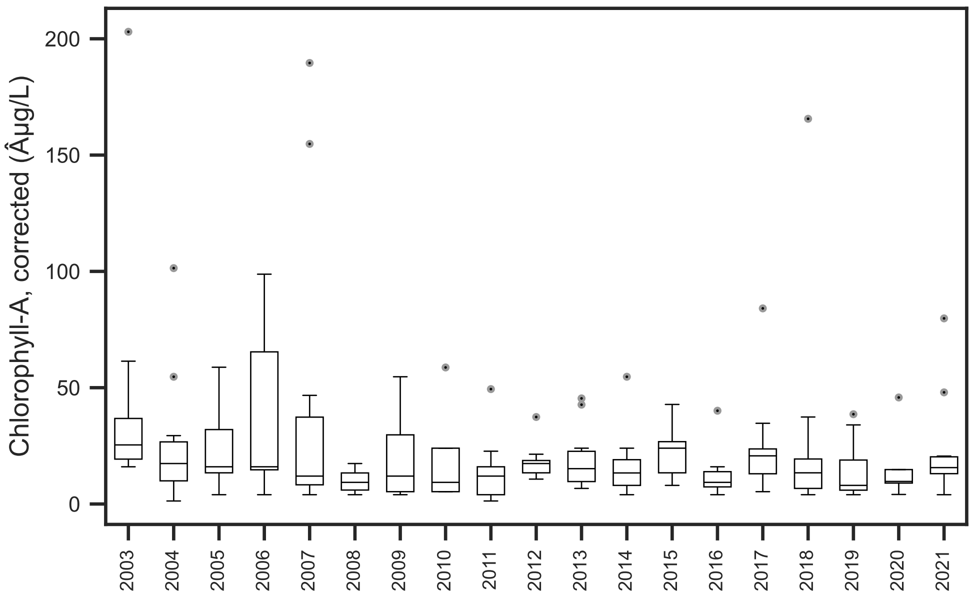
Crystal Lk Outlet-Rt 31, Algonquin (CL1) : Chlorophyll-A, corrected (Âµg/L)



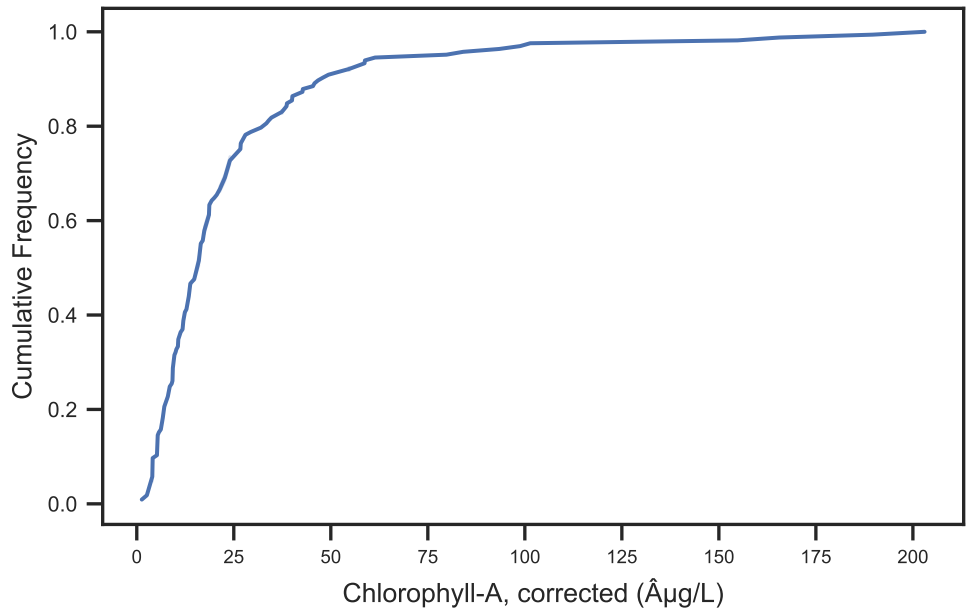
(a) Data Samples



(b) Monthly Boxplots

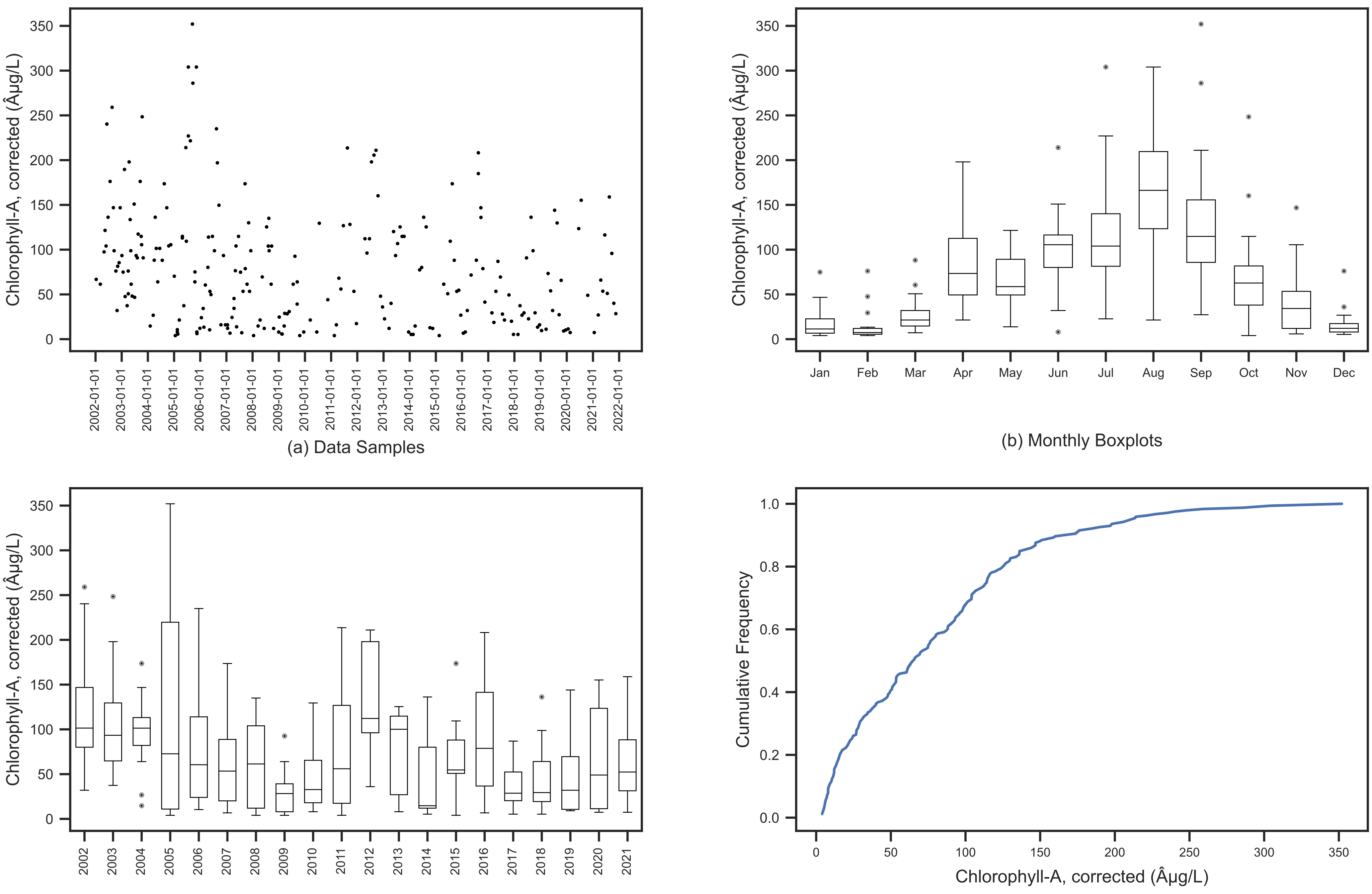


(c) Annual Boxplots



(d) Empirical CDF

Fox River at Algonquin (FR5) : Chlorophyll-A, corrected (Âµg/L)



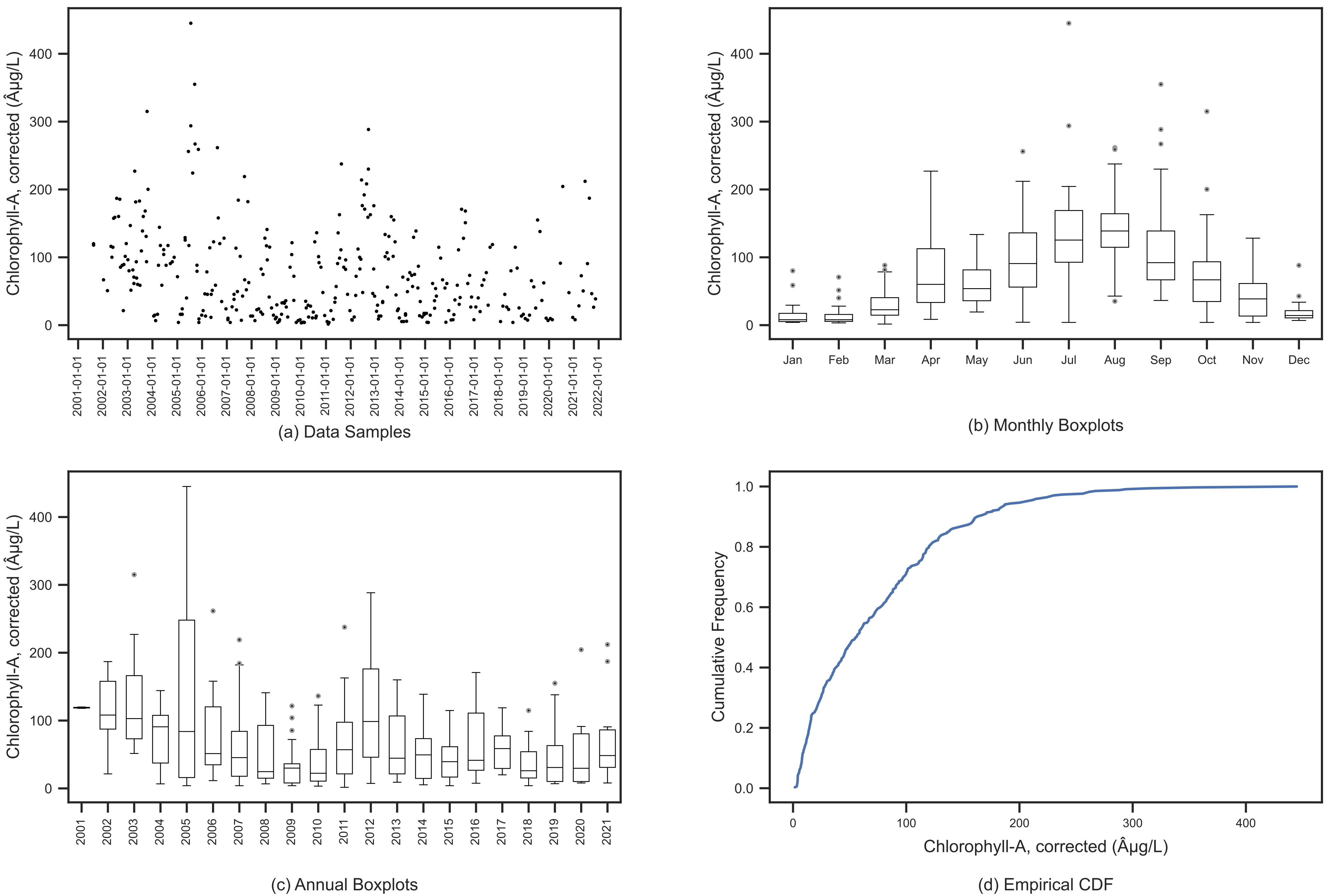
(a) Data Samples

(b) Monthly Boxplots

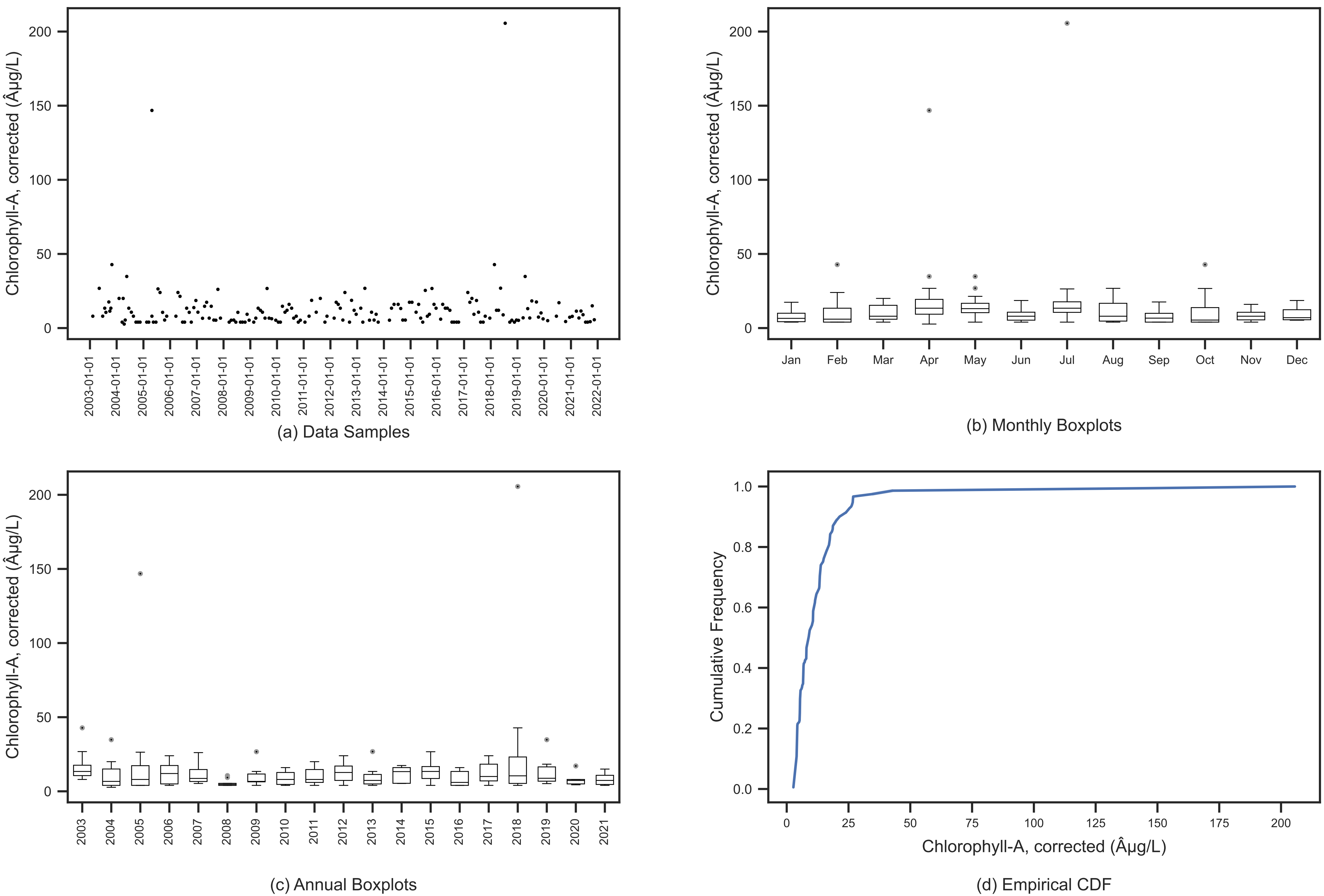
(c) Annual Boxplots

(d) Empirical CDF

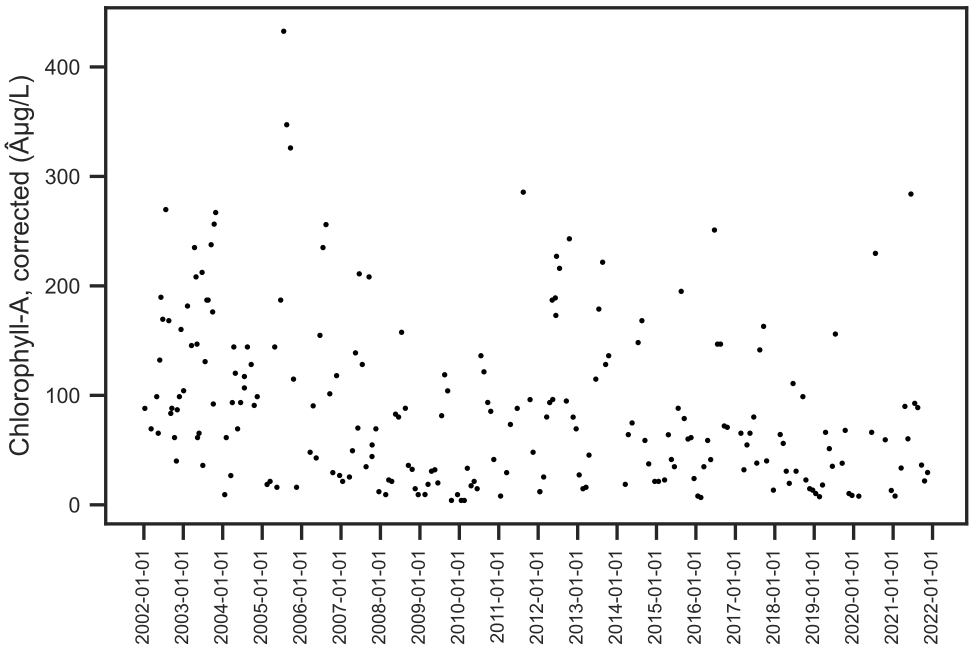
Fox River at South Elgin (FR6) : Chlorophyll-A, corrected (Âµg/L)



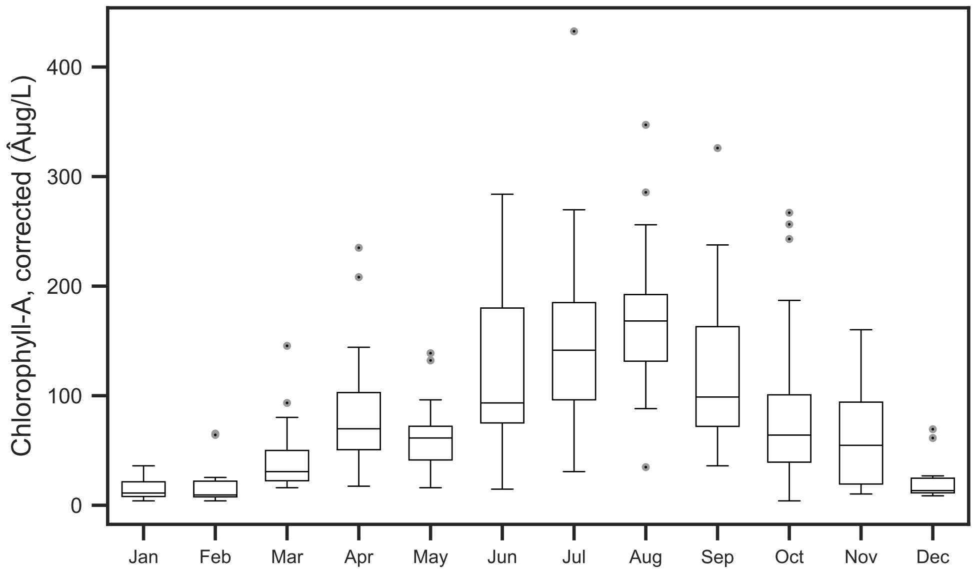
Ferson Creek near St. Charles (FC5) : Chlorophyll-A, corrected (Âµg/L)



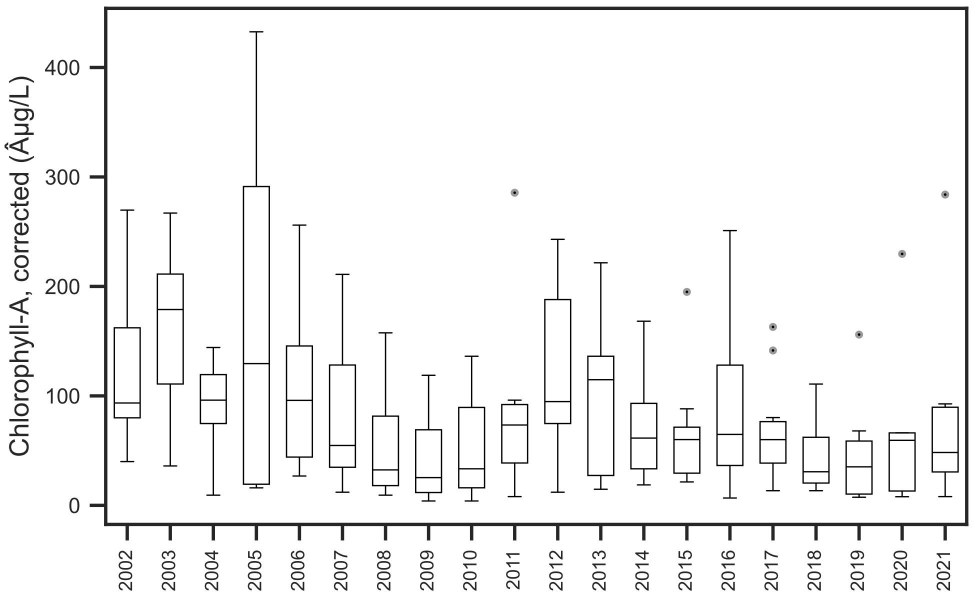
Fox River at Fabyan Pk-Geneva (FR7) : Chlorophyll-A, corrected (Âµg/L)



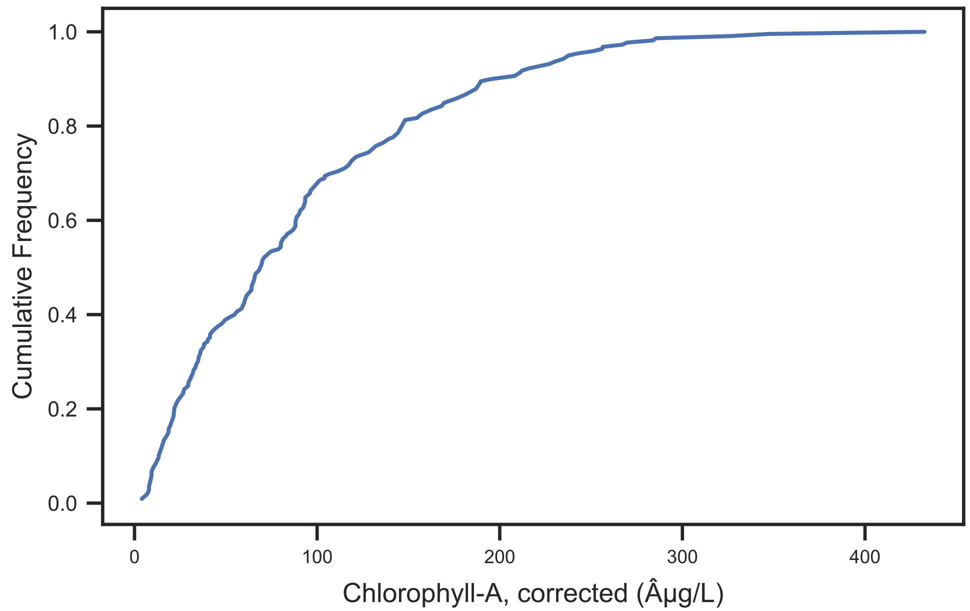
(a) Data Samples



(b) Monthly Boxplots

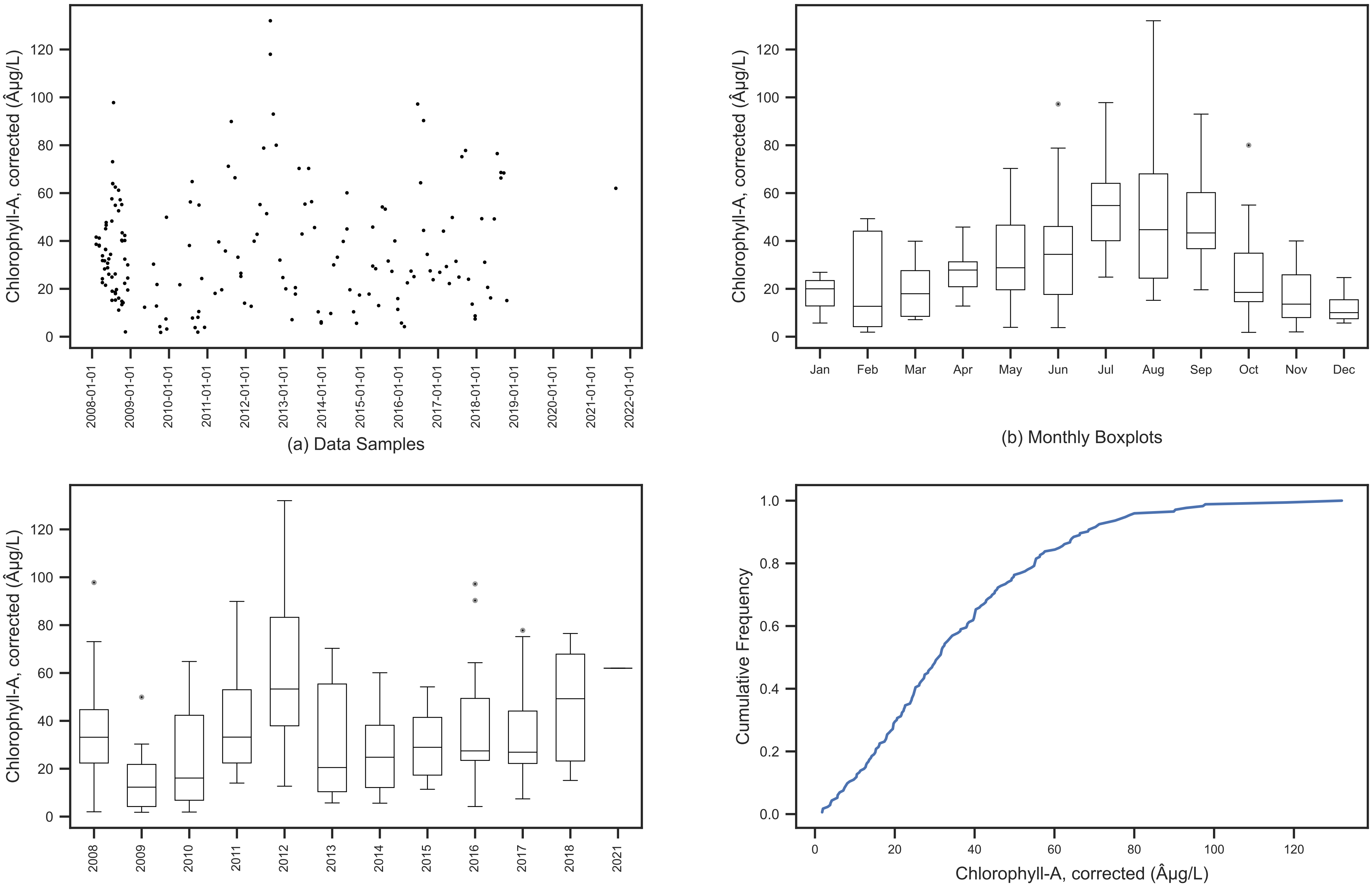


(c) Annual Boxplots



(d) Empirical CDF

Fox River at Sullivan Br. (FR8) : Chlorophyll-A, corrected (Âµg/L)



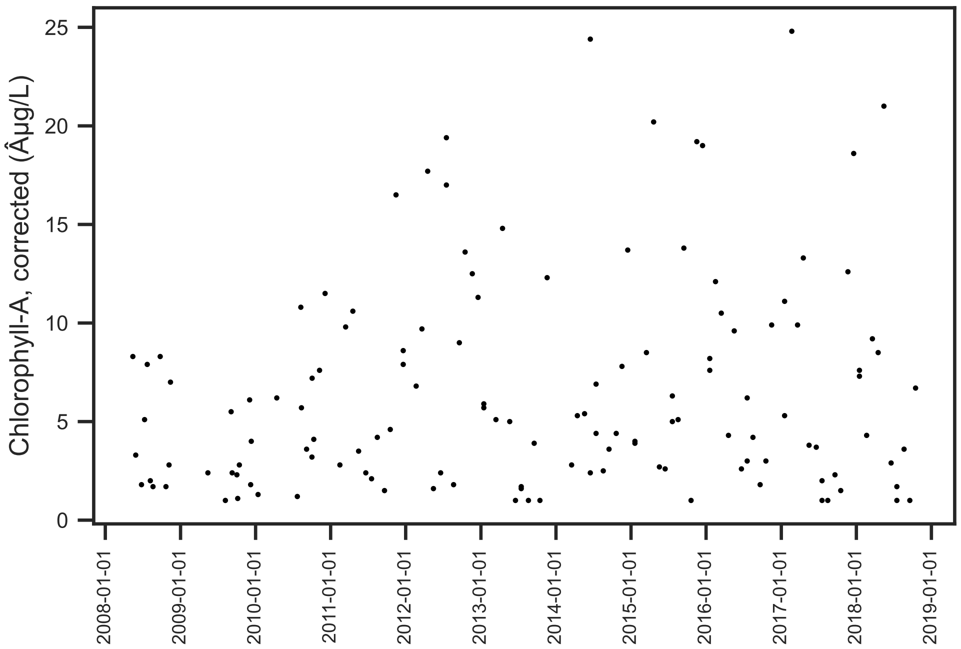
(a) Data Samples

(b) Monthly Boxplots

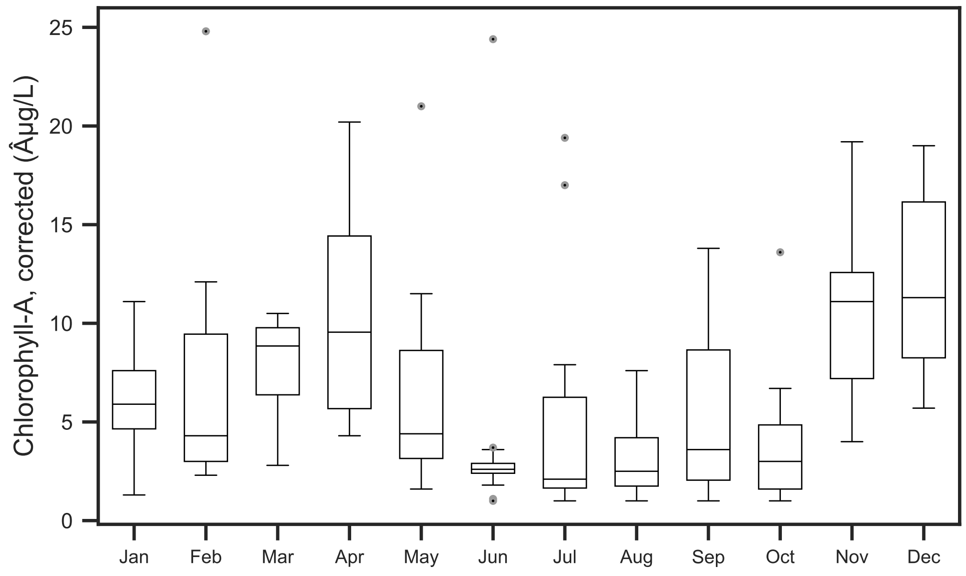
(c) Annual Boxplots

(d) Empirical CDF

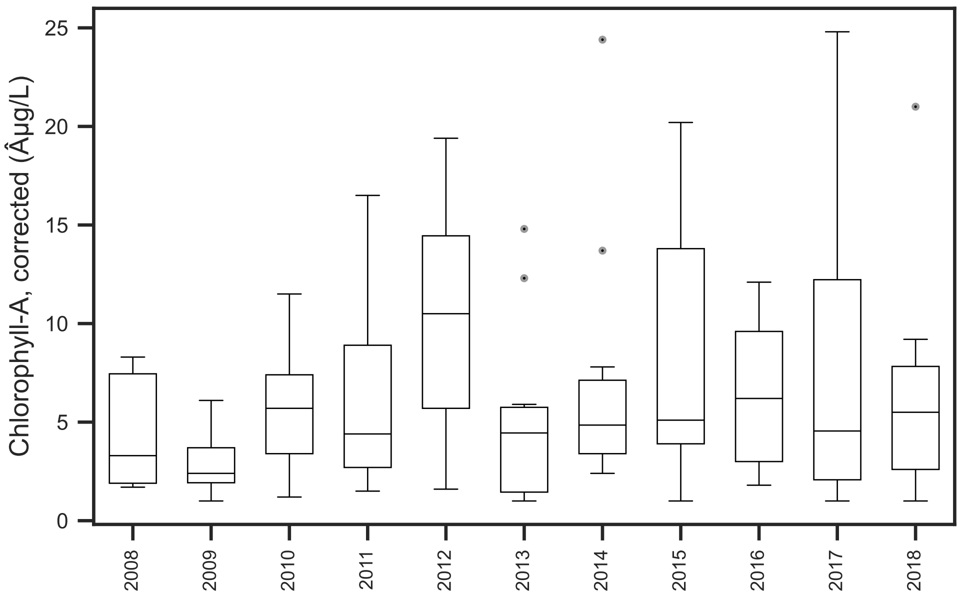
Indian Creek at Reckinger Rd. (IC1) : Chlorophyll-A, corrected (Âµg/L)



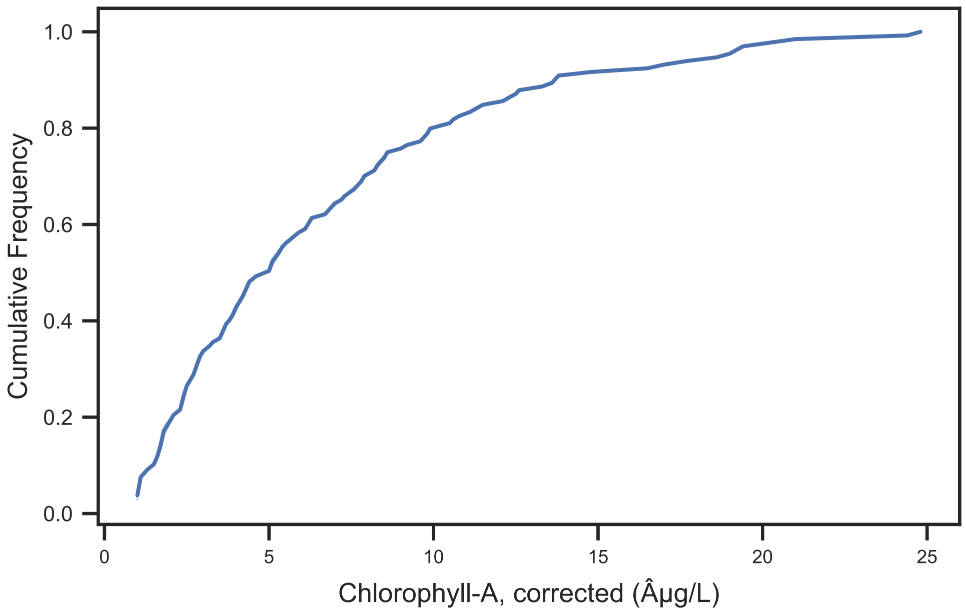
(a) Data Samples



(b) Monthly Boxplots

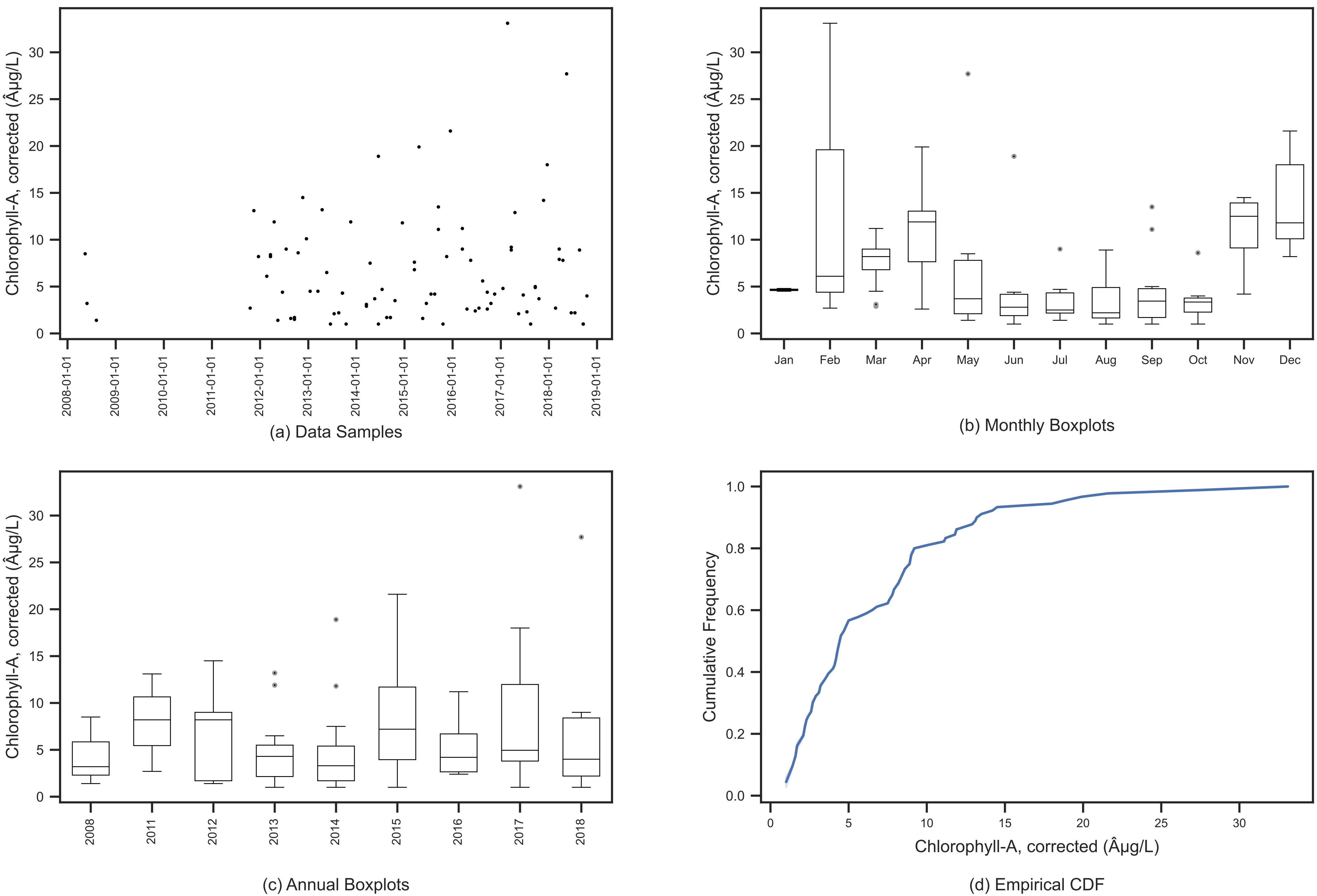


(c) Annual Boxplots

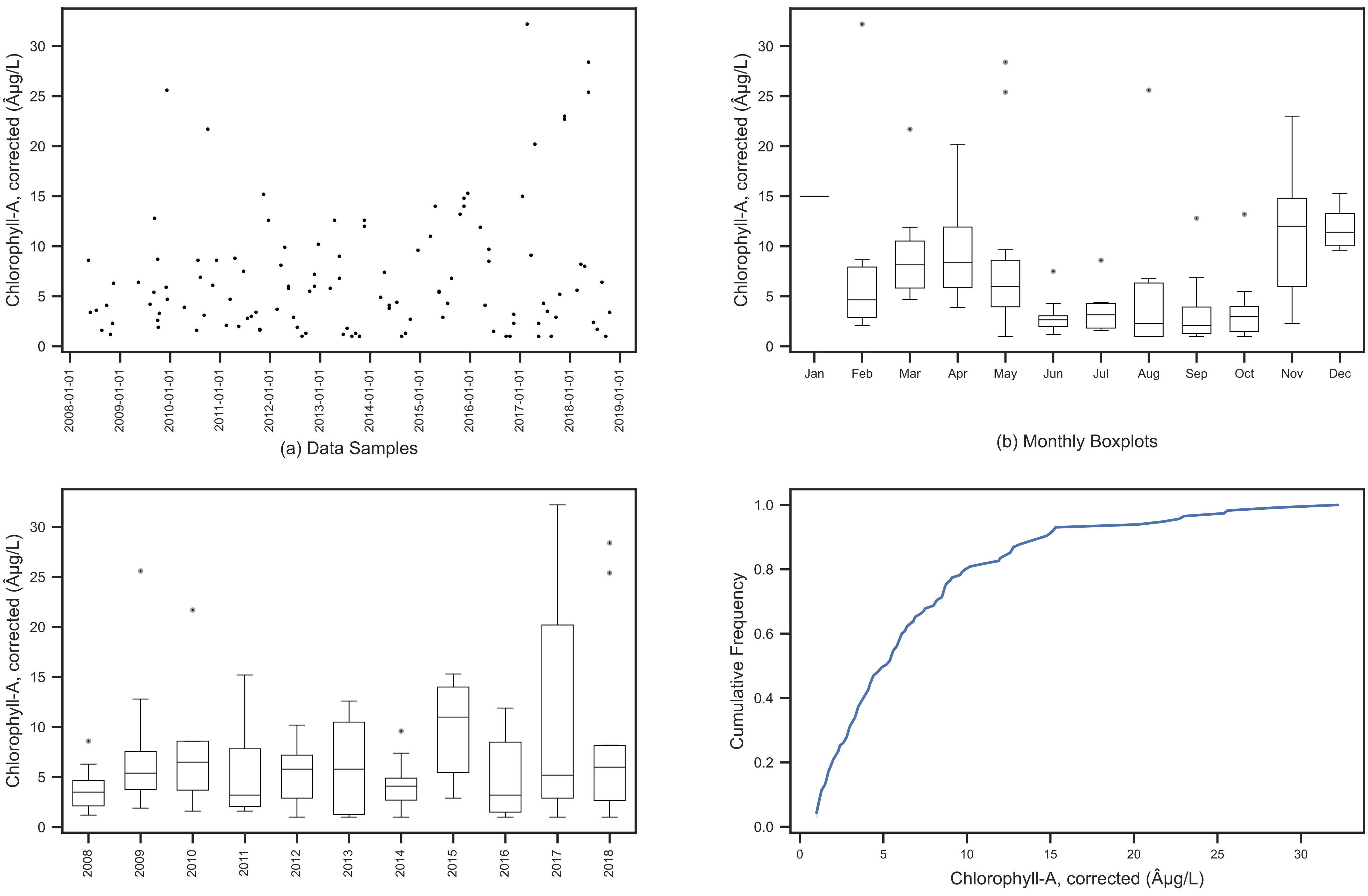


(d) Empirical CDF

Indian Creek ups Outfall (IC2) : Chlorophyll-A, corrected (Âµg/L)



Indian Creek dns Outfall (IC3) : Chlorophyll-A, corrected (Âµg/L)



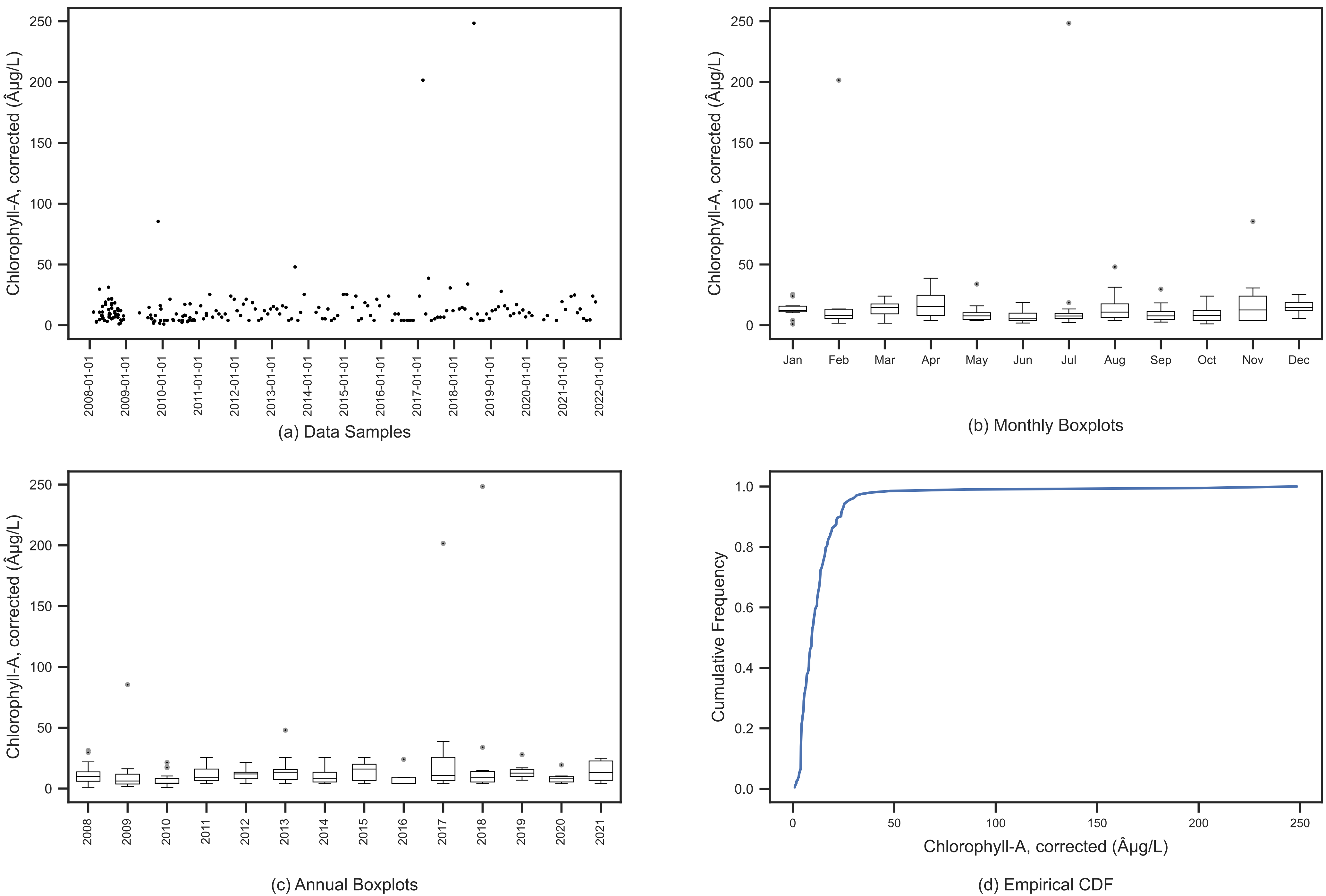
(a) Data Samples

(b) Monthly Boxplots

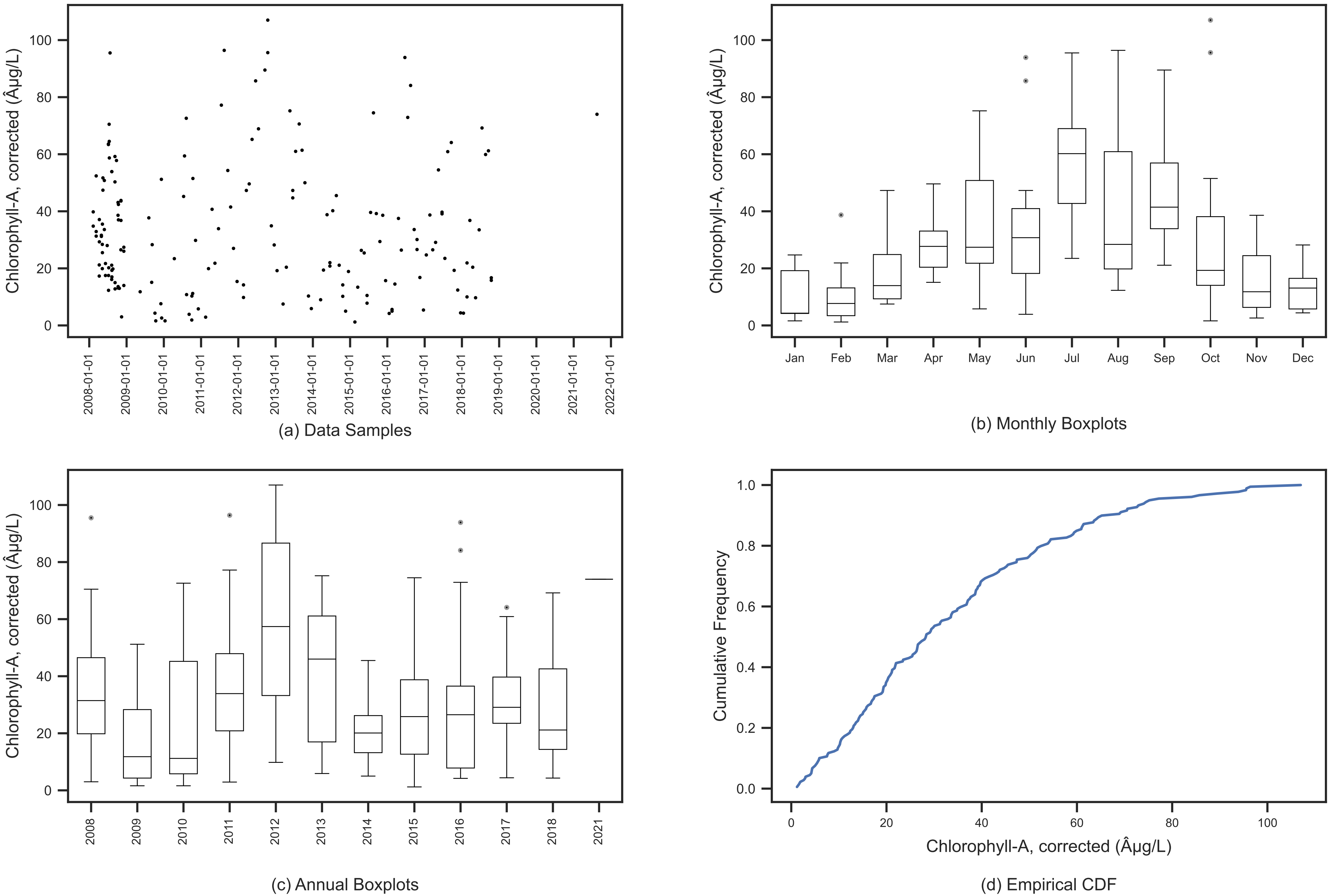
(c) Annual Boxplots

(d) Empirical CDF

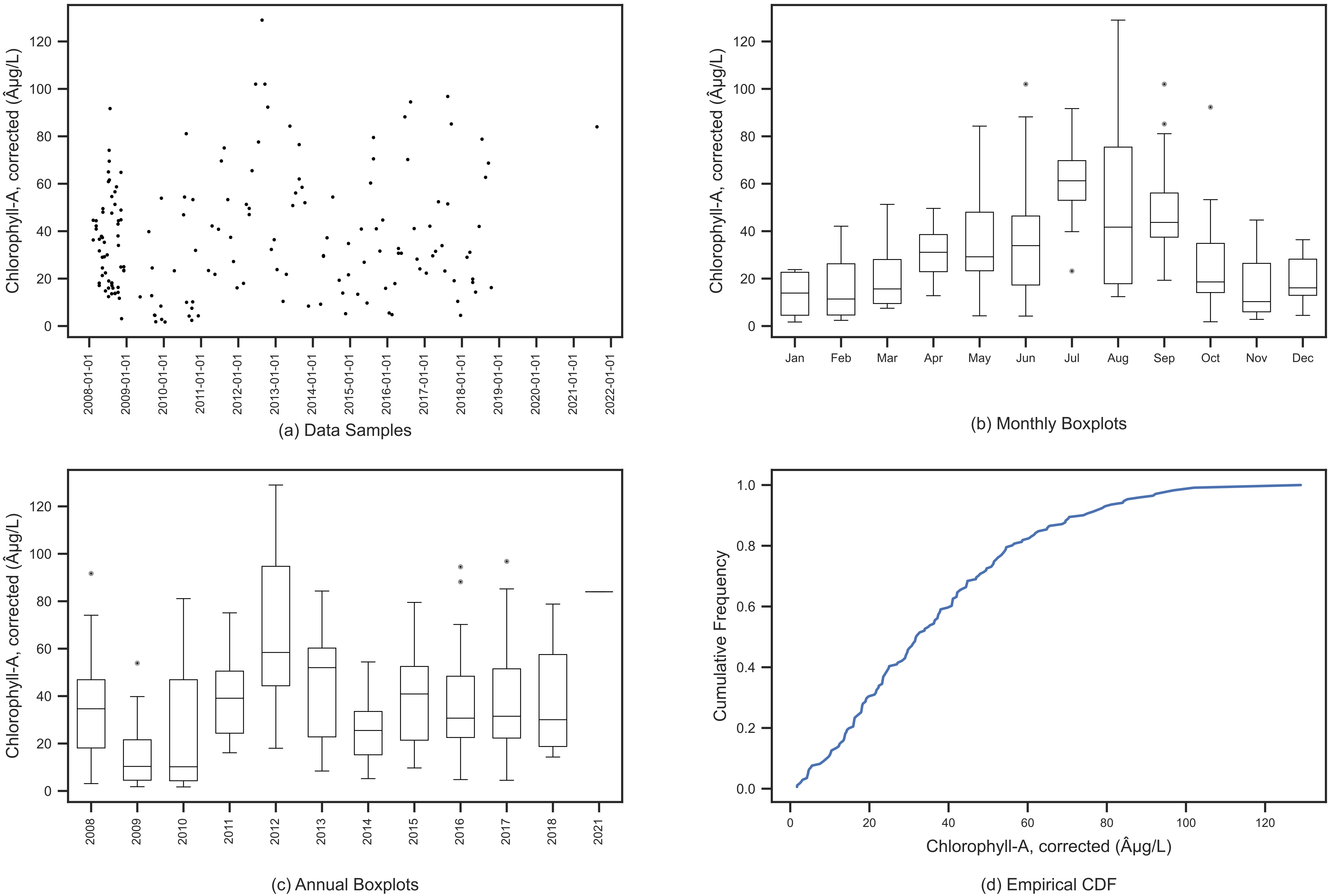
Indian Creek u/s Rt. 25 (IC4) : Chlorophyll-A, corrected (Âµg/L)



Fox River at North Ave. Br. (FR9) : Chlorophyll-A, corrected (Âµg/L)



Fox River at Ashland Ave. (FR10) : Chlorophyll-A, corrected (Âµg/L)



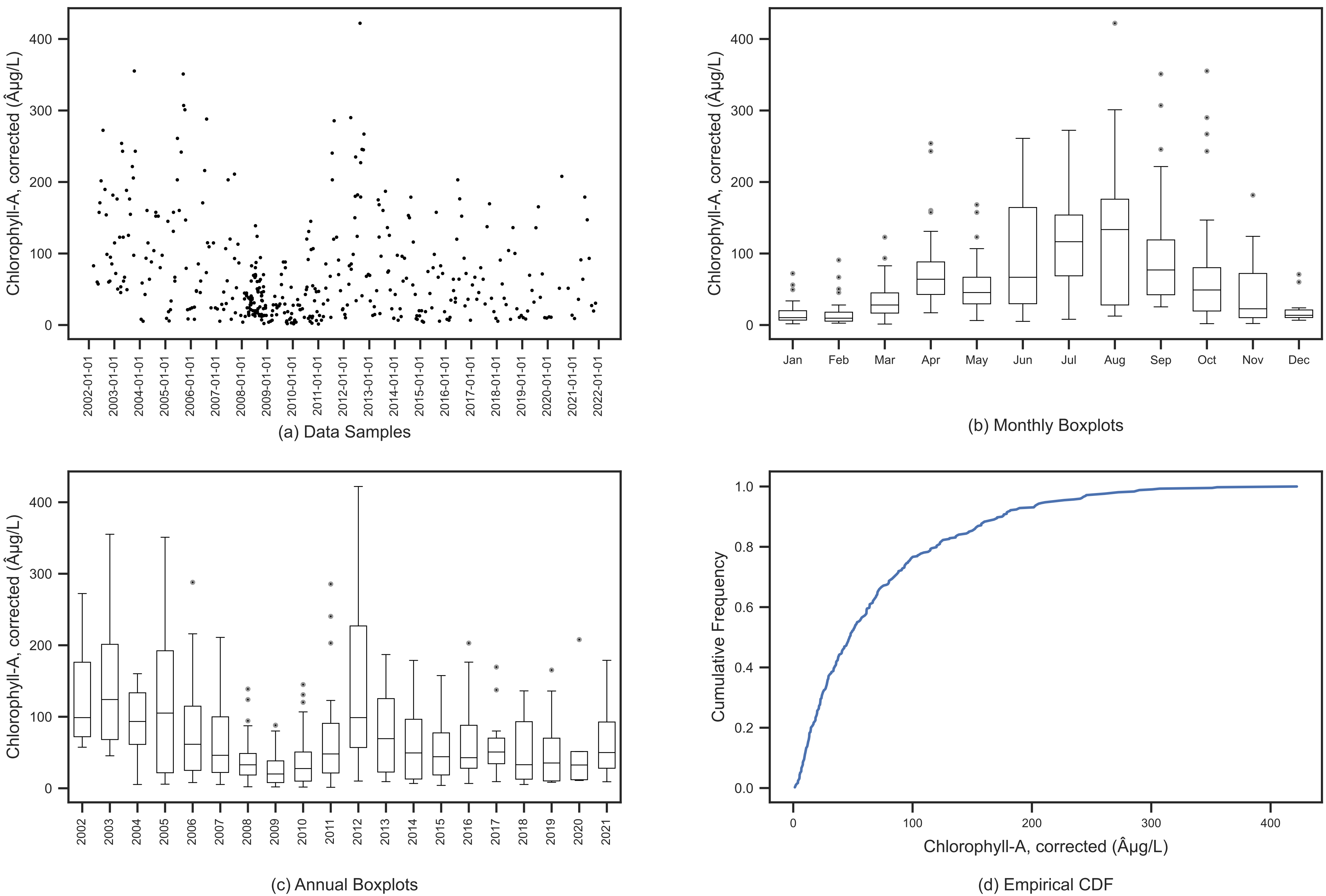
(a) Data Samples

(b) Monthly Boxplots

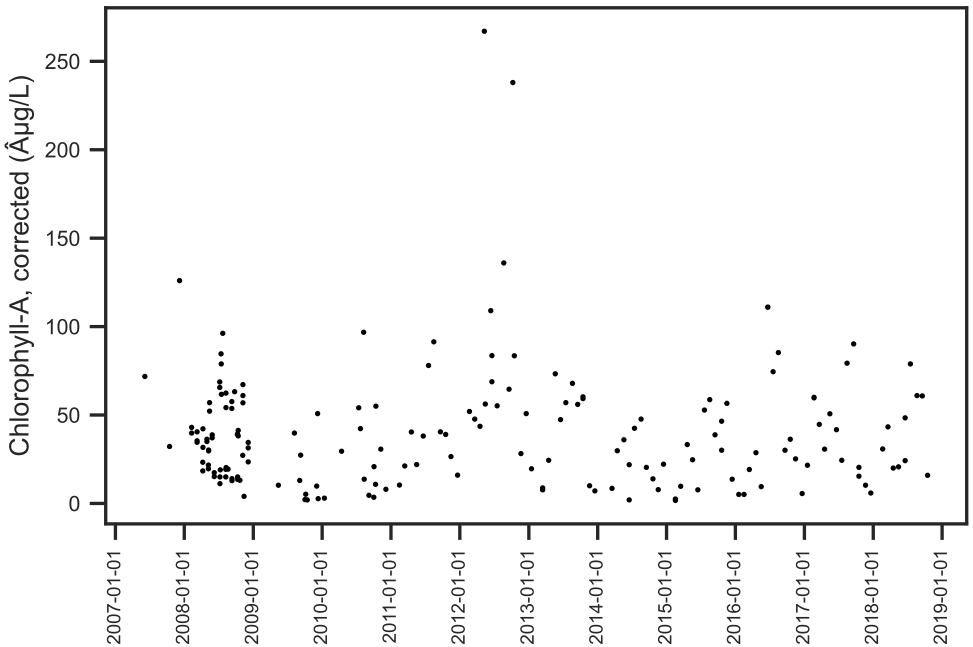
(c) Annual Boxplots

(d) Empirical CDF

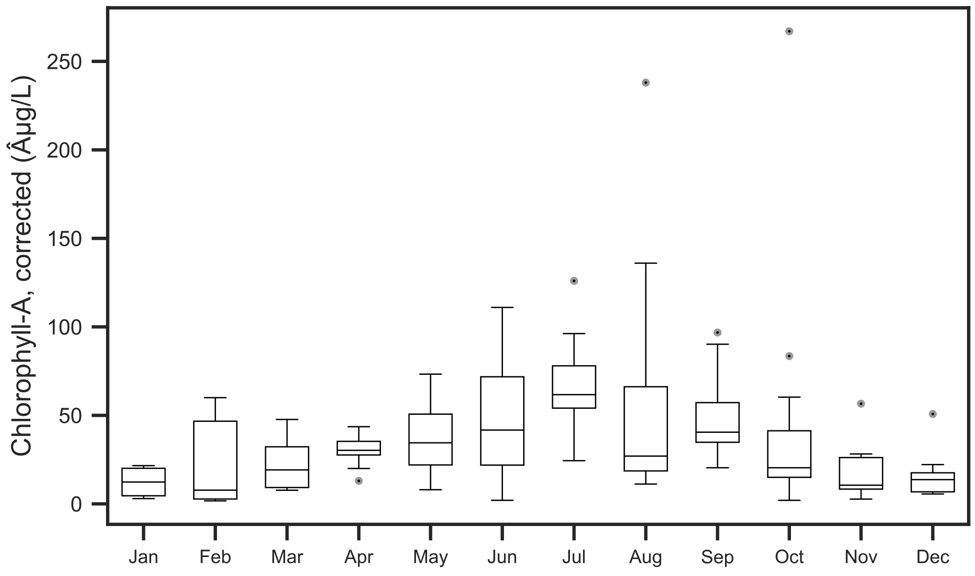
Fox River at Montgomery (FR11) : Chlorophyll-A, corrected (Âµg/L)



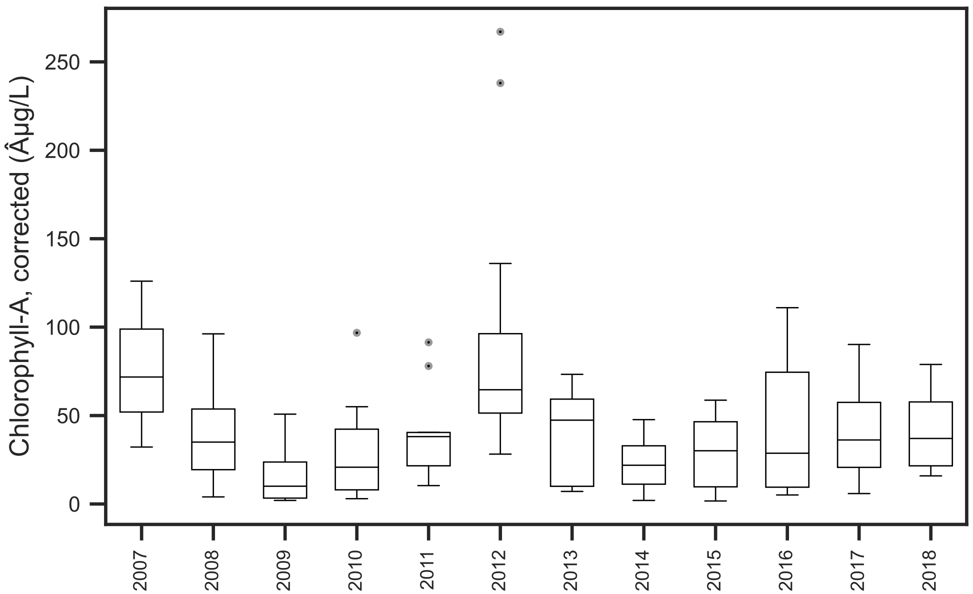
Fox River at Rt. 34, Oswego (FR12) : Chlorophyll-A, corrected (Âµg/L)



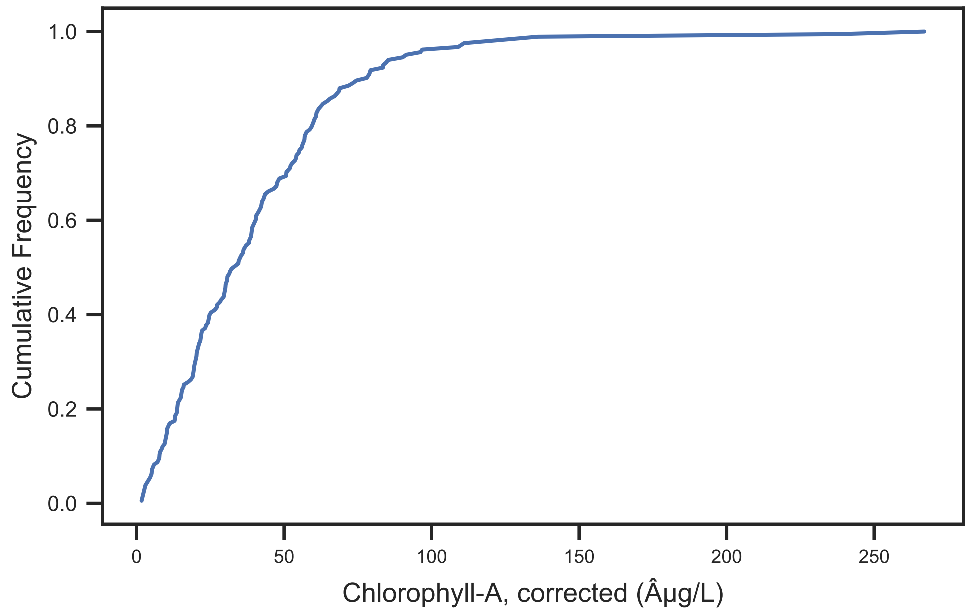
(a) Data Samples



(b) Monthly Boxplots

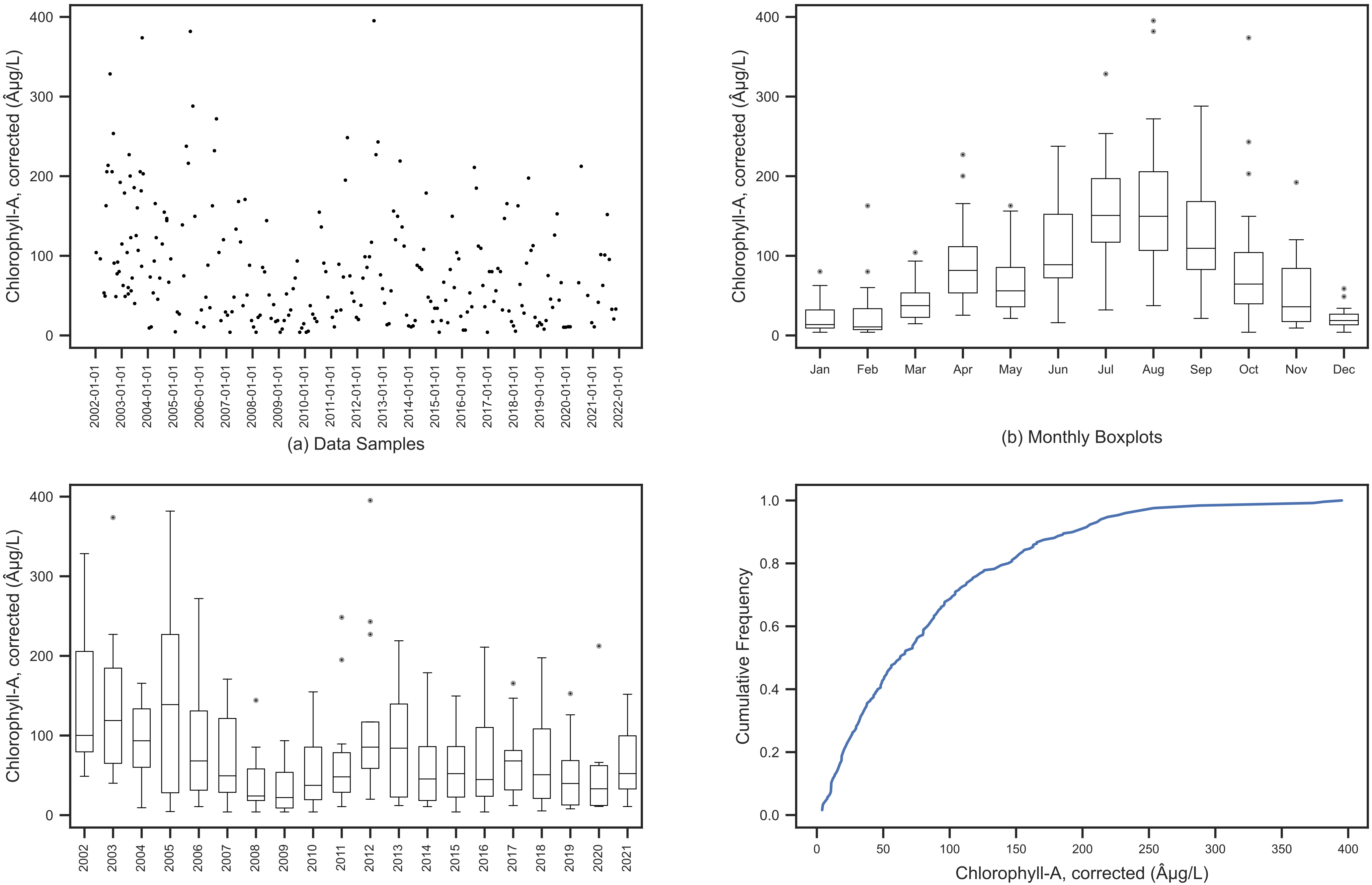


(c) Annual Boxplots



(d) Empirical CDF

Fox River at Yorkville (FR13) : Chlorophyll-A, corrected (Âµg/L)



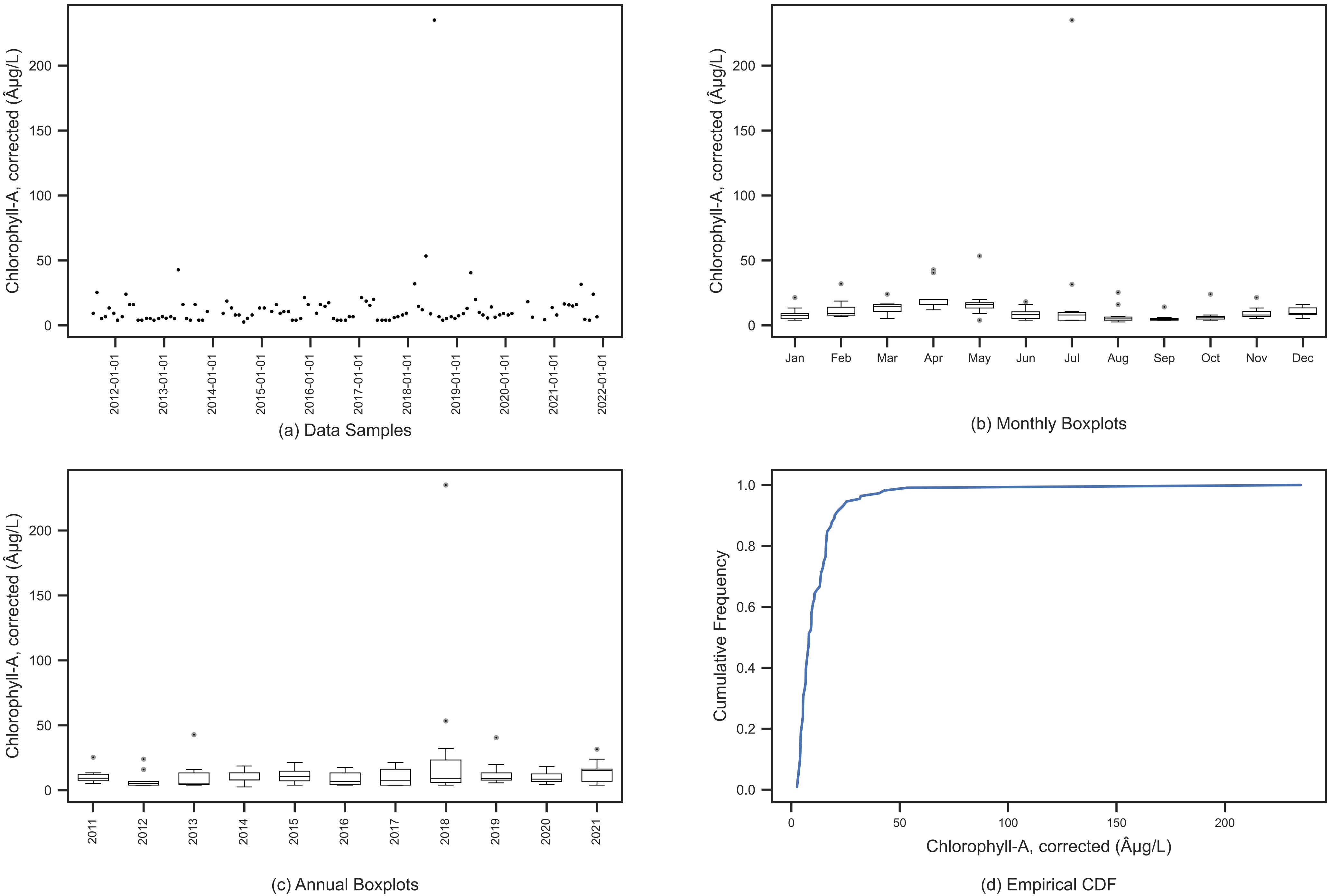
(a) Data Samples

(b) Monthly Boxplots

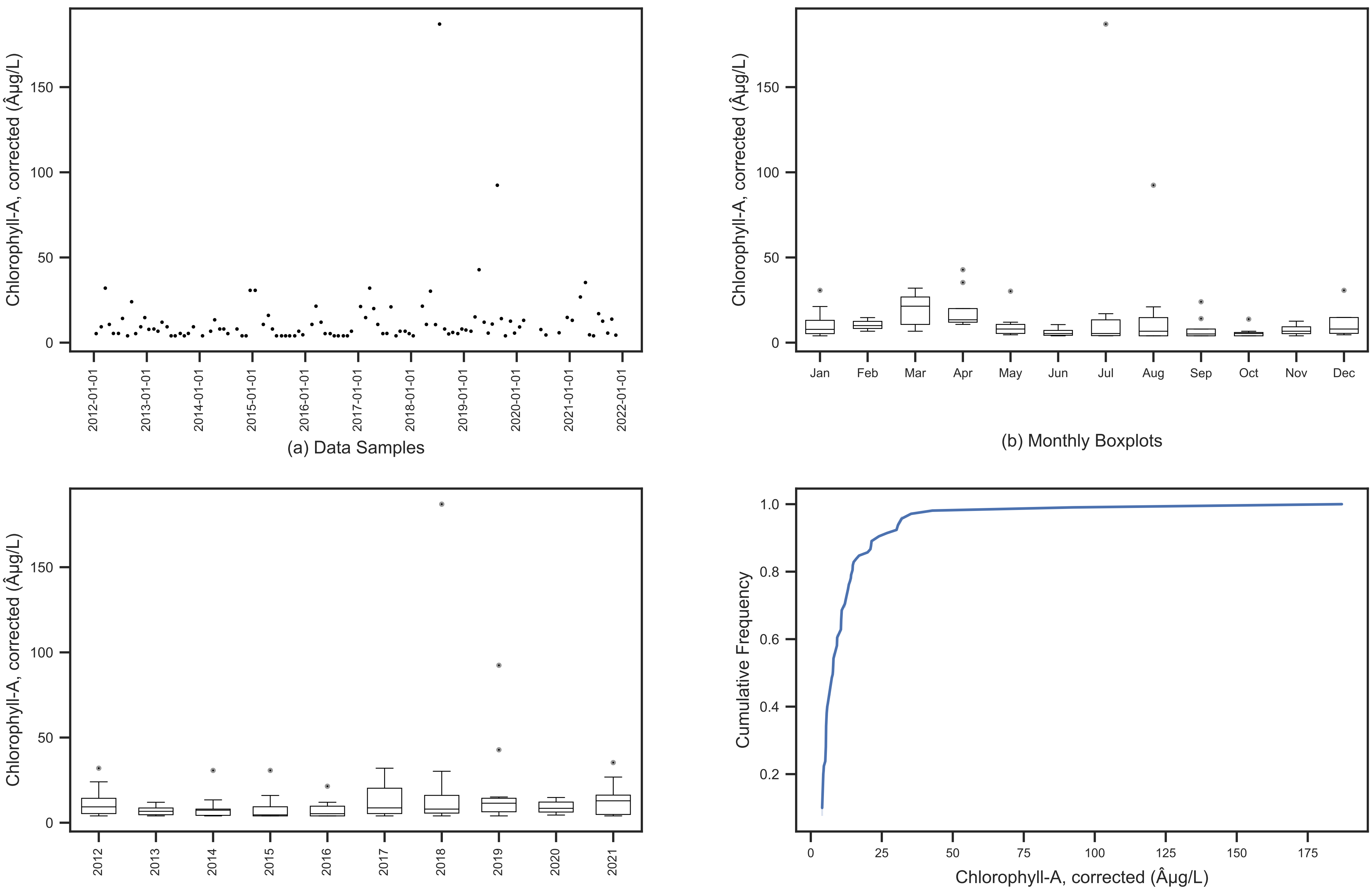
(c) Annual Boxplots

(d) Empirical CDF

Blackberry Creek near Yorkville Side Rd. (BC2) : Chlorophyll-A, corrected (Âµg/L)



Little Indian Creek at dns Unversity Rd. Br. (LC1) : Chlorophyll-A, corrected (Âµg/L)



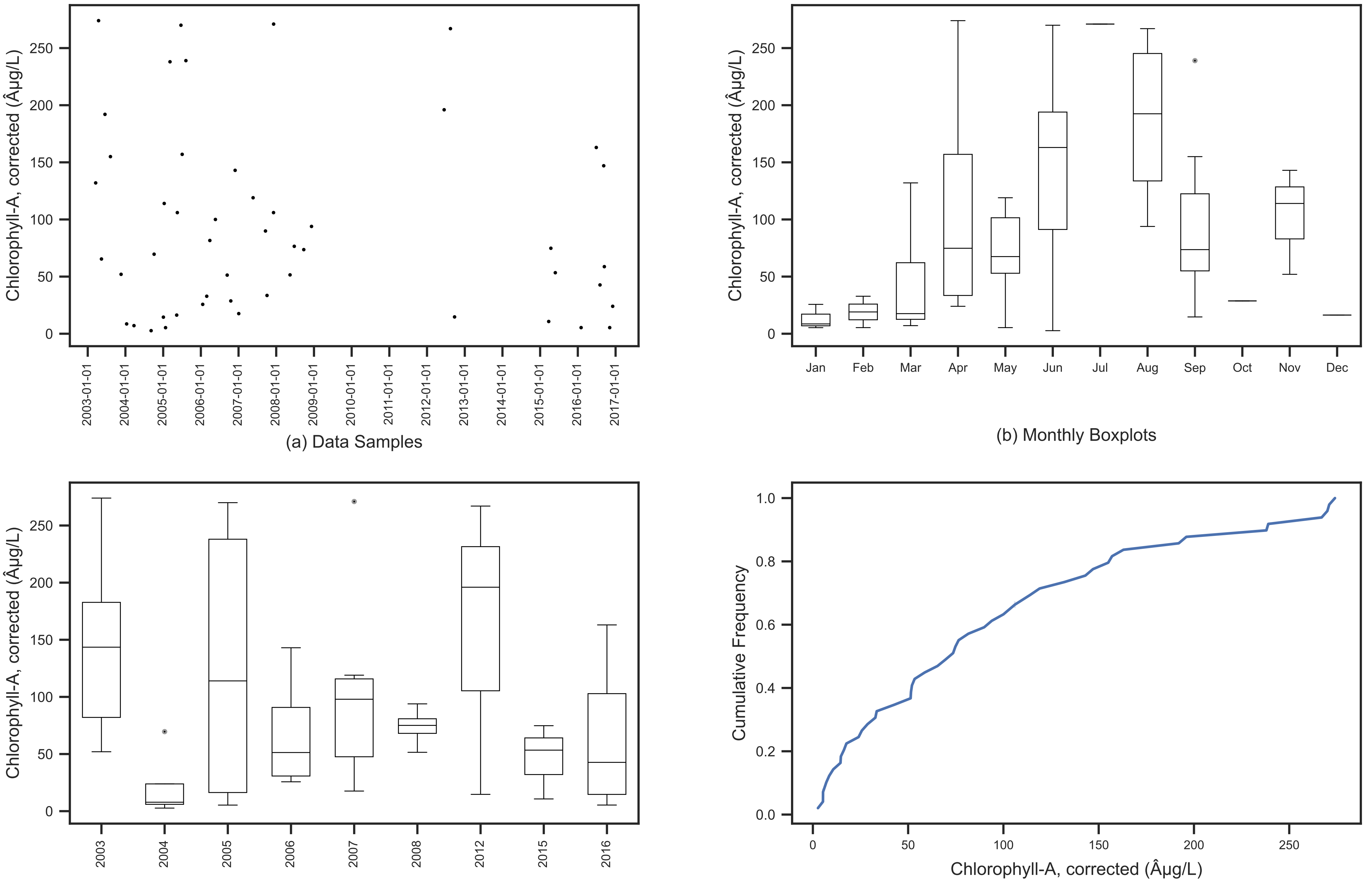
(a) Data Samples

(b) Monthly Boxplots

(c) Annual Boxplots

(d) Empirical CDF

Fox River at Rt. 71 (FR14) : Chlorophyll-A, corrected (Âµg/L)



(a) Data Samples

(b) Monthly Boxplots

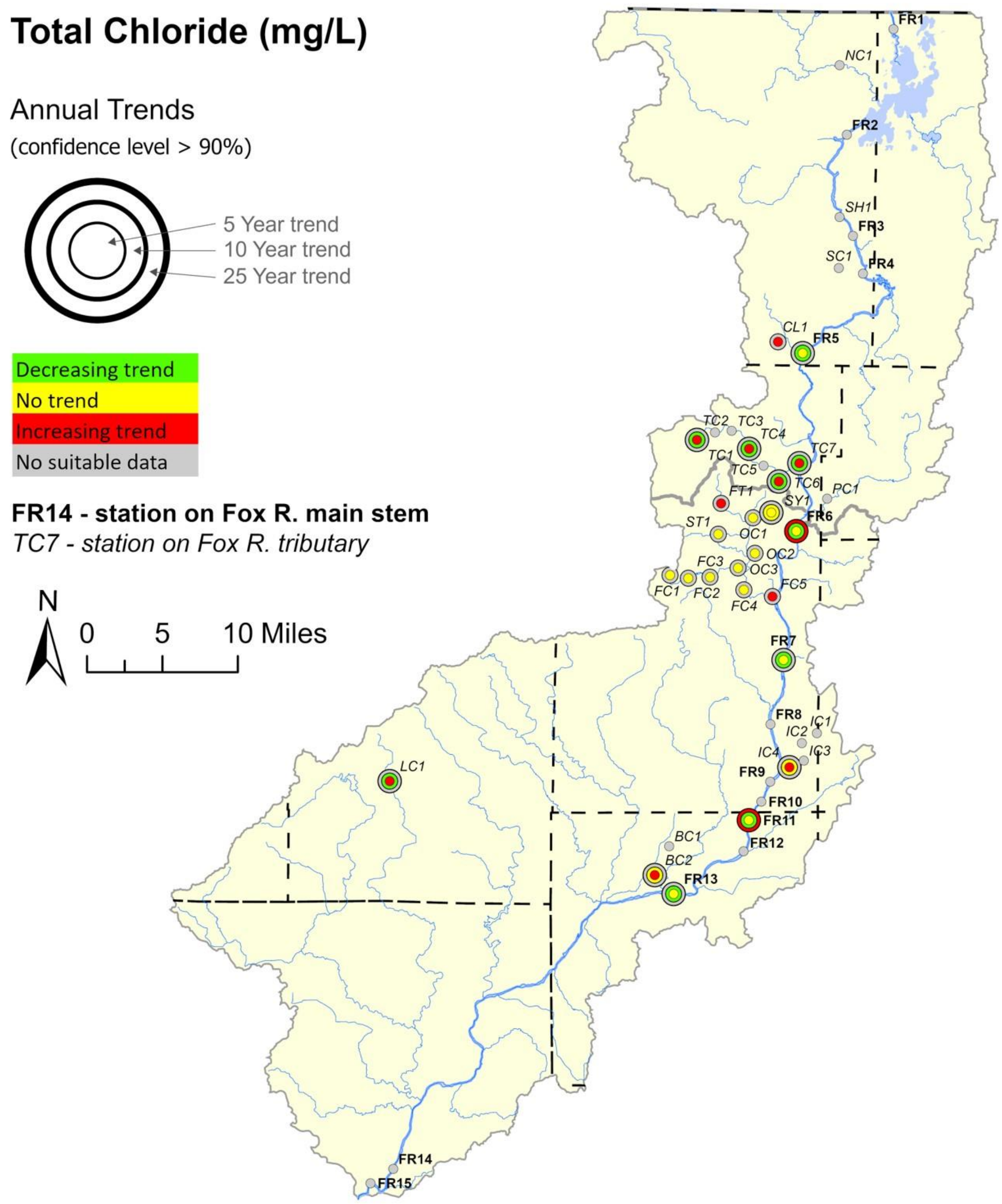
(c) Annual Boxplots

(d) Empirical CDF

Appendix B: Annual and Seasonal Trend Maps and Slopes for Water Quality Constituents

Table B.1. Trend maps and slopes for water quality consituents

Parameter Code in FoxDB	Trend maps and slopes
940	Chloride: Annual trends and slopes Chloride: Winter trends and slopes Chloride: Spring trends and slopes Chloride: Summer trends and slopes Chloride: Fall trends and slopes
10	Water temperature: Annual trends and slopes Water temperature: Winter trends and slopes Water temperature: Spring trends and slopes Water temperature: Summer trends and slopes Water temperature: Fall trends and slopes
406	pH: Annual trends and slopes pH: Winter trends and slopes pH: Spring trends and slopes pH: Summer trends and slopes pH: Fall trends and slopes
94	Specific Conductance @ 25^{0}C: Annual trends and slopes Specific Conductance @ 25^{0}C: Winter trends and slopes Specific Conductance @ 25^{0}C: Spring trends and slopes Specific Conductance @ 25^{0}C: Summer trends and slopes Specific Conductance @ 25^{0}C: Fall trends and slopes
82079	Turbidity: Annual trends and slopes Turbidity: Winter trends and slopes Turbidity: Spring trends and slopes Turbidity: Summer trends and slopes Turbidity: Fall trends and slopes
32209	Chlorophyll-A, corrected: Annual trends and slopes Chlorophyll-A, corrected Winter trends and slopes Chlorophyll-A, corrected Spring trends and slopes Chlorophyll-A, corrected Summer trends and slopes Chlorophyll-A, corrected Fall trends and slopes

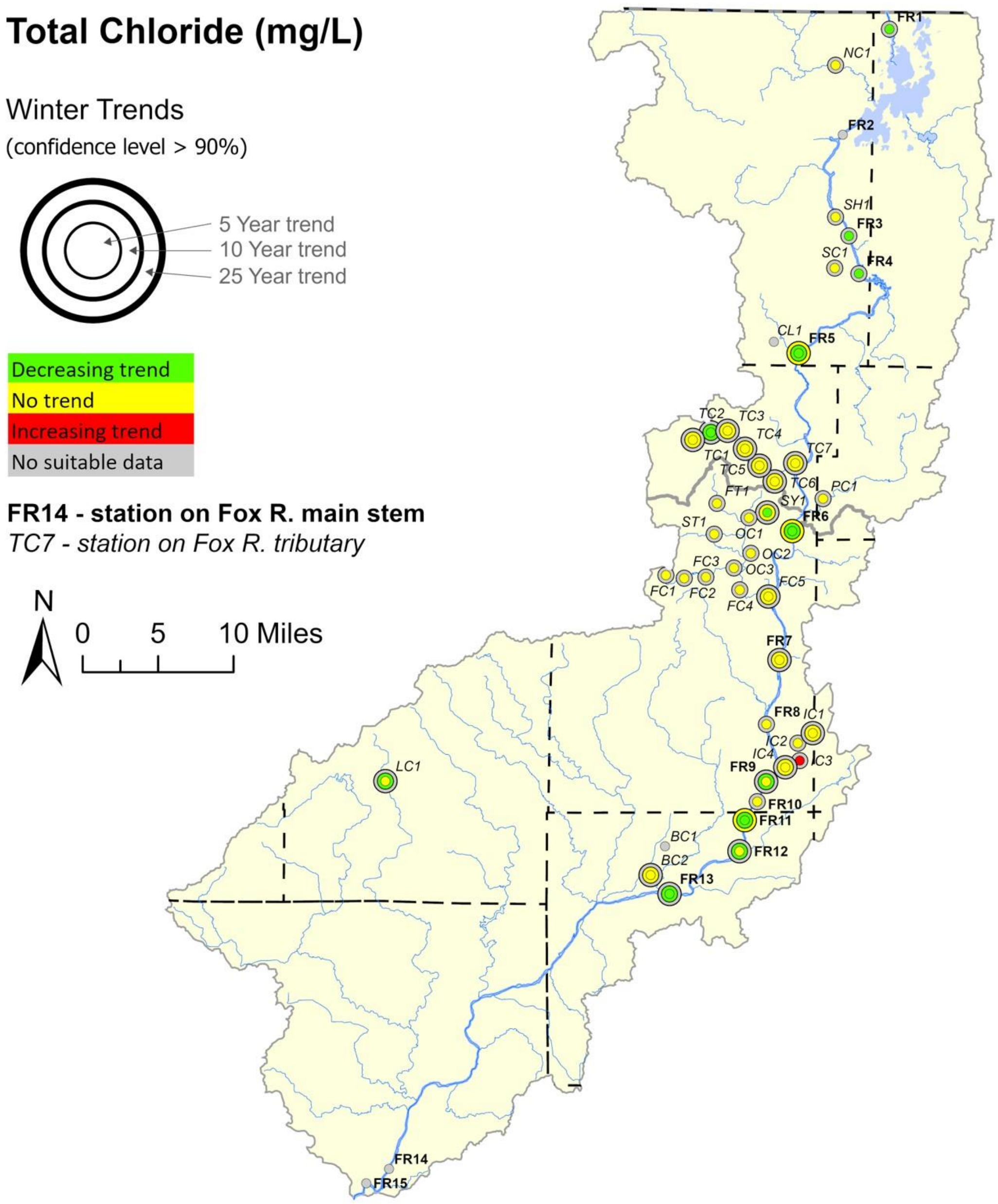


Annual trend slopes for chloride (mg/L per year)

Trend year	CL1	FR5	TC1	TC4	TC6	TC7	FR6	FT1	FC5	FR7	IC4	FR11
5	42.88	-	11.55	8.67	9.39	11.70	-	4.30	8.83	-	66.42	-
10	-	-4.92	-3.30	-7.98	-7.48	-5.58	-5.00	-	-	-3.50	-	-5.50
25	-	-	-	-	-	-	1.49	-	-	-	-	1.20

Monitoring sites (contd.)

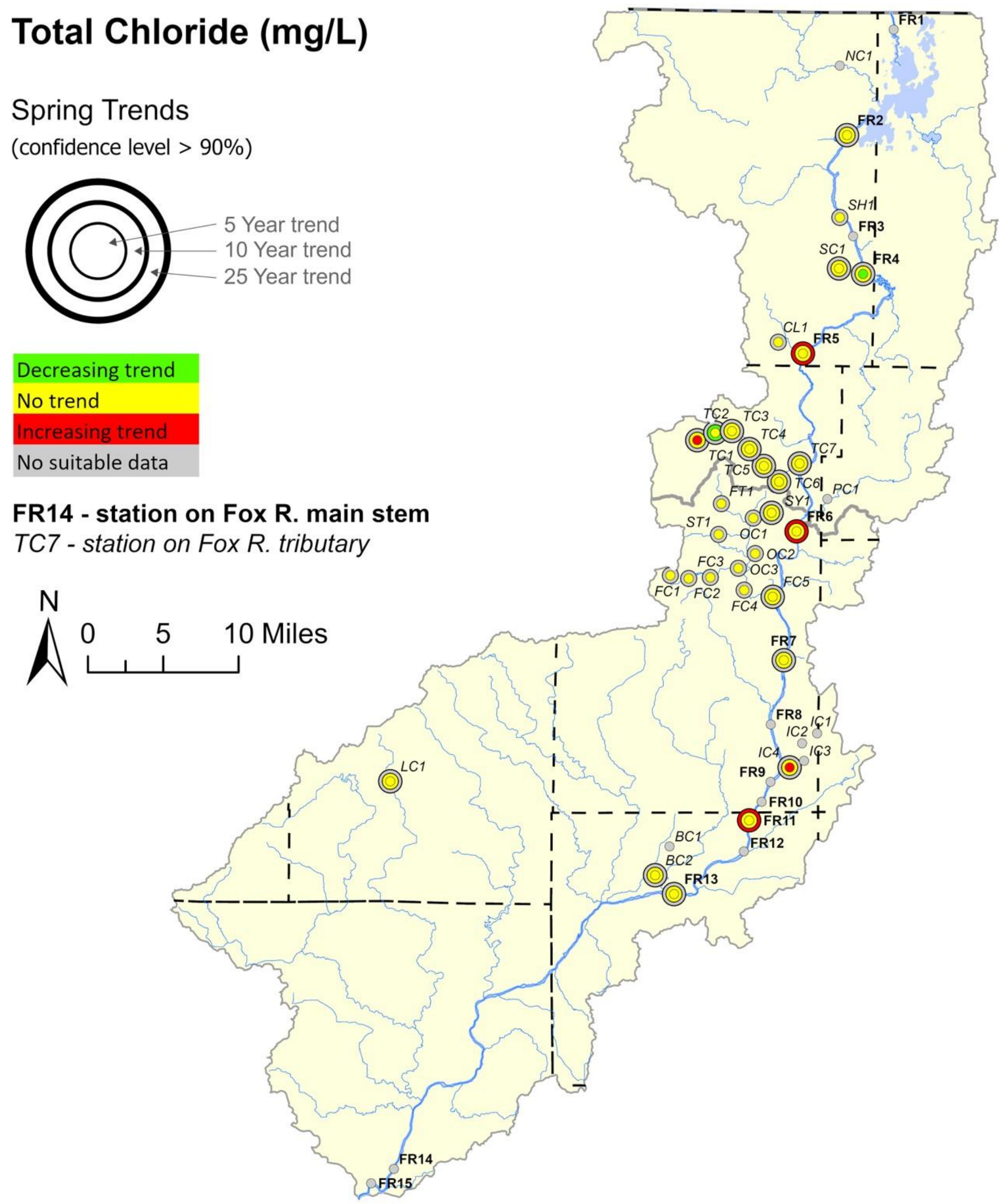
Trend year	FR13	BC2	LC1
5	-	5.32	21.30
10	-4.93	-	-6.80
25	-	-	-



Winter trend slopes for chloride (mg/L per year)

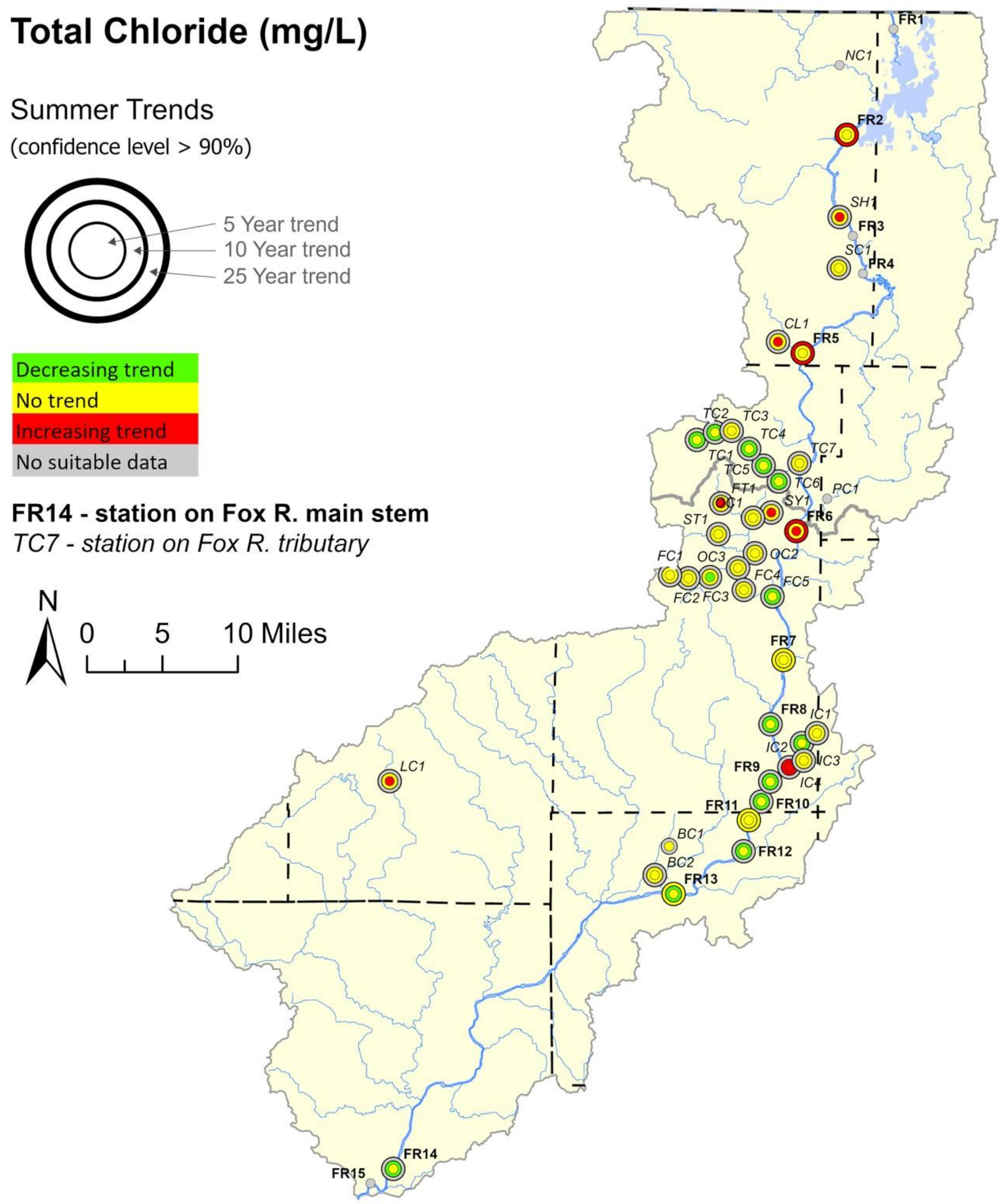
Trend year	Monitoring sites											
	FR1	FR3	FR4	FR5	TC2	FR6	SY1	IC3	FR9	FR11	FR12	FR13
5	-15.06	-12.79	-4.67	-7.35	-7.65	-13.88	-8.97	50.50	-	-11.83	-	-13.67
10	-	-	-	-8.82	-5.21	-5.68	-	-	-5.00	-7.40	-6.50	-6.44
25	-	-	-	-	-	-	-	-	-	-	-	-

Trend year	Monitoring sites (contd.)
	LC1
5	-
10	-16.45
25	-



Spring trend slopes for chloride (mg/L per year)

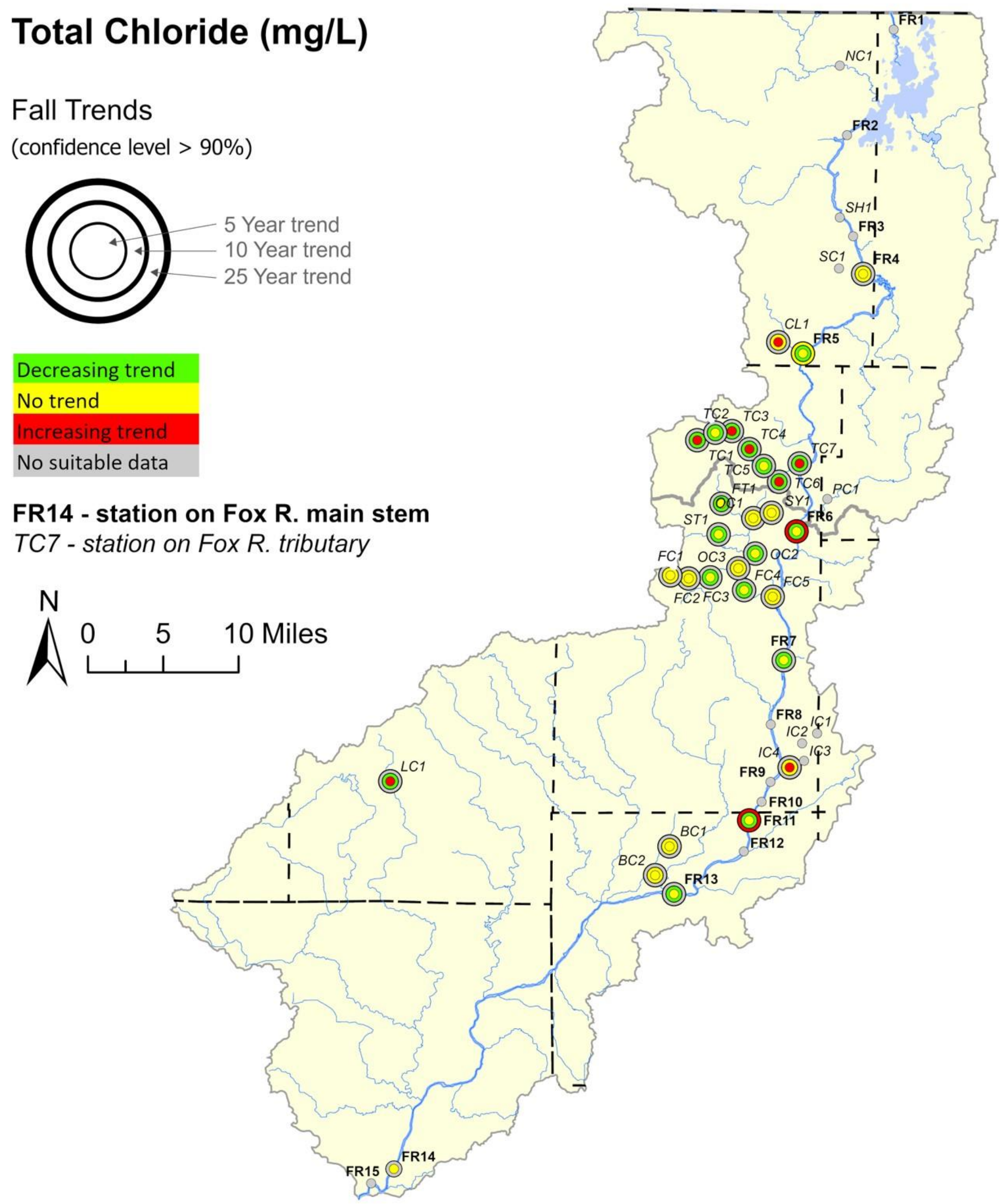
Trend year	Monitoring sites FR4	FR5	TC1	TC2	FR6	IC4	FR11
5	-8.30	-	8.92	-	-	81.63	-
10	-	-	-	-3.61	-	-	-
25	-	1.00	-	-	1.42	-	1.77



Summer trend slopes for chloride (mg/L per year)

Trend year	FR2	SH1	CL1	FR5	TC1	TC2	TC4	TC5	TC6	FR6	SY1	FT1
	Monitoring sites											
5	-	22.30	53.00	-	-	-	-	-	-	12.42	6.65	7.58
10	-	-	-	-	-7.87	-4.45	-8.94	-8.77	-11.33	-	-	-
25	0.93	-	-	2.08	-	-	-	-	-	1.78	-	-

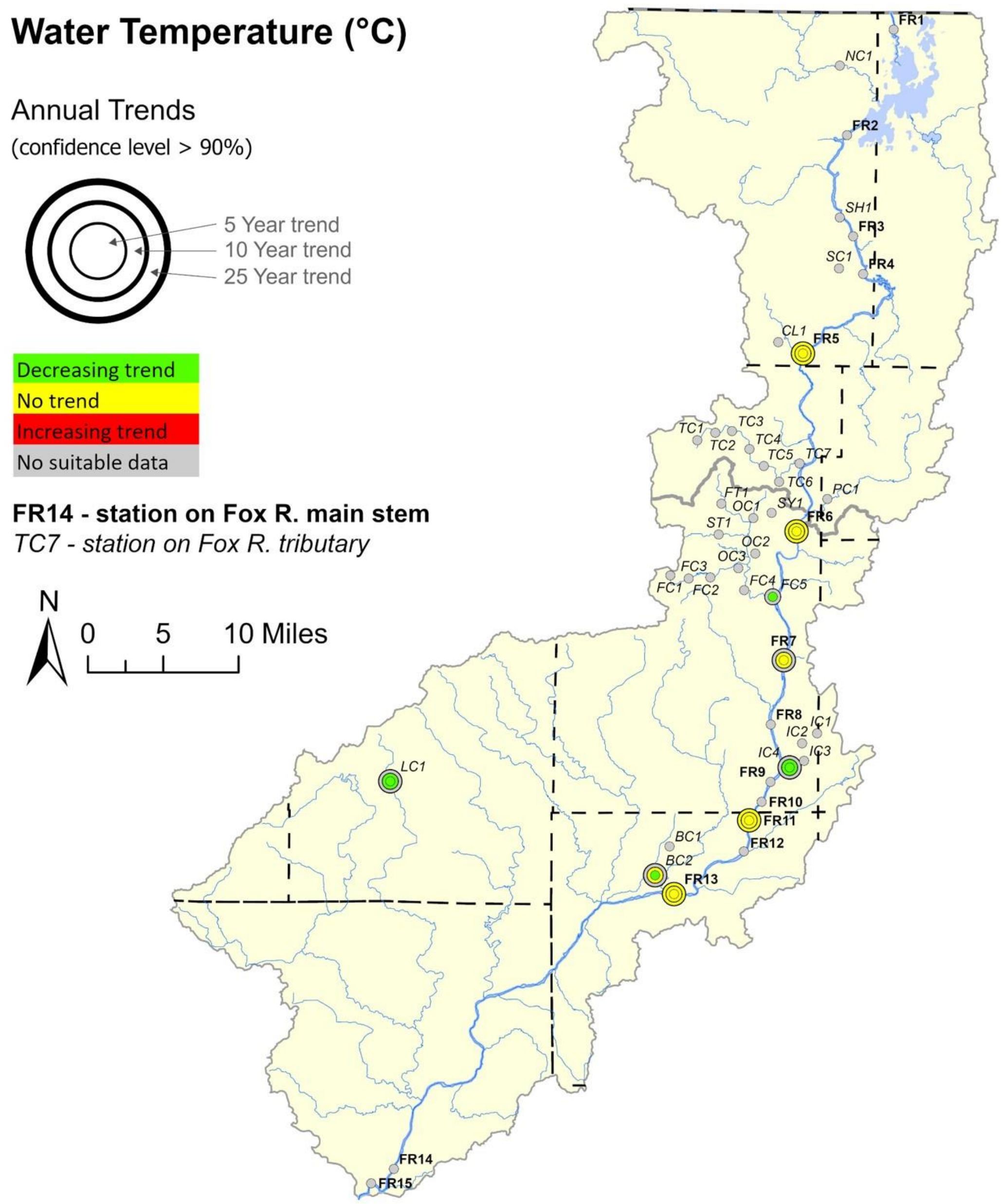
Trend year	FC3	FC5	FR8	IC2	IC4	FR9	FR10	FR12	FR13	LC1	FR14
	Monitoring sites (contd.)										
5	-2.97	-	-	-	51.25	-	-	-	-	22.67	-
10	-	-5.00	-7.00	-11.42	12.76	-7.31	-8.85	-10.25	-4.00	-	-7.96
25	-	-	-	-	-	-	-	-	-	-	-



Fall trend slopes for chloride (mg/L per year)

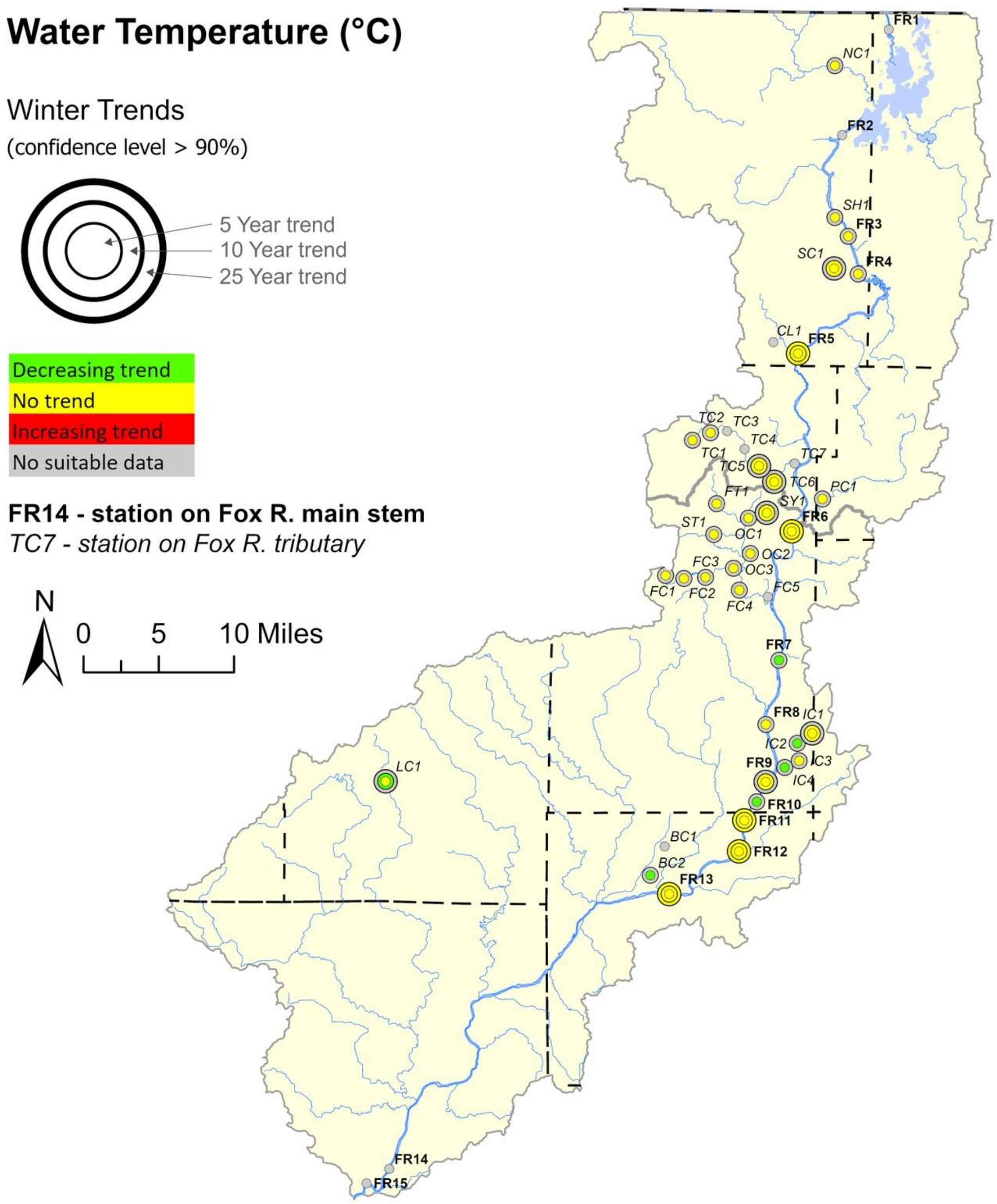
Trend year	Monitoring sites											
	CL1	FR5	TC1	TC2	TC3	TC4	TC5	TC6	TC7	FR6	FT1	ST1
5	60.33	-	24.04	-	16.63	22.03	-	12.69	36.89	-	-	-
10	-	-10.72	-5.21	-7.85	-10.21	-23.04	-17.28	-12.62	-8.84	-7.31	-5.52	-2.56
25	-	-	-	-	-	-	-	-	-	1.84	-	-

Trend year	Monitoring sites (contd.)							
	OC2	FC3	FC4	FR7	IC4	FR11	FR13	LC1
5	-	-	-	-	73.00	-	-	29.20
10	-12.12	-4.21	-6.33	-9.67	-	-7.58	-9.57	-10.33
25	-	-	-	-	-	1.43	-	-



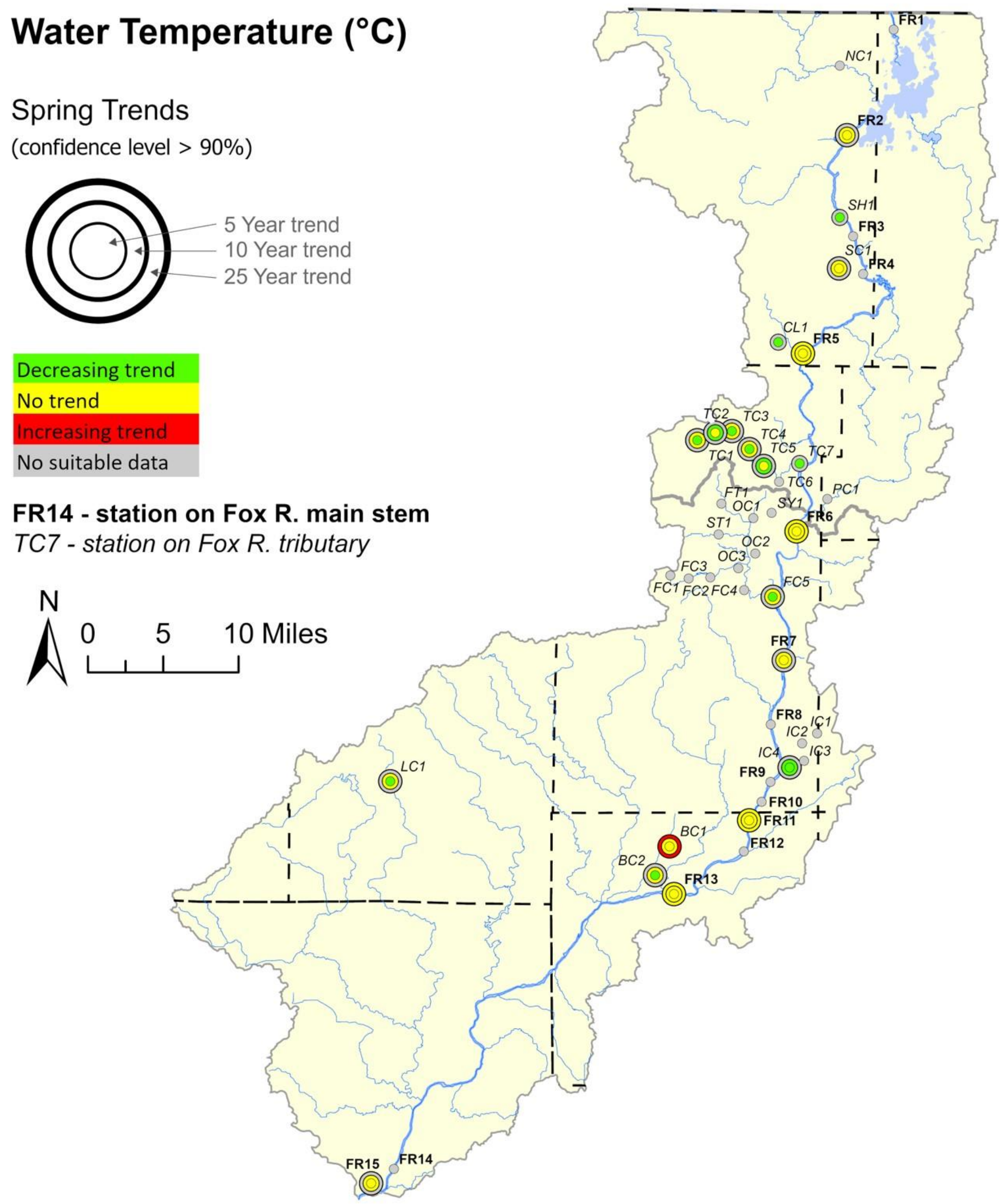
Annual trend slopes for water temperature (°C per year)

Trend year	FC5	IC4	BC2	LC1
	Monitoring sites			
5	-0.37	-0.33	-0.42	-0.25
10	-	-0.13	-	-0.18
25	-	-	-	-



Winter trend slopes for water temperature (ºC per year)

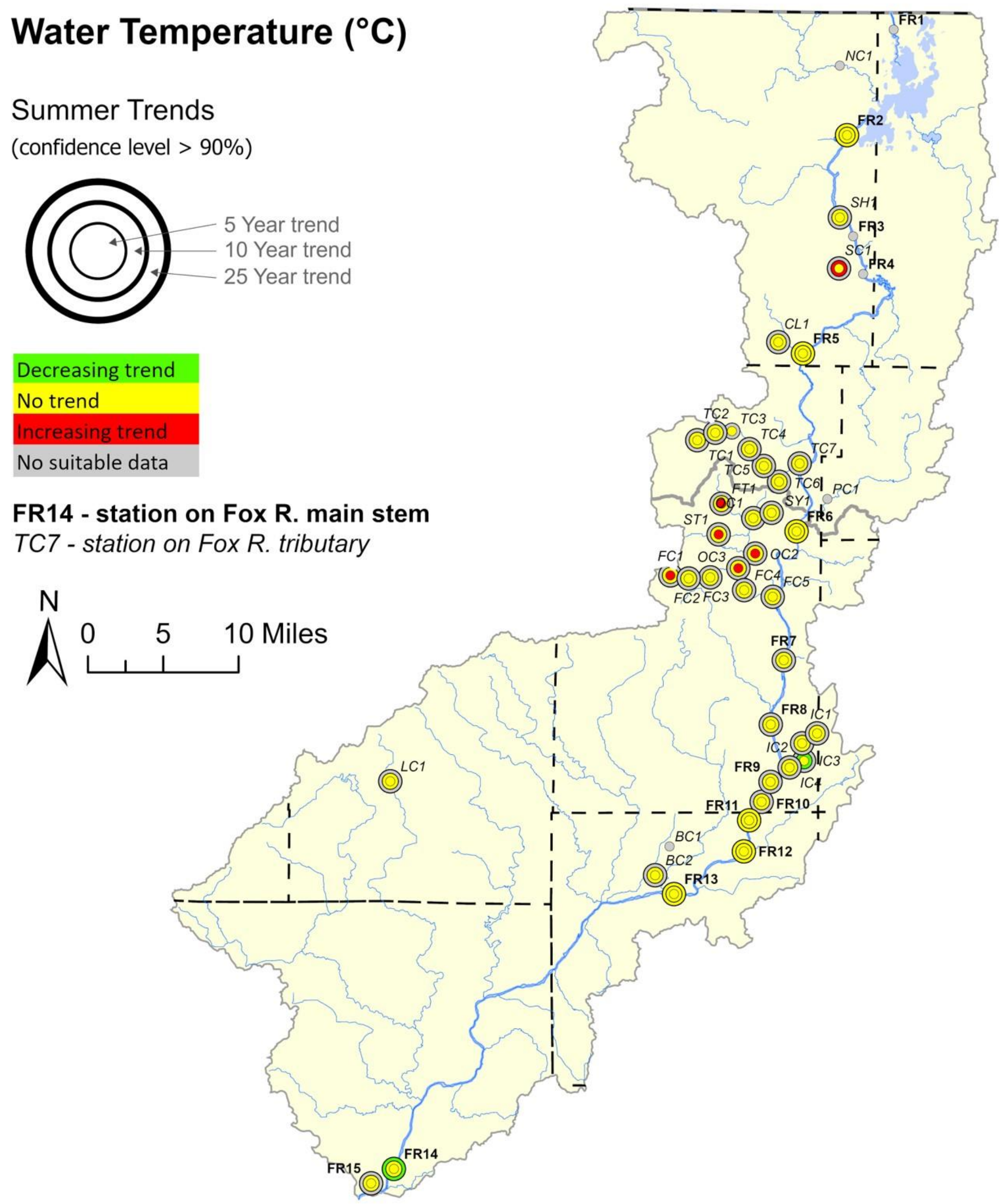
Trend year	Monitoring sites					
	FR7	IC2	IC4	FR10	BC2	LC1
5	-0.95	-0.38	-0.54	-0.52	-0.65	-
10	-0.40	-	-0.37	-	-0.19	-0.20
25	-	-	-	-	-	-



Spring trend slopes for water temperature (ºC per year)

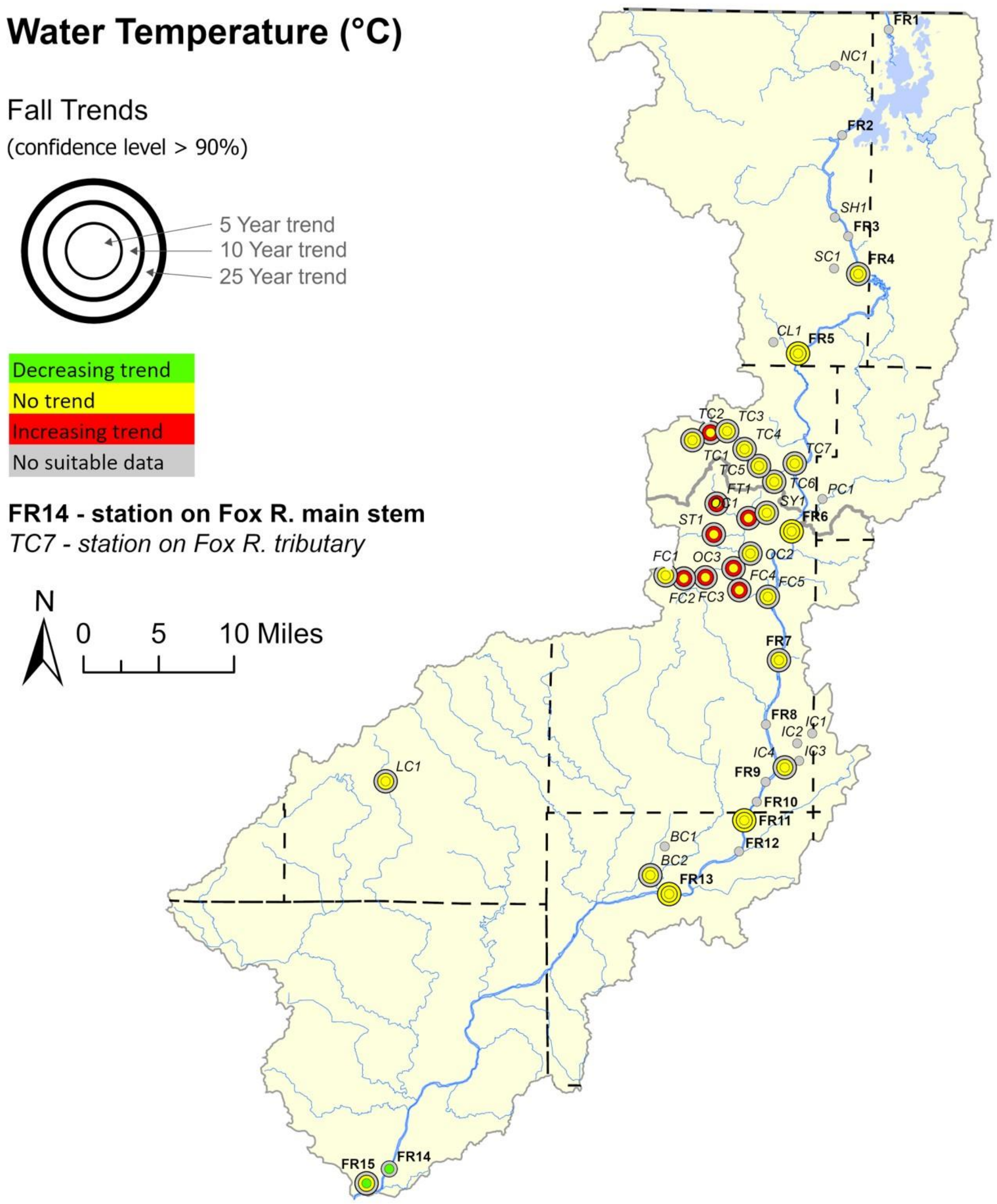
Trend year	SH1	CL1	TC1	TC2	TC3	TC4	TC5	TC7	FC5	IC4	BC1	BC2
5	-0.66	-0.78	-0.77	-	-0.60	-0.75	-	-1.02	-0.74	-0.91	-	-0.61
10	-	-	-	-0.50	-	-	-0.80	-	-	-0.37	-	-
25	-	-	-	-	-	-	-	-	-	-	0.12	-

Trend year	LC1
5	-0.59
10	-
25	-



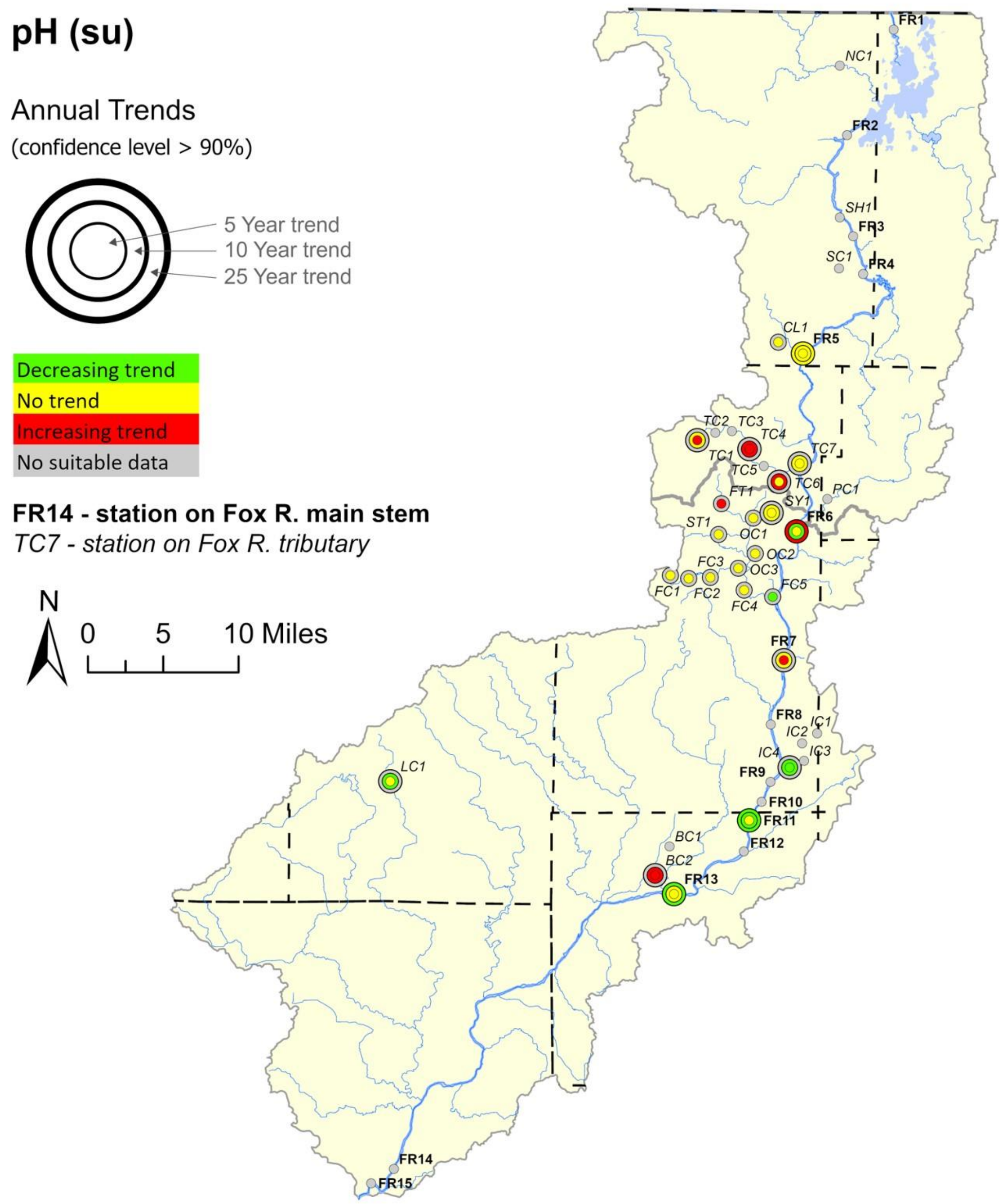
Summer trend slopes for water temperature (°C per year)

Trend year	Monitoring sites							
	SC1	FT1	ST1	OC2	OC3	FC1	IC3	FR14
5	-	0.94	0.73	1.02	1.24	1.54	-	-
10	0.90	-	-	-	-	-	-0.39	-
25	-	-	-	-	-	-	-	-0.07



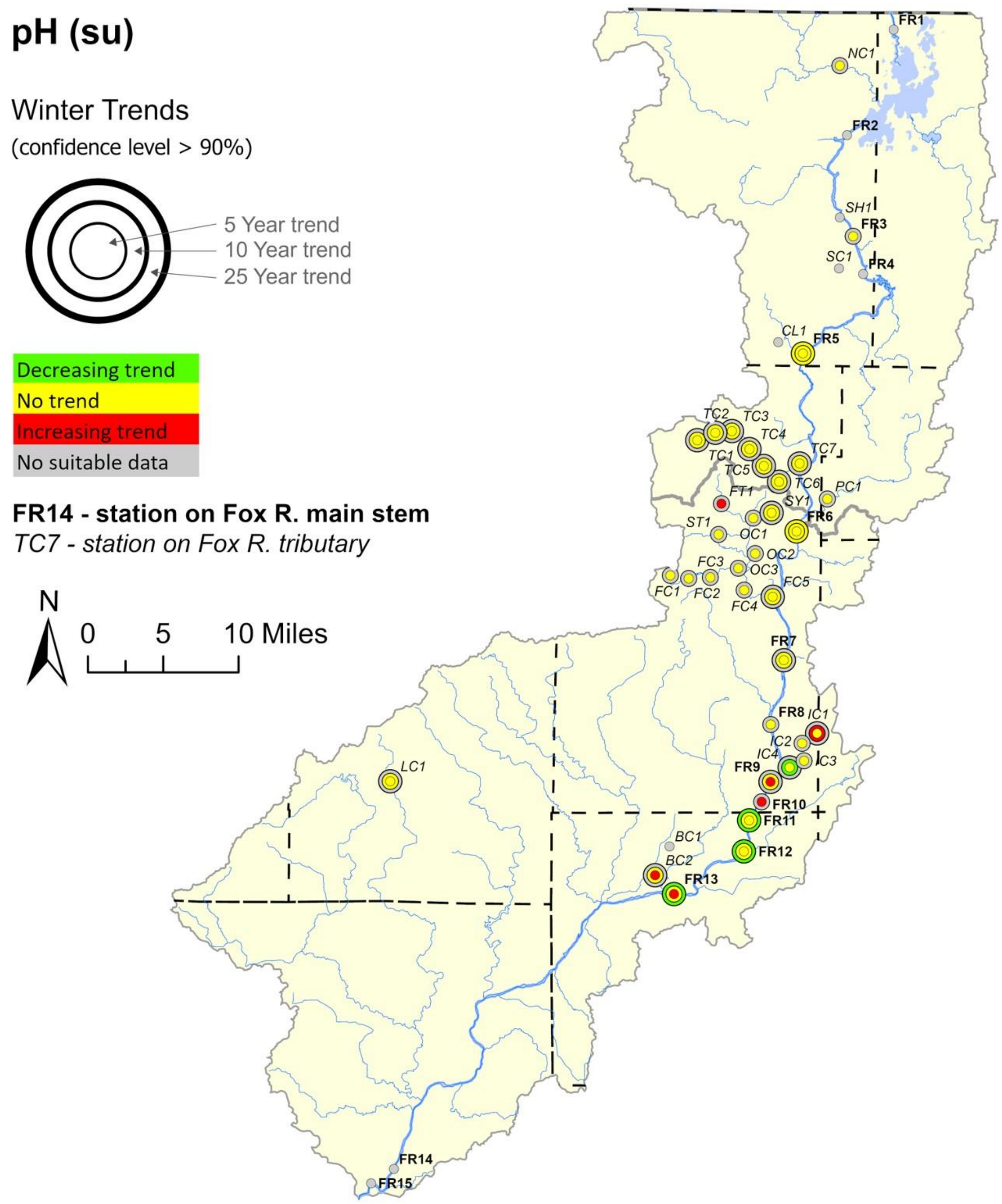
Fall trend slopes for water temperature (ºC per year)

Trend year	TC2	OC1	FT1	ST1	OC3	FC2	FC3	FC4	FR14	FR15
	Monitoring sites									
5	-	-	-	-	-	-	-	-	-1.25	-1.25
10	0.25	0.46	0.50	0.79	0.64	0.75	0.47	0.57	-	-
25	-	-	-	-	-	-	-	-	-	-



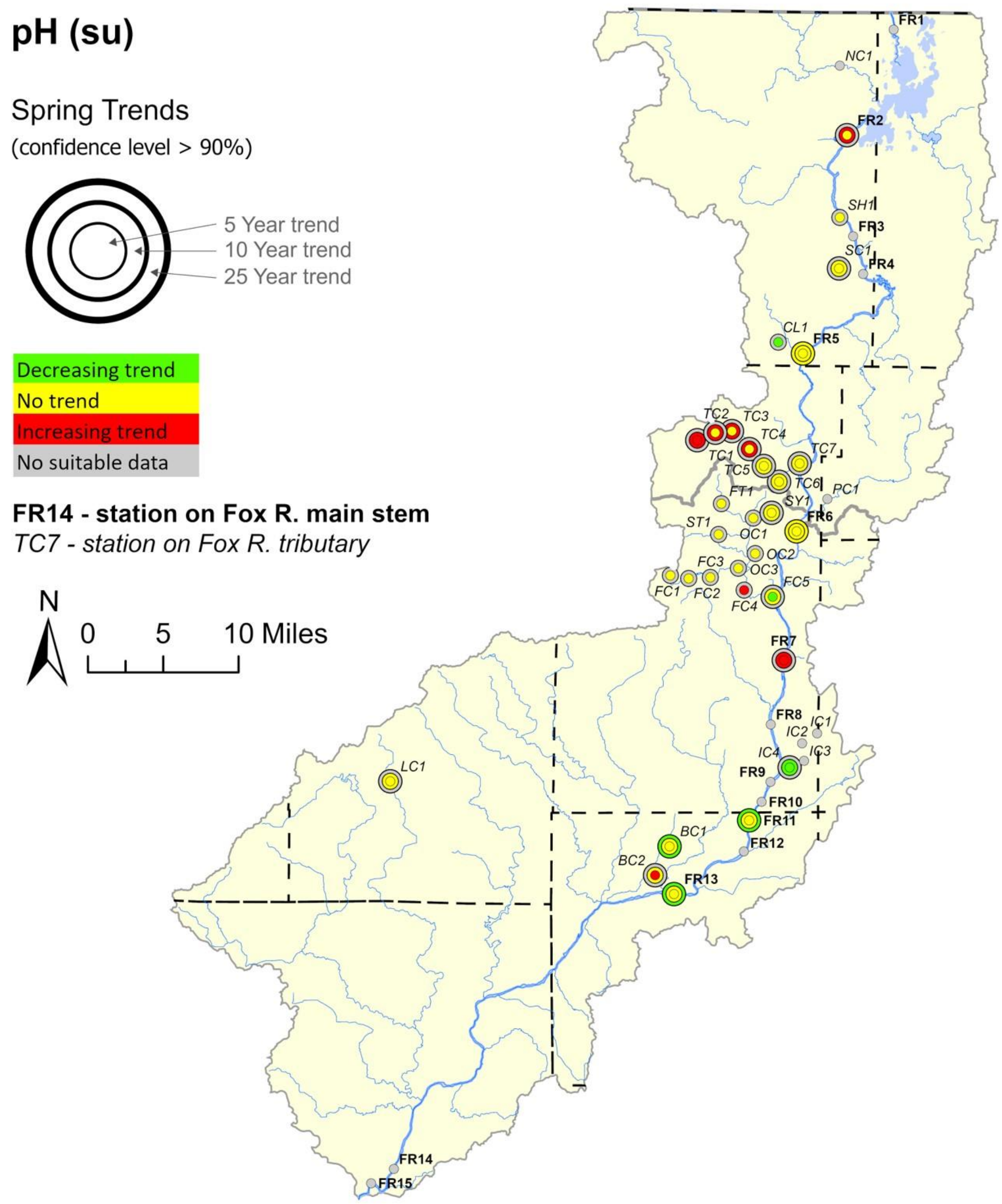
Annual trend slopes for pH (su per year)

Trend year	Monitoring sites											
	TC1	TC4	TC6	FR6	FT1	FC5	FR7	IC4	FR11	FR13	BC2	LC1
5	0.05	0.04	-	-	0.02	-0.12	0.09	-0.09	-	-	0.09	-
10	-	0.02	0.01	-0.02	-	-	-	-0.03	-0.04	-	0.04	-0.01
25	-	-	-	0.00	-	-	-	-	-0.02	-0.02	-	-



Winter trend slopes for pH (su per year)

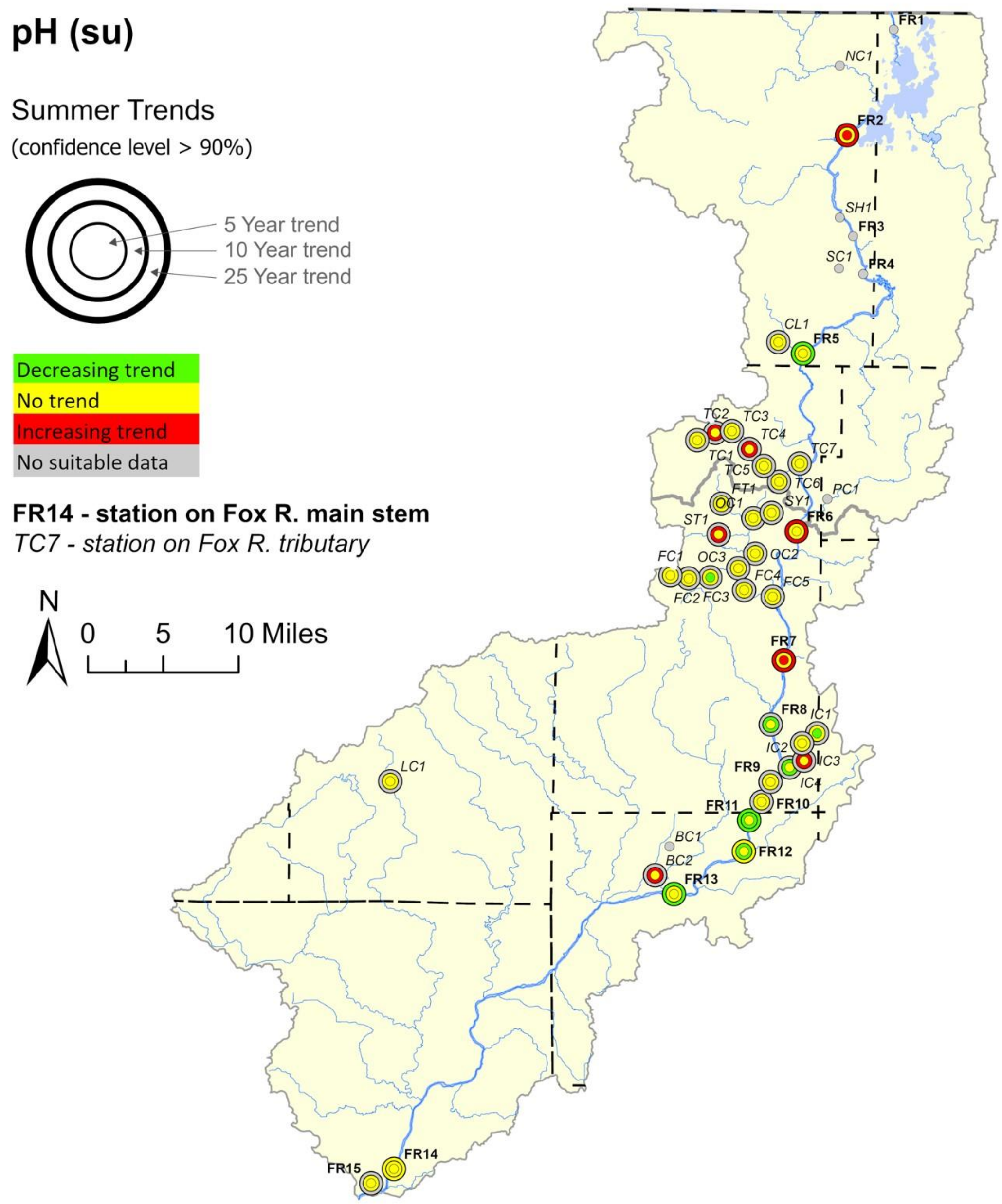
Trend year	Monitoring sites								
	FT1	IC1	IC4	FR9	FR10	FR11	FR12	FR13	BC2
5	0.02	-	-	0.10	0.10	-	-	0.23	0.25
10	-	0.05	-0.04	-	-	-	-	-	-
25	-	-	-	-	-	-0.01	-0.01	-0.01	-



Spring trend slopes for pH (su per year)

Trend year	FR2	CL1	TC1	TC2	TC3	TC4	FC4	FC5	FR7	IC4	FR11	FR13
	Monitoring sites											
5	-	-0.23	0.05	-	-	-	0.02	-0.17	0.08	-0.17	-	-
10	0.10	-	0.03	0.03	0.02	0.02	-	-	0.07	-0.06	-	-
25	-	-	-	-	-	-	-	-	-	-	-0.02	-0.02

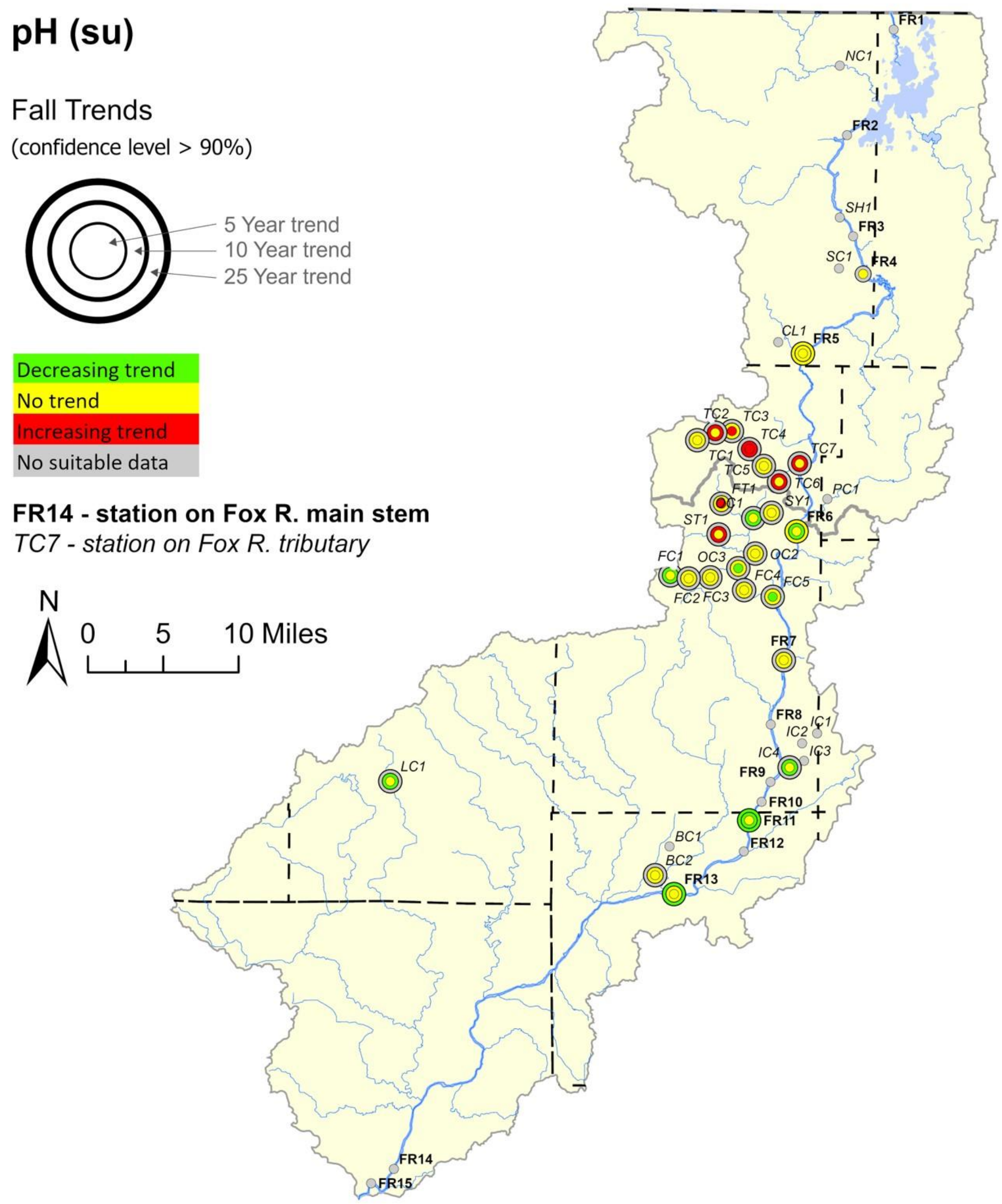
Trend year	BC1	BC2
	Monitoring sites (contd.)	
5	-	0.06
10	-	-
25	-0.02	-



Summer trend slopes for pH (su per year)

Trend year	FR2	FR5	TC2	TC4	FR6	ST1	FC3	FR7	FR8	IC1	IC3	IC4
	Monitoring sites											
5	0.25	-	-	-	-	-	-0.04	0.12	-	-0.07	-	-
10	-	-	0.04	0.02	-	0.02	-	-	-0.06	-	0.01	-0.03
25	0.02	-0.01	-	-	0.01	-	-	0.01	-	-	-	-

Trend year	FR11	FR12	FR13	BC2
	Monitoring sites (contd.)			
5	-	-	-	-
10	-0.08	-0.06	-	0.06
25	-0.01	-	-0.02	-

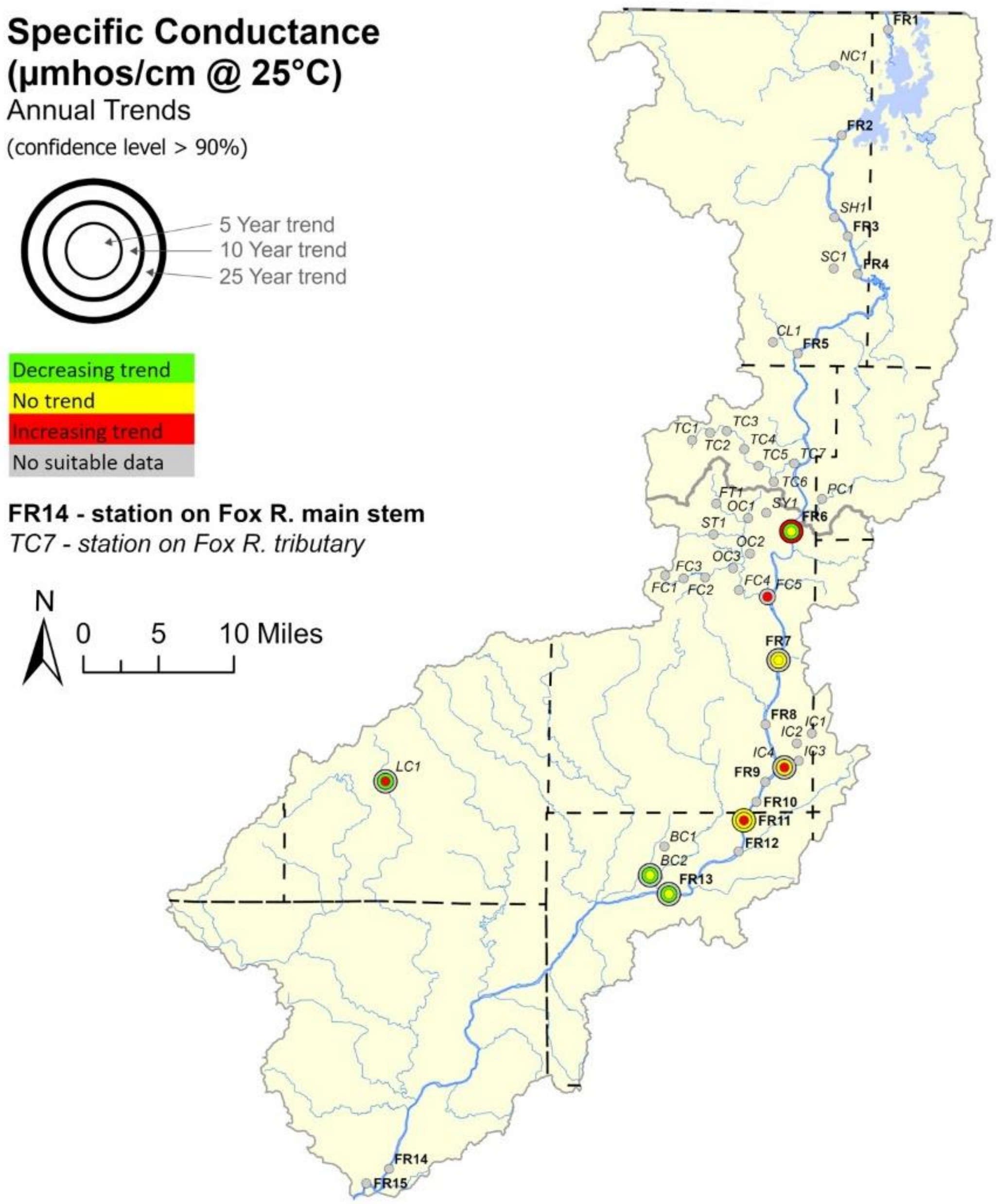


Fall trend slopes for pH (su per year)

Trend year	TC2	TC3	TC4	TC6	TC7	FR6	OC1	FT1	ST1	OC3	FC1	FC5
5	-	0.06	0.06	-	-	-	-	0.03	-	-0.03	-	-0.18
10	0.04	-	0.02	0.03	0.01	-0.06	-0.02	-	0.02	-	-0.01	-
25	-	-	-	-	-	-	-	-	-	-	-	-

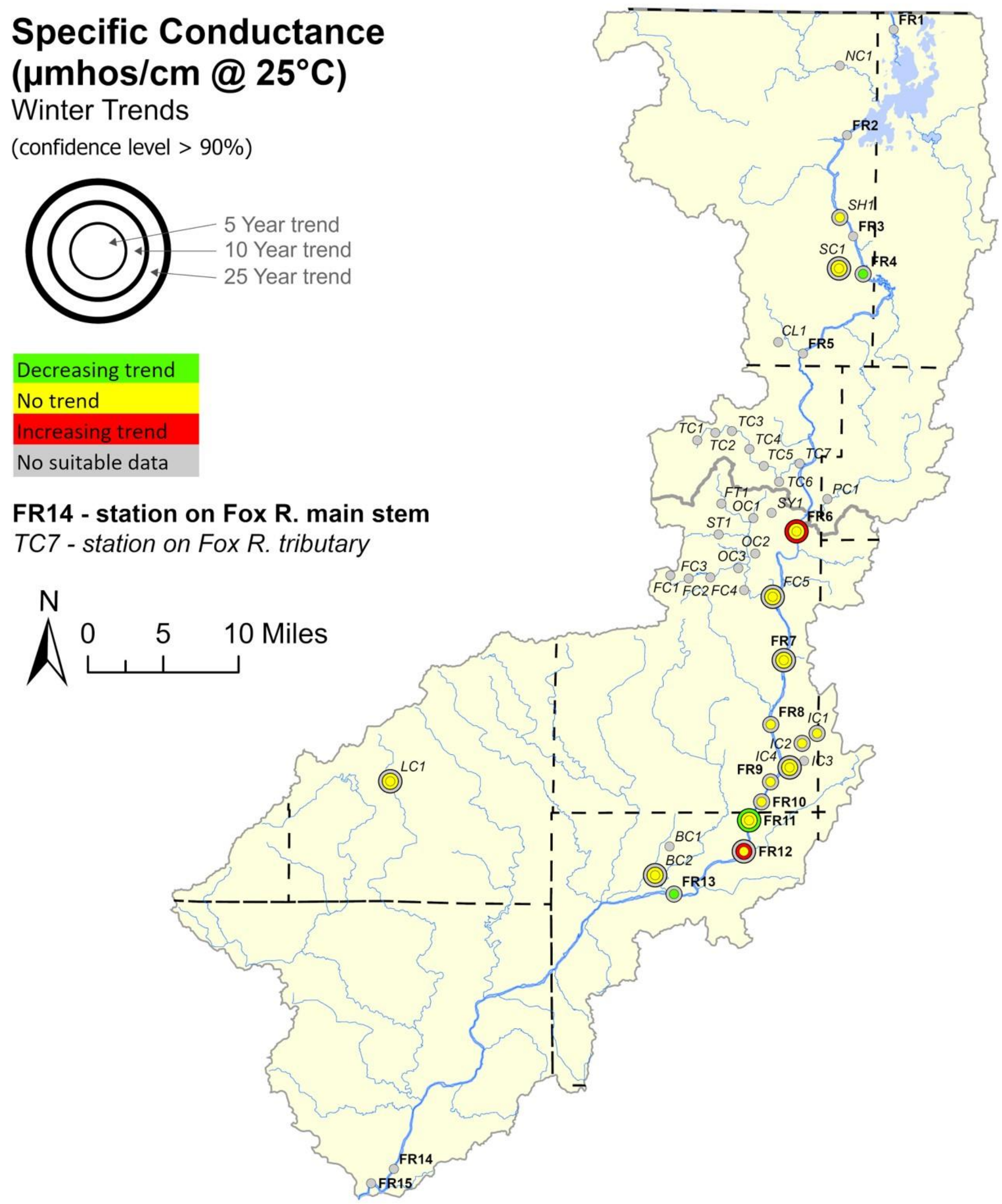
Monitoring sites (contd.)

Trend year	IC4	FR11	FR13	LC1
5	-	-	-	-
10	-0.02	-0.06	-	-0.02
25	-	-0.02	-0.02	-



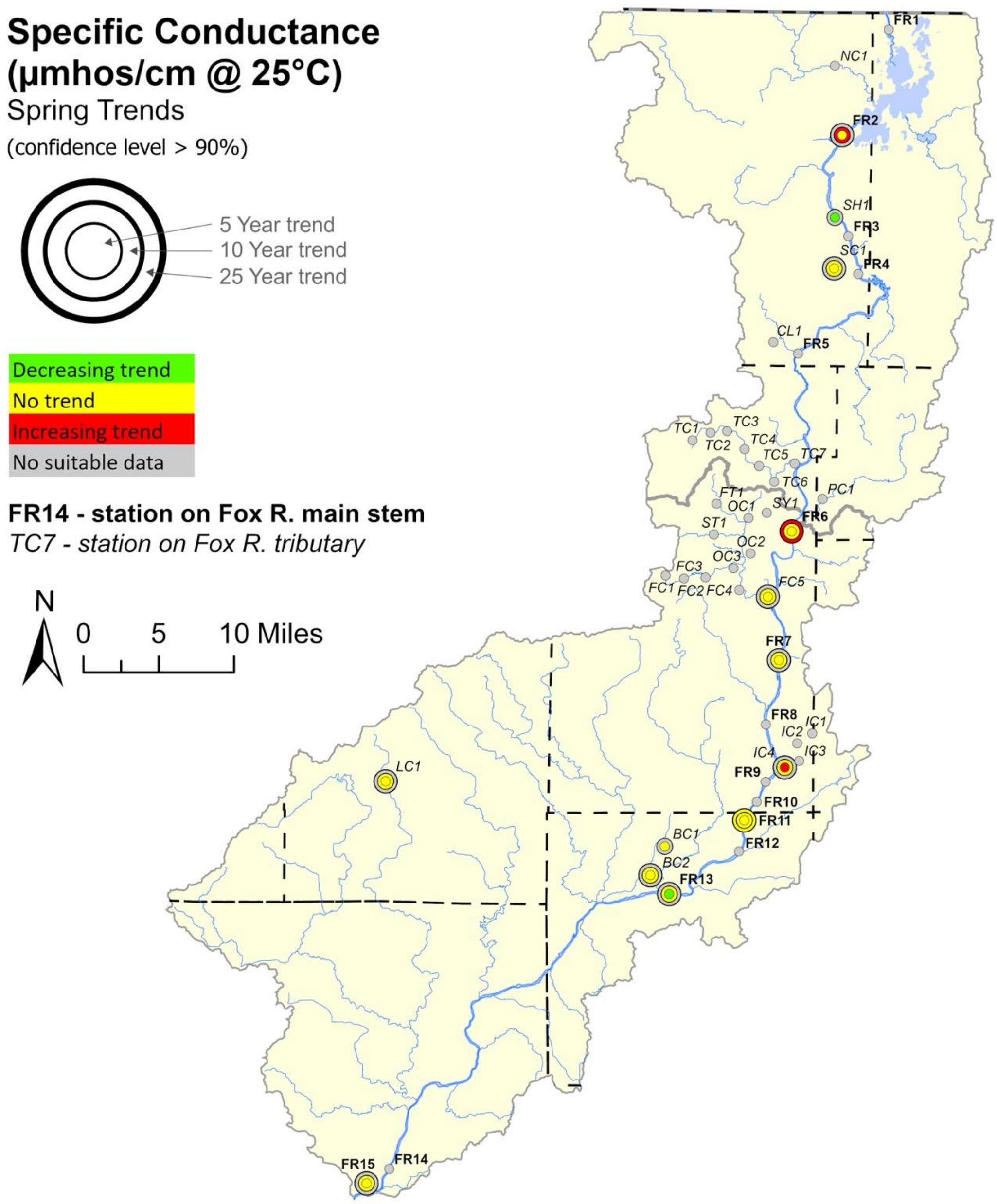
Annual trend slopes for specific conductance (µmhos/cm @ 25ºC per year)

Trend year	Monitoring sites						
	FR6	FC5	IC4	FR11	FR13	BC2	LC1
5	-	53.88	169.25	46.25	-	-	80.00
10	-10.00	-	-	-	-23.42	-13.48	-20.00
25	9.83	-	-	-	-	-	-



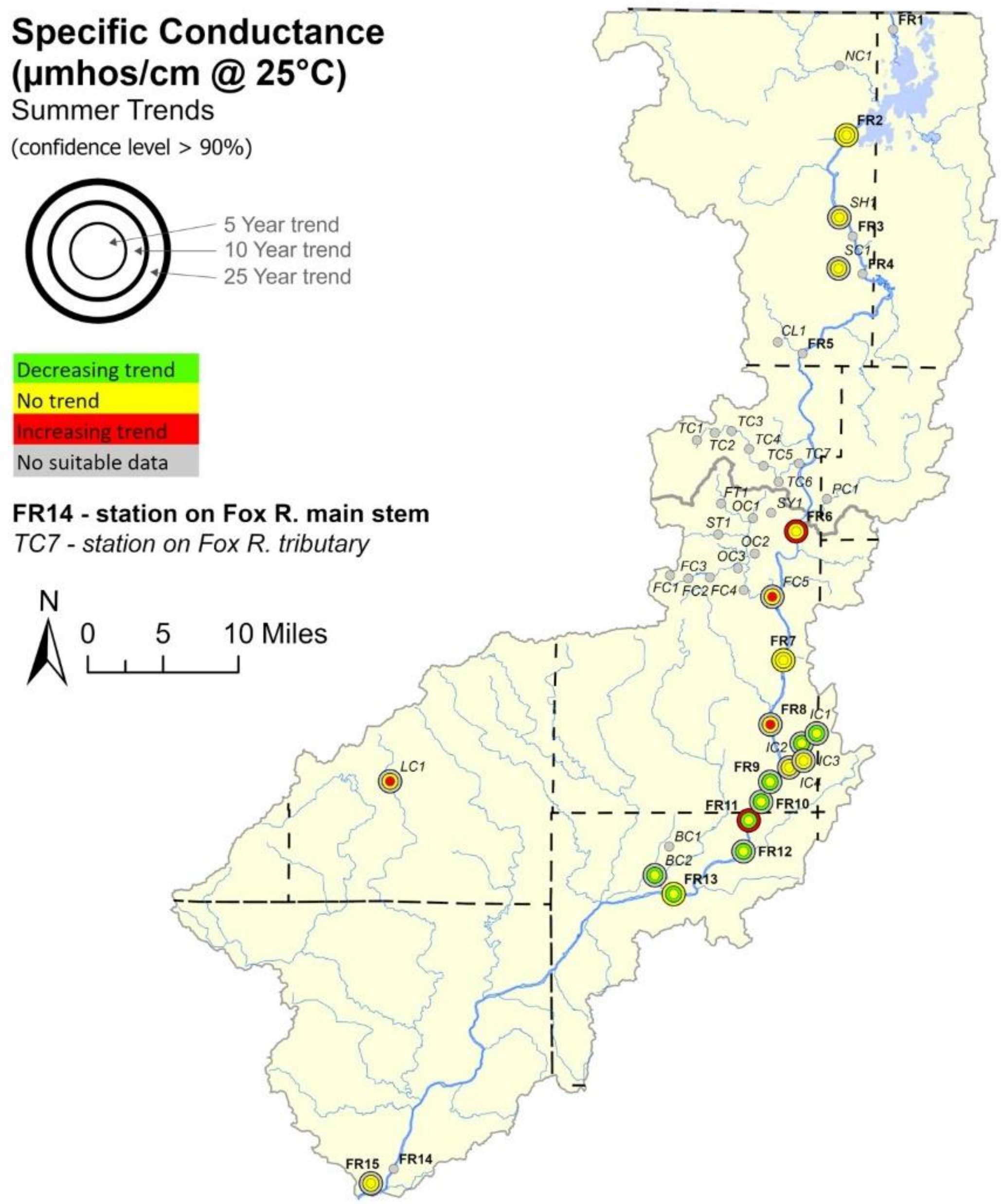
Winter trend slopes for specific conductance (µmhos/cm @ 25ºC per year)

Trend year	Monitoring sites				
	FR4	FR6	FR11	FR12	FR13
5	-26.67	-	-	-	-103.50
10	-	-	-	49.87	-28.80
25	-	12.14	-12.91	-	-



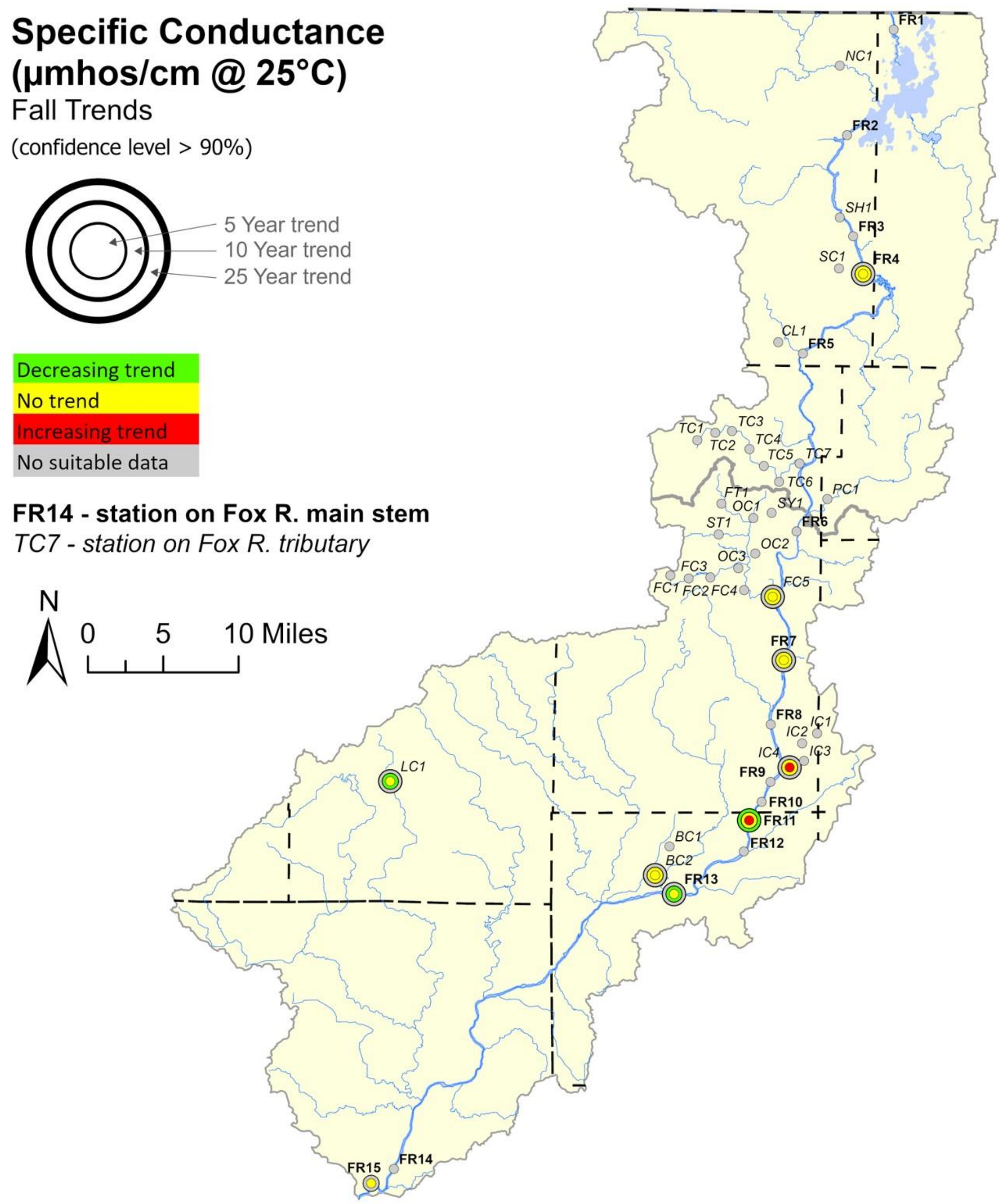
Spring trend slopes for specific conductance (µmhos/cm @ 25ºC per year)

Trend year	Monitoring sites				
	FR2	SH1	FR6	IC4	FR13
5	-	-34.63	-	182.29	-61.13
10	10.56	-	-	-	-
25	-	-	7.13	-	-



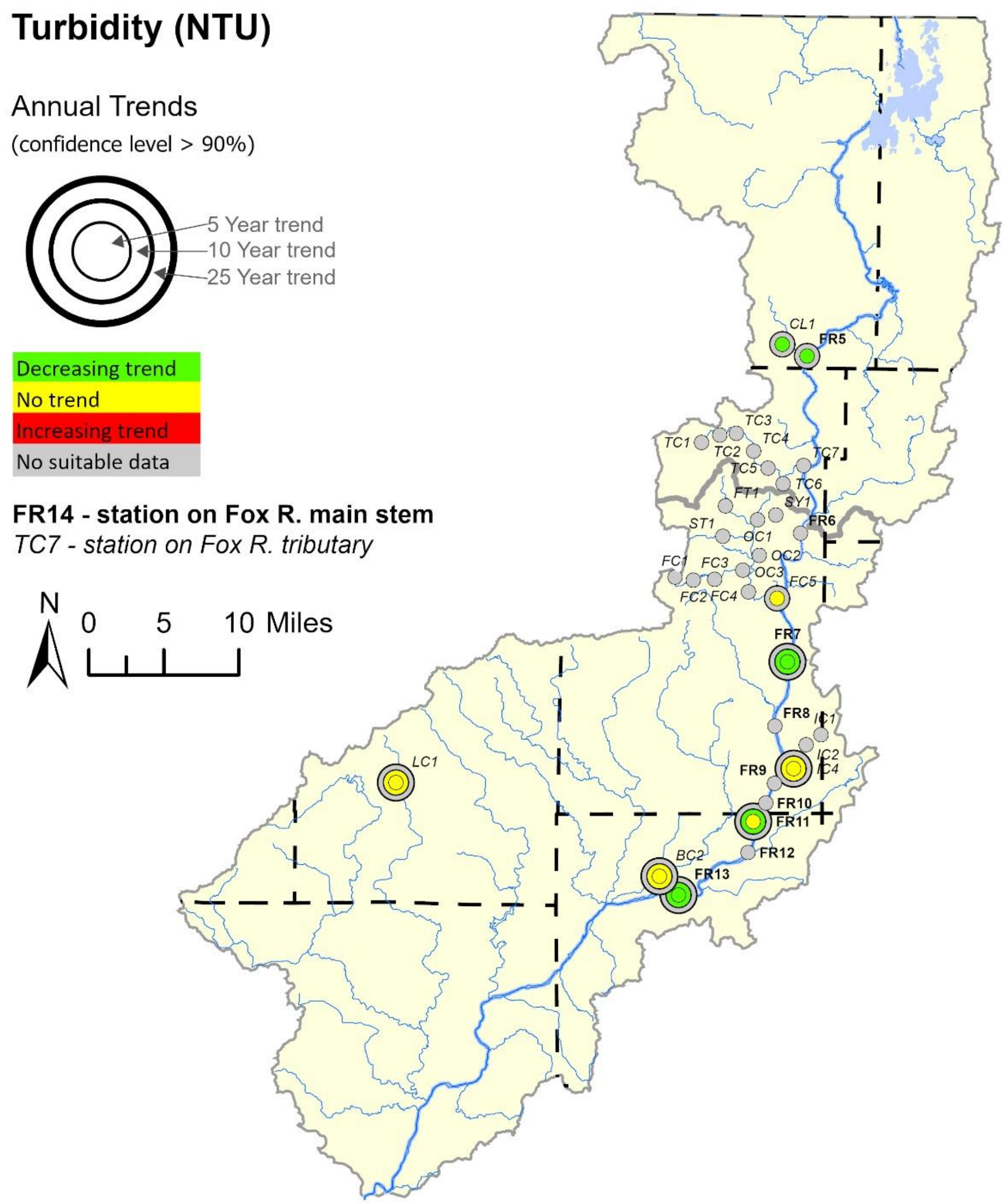
Summer trend slopes for specific conductance (µmhos/cm @ 25ºC per year)

Trend year	Monitoring sites											
	FR6	FC5	FR8	IC1	IC2	FR9	FR10	FR11	FR12	FR13	BC2	LC1
5	-	59.00	55.88	-	-	-	-	-	-	-	-	100.00
10	-	-	-	-34.00	-32.00	-20.63	-21.18	-22.71	-27.79	-22.68	-13.01	-
25	9.38	-	-	-	-	-	-	6.91	-	-	-	-



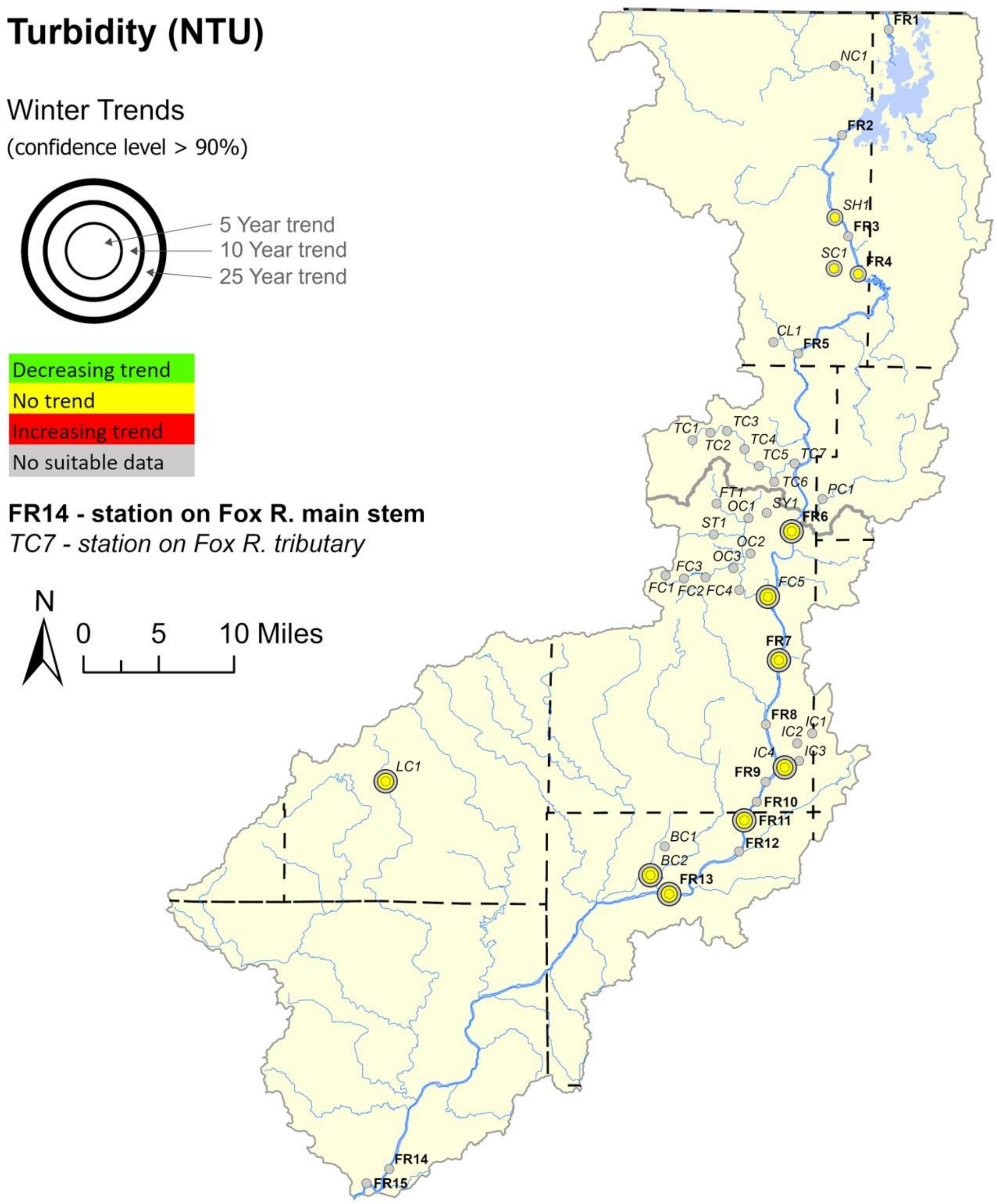
Fall trend slopes for specific conductance (µmhos/cm @ 25°C per year)

Trend year	IC4	FR11	FR13	LC1
	Monitoring sites			
5	203.50	57.50	-	-
10	-	-	-35.00	-33.33
25	-	-4.64	-	-



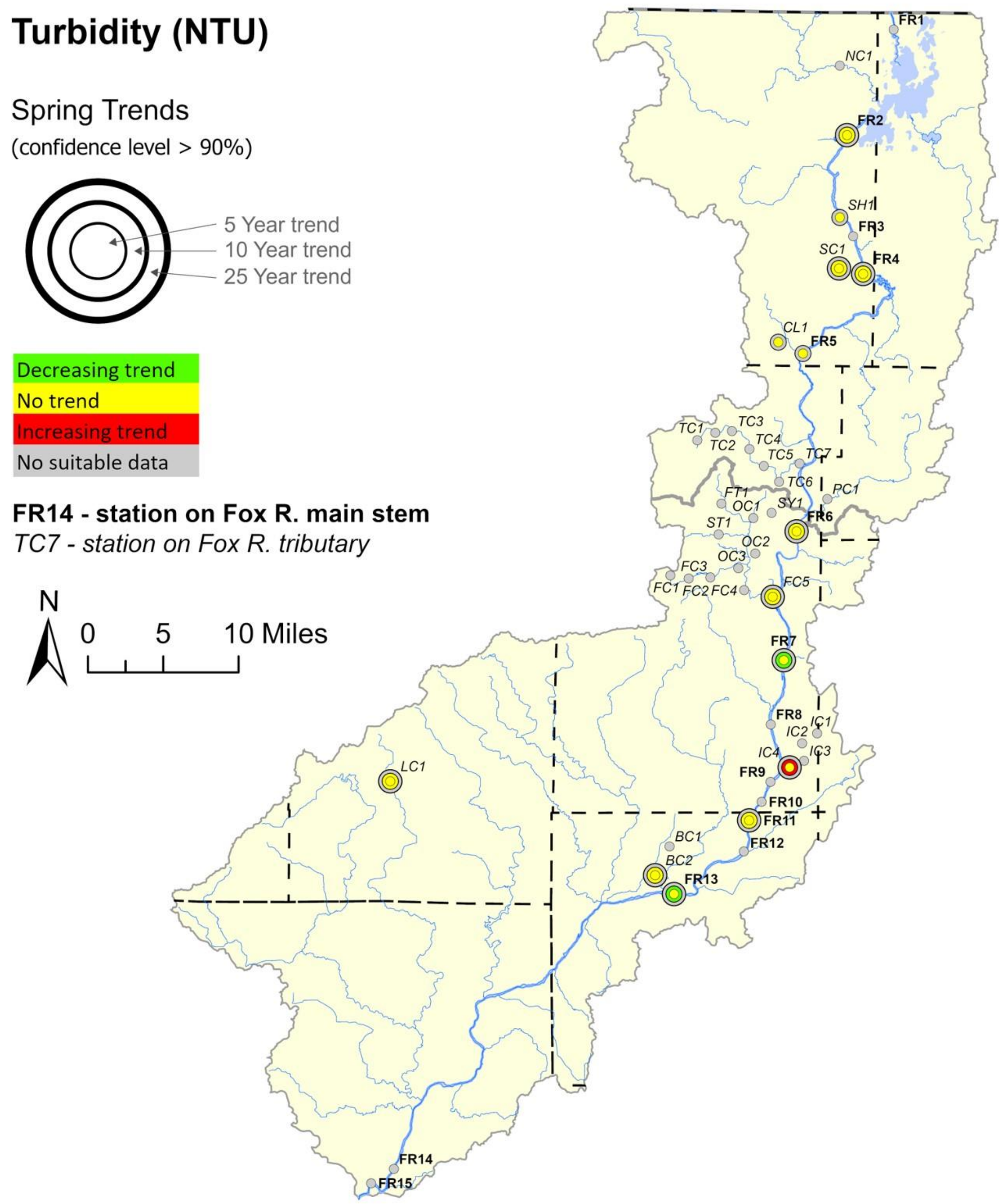
Annual trend slopes for turbidity (NTU per year)

Trend year	Monitoring sites				
	FR7	IC4	FR11	FR13	LC1
5	-1.50	-1.10	-	-0.95	-0.57
10	-0.75	-	-0.50	-0.40	-
25	-	-	-	-	-



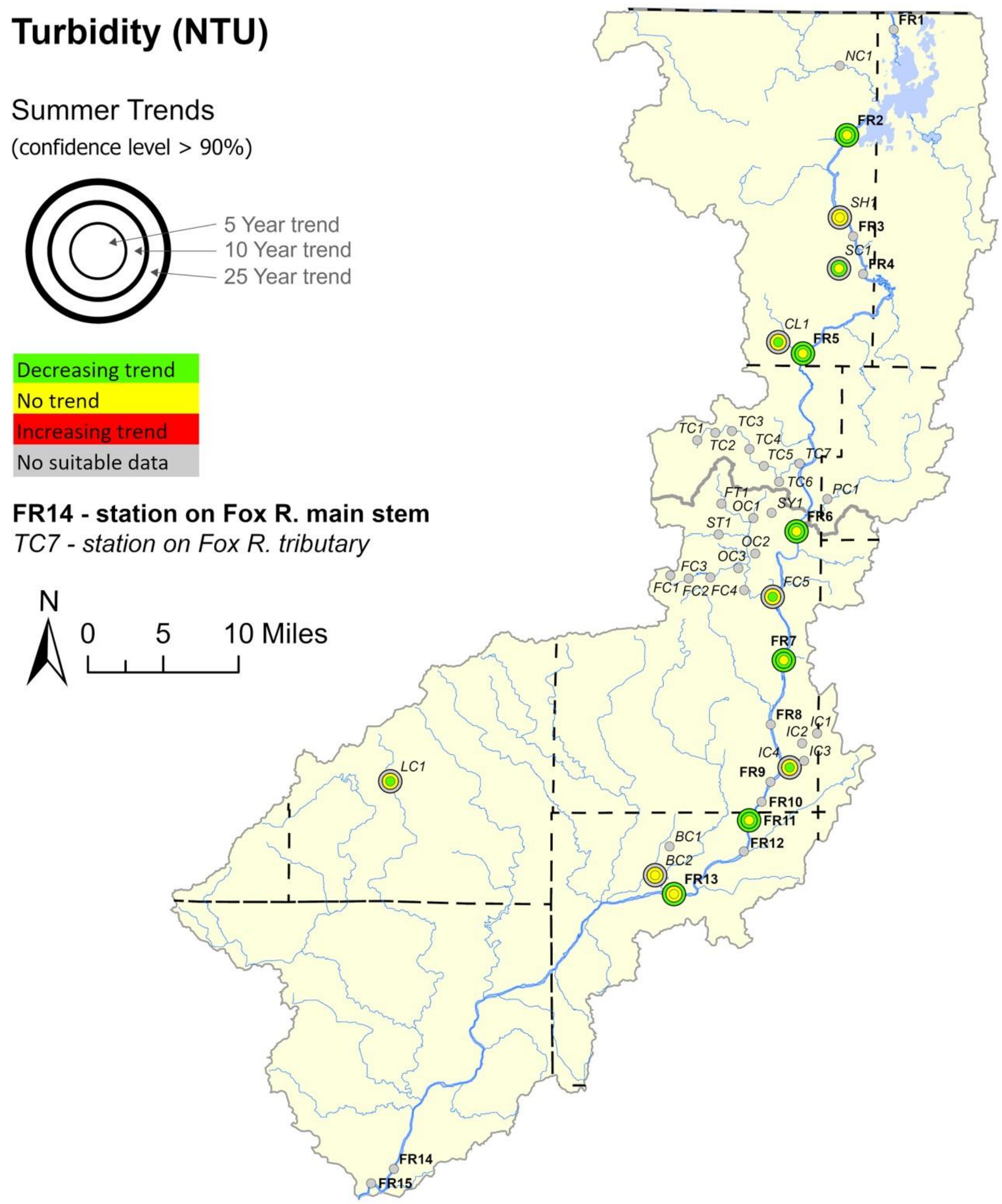
Winter trend slopes for turbidity (NTU per year)

Trend year	Monitoring sites
5	-
10	-
25	-



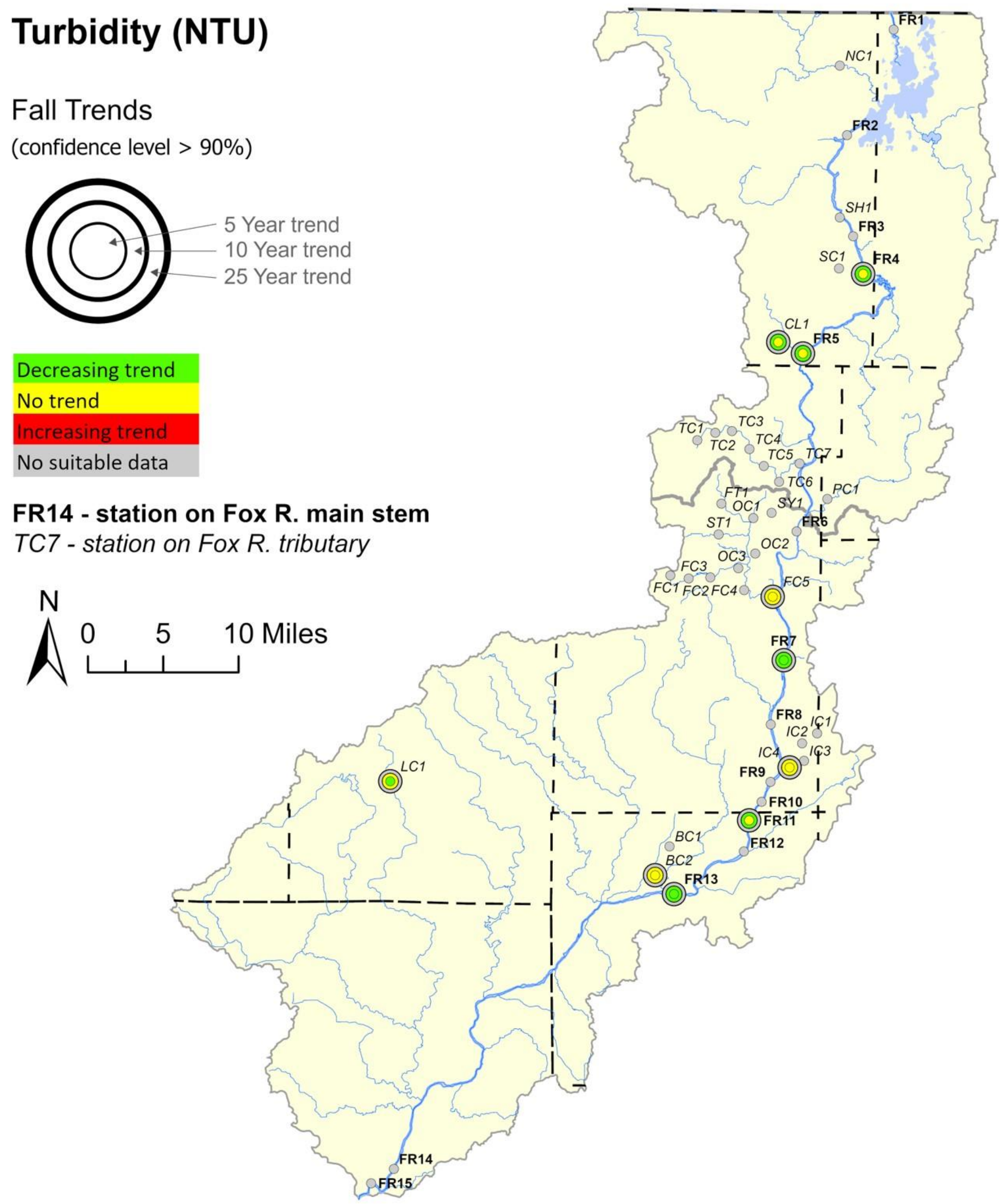
Spring trend slopes for turbidity (NTU per year)

Trend year	Monitoring sites		
	FR7	IC4	FR13
5	-	-	-
10	-0.93	0.52	-1.00
25	-	-	-



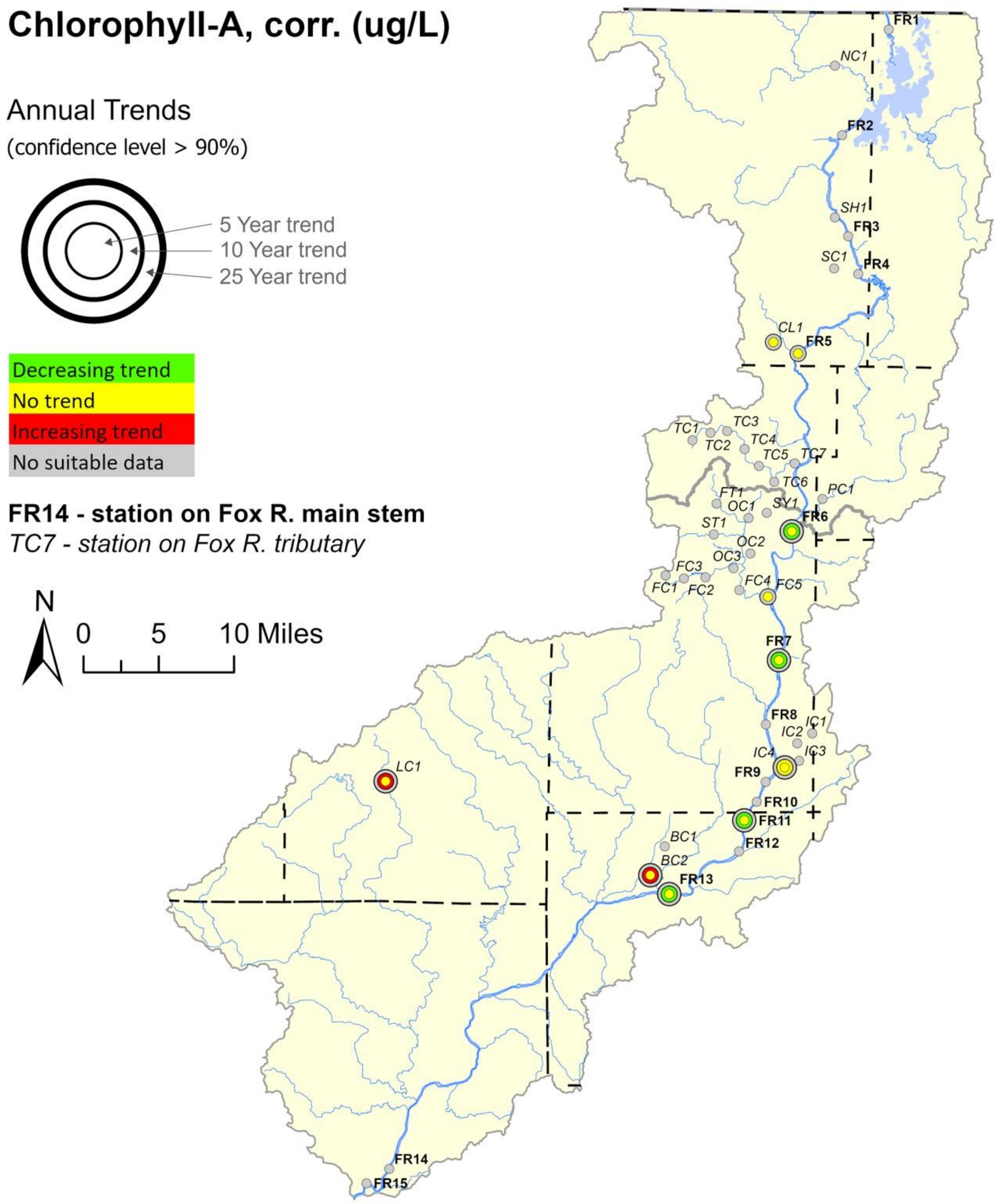
Summer trend slopes for turbidity (NTU per year)

Trend year	FR2	SC1	CL1	FR5	FR6	FC5	FR7	IC4	FR11	FR13	LC1
	Monitoring sites										
5	-	-	-1.60	-	-	-4.60	-	-1.03	-	-	-2.07
10	-1.21	-0.28	-	-1.50	-1.11	-	-1.00	-	-0.57	-	-
25	-0.54	-	-	-1.00	-0.67	-	-0.60	-	-0.59	-0.41	-



Fall trend slopes for turbidity (NTU per year)

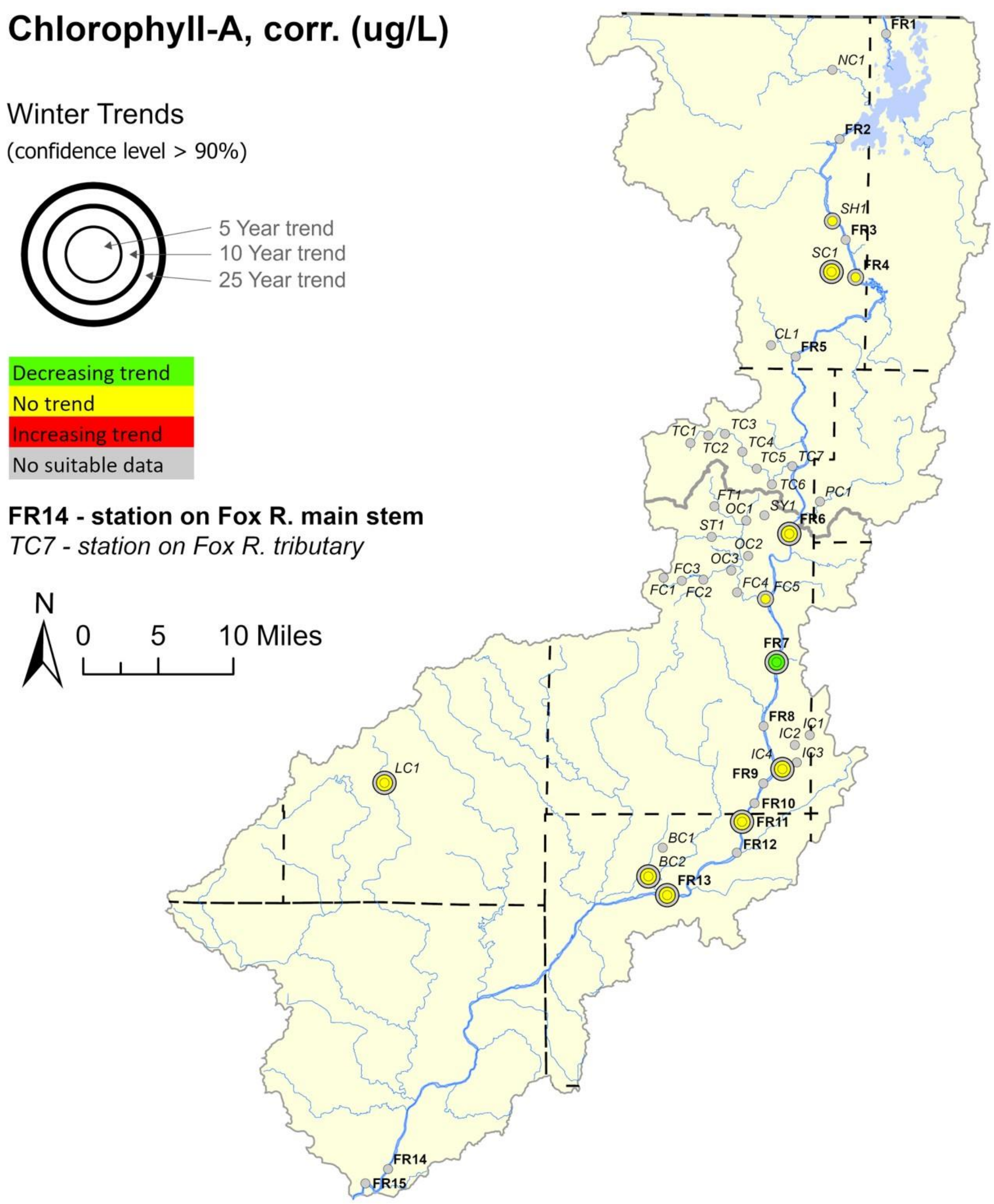
Trend year	FR4	CL1	FR5	FR7	FR11	FR13	LC1
	Monitoring sites						
5	-	-	-	-2.43	-	-1.23	-0.65
10	-0.82	-0.33	-0.82	-1.00	-1.00	-0.77	-
25	-	-	-	-	-	-	-



Annual trend slopes for chlorophyll-A, corrected (μg/L per year)

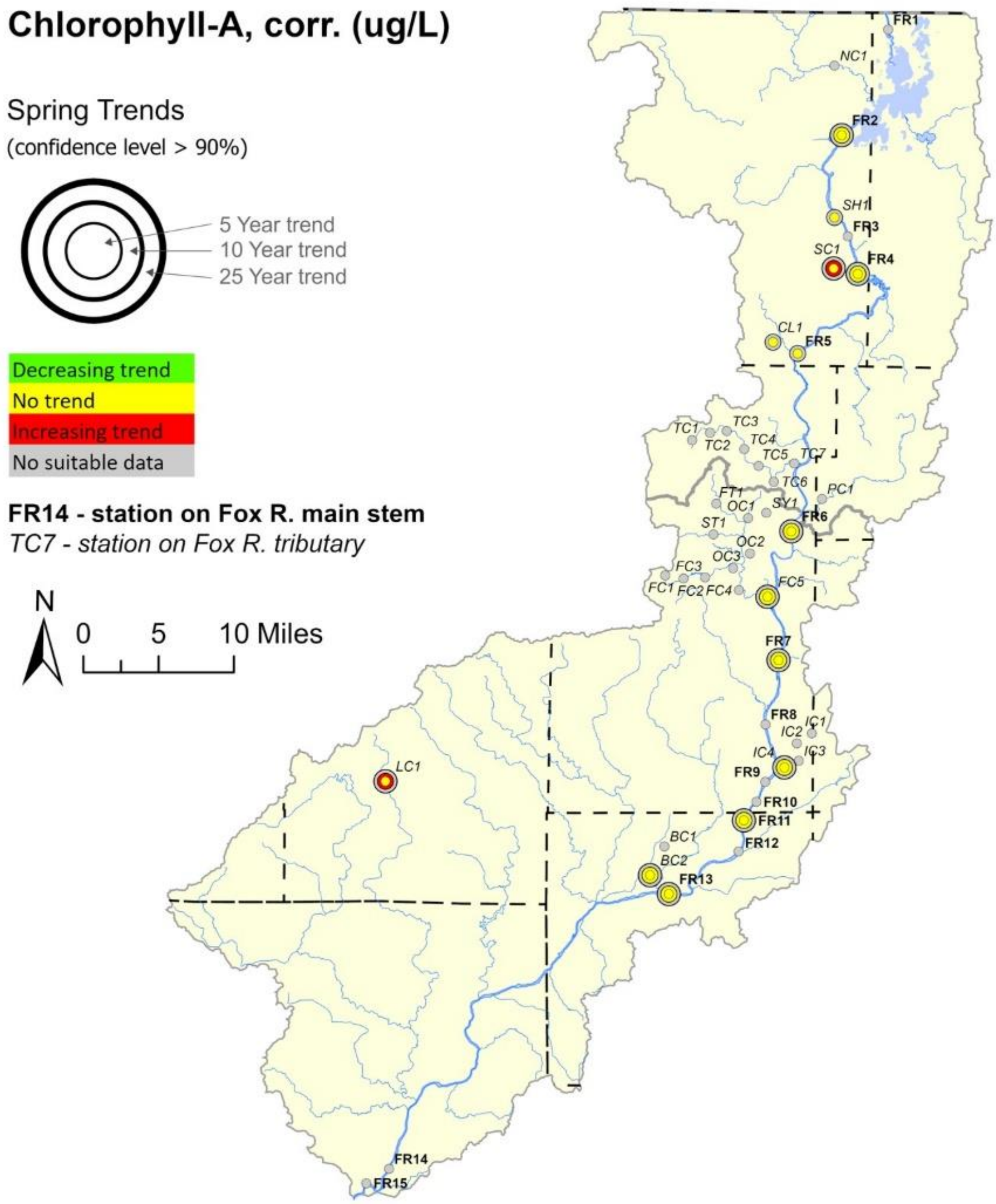
Trend year	FR6	FR7	FR11	FR13	BC2	LC1
5	-	-	-	-	-	-
10	-1.85	-4.00	-3.78	-3.36	0.28	0.30
25	-	-	-	-	-	-

Monitoring sites: FR6, FR7, FR11, FR13, BC2, LC1



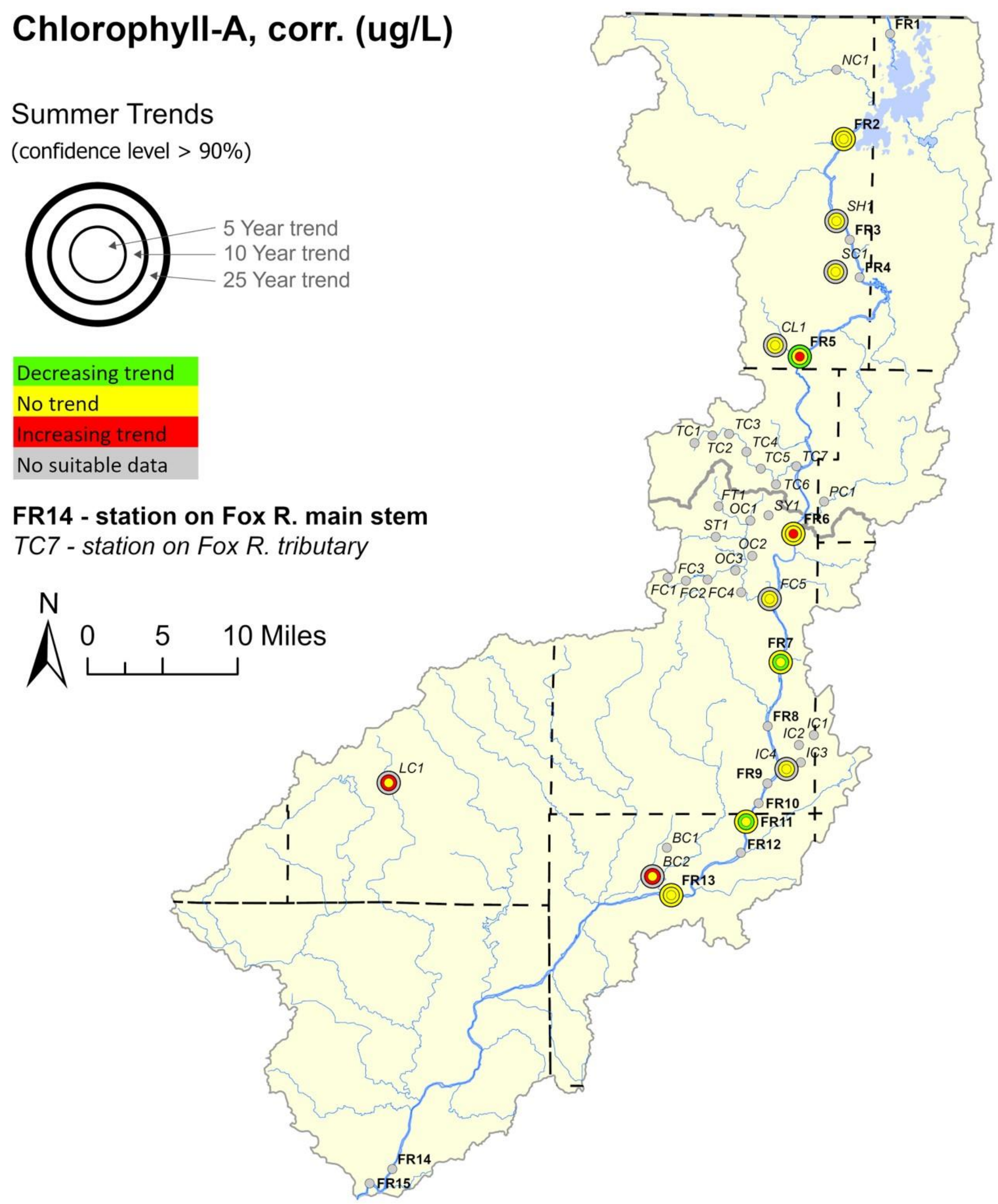
Winter trend slopes for chlorophyll-A, corrected (µg/L per year)

Trend year	Monitoring sites FR7
5	-1.20
10	-1.38
25	-



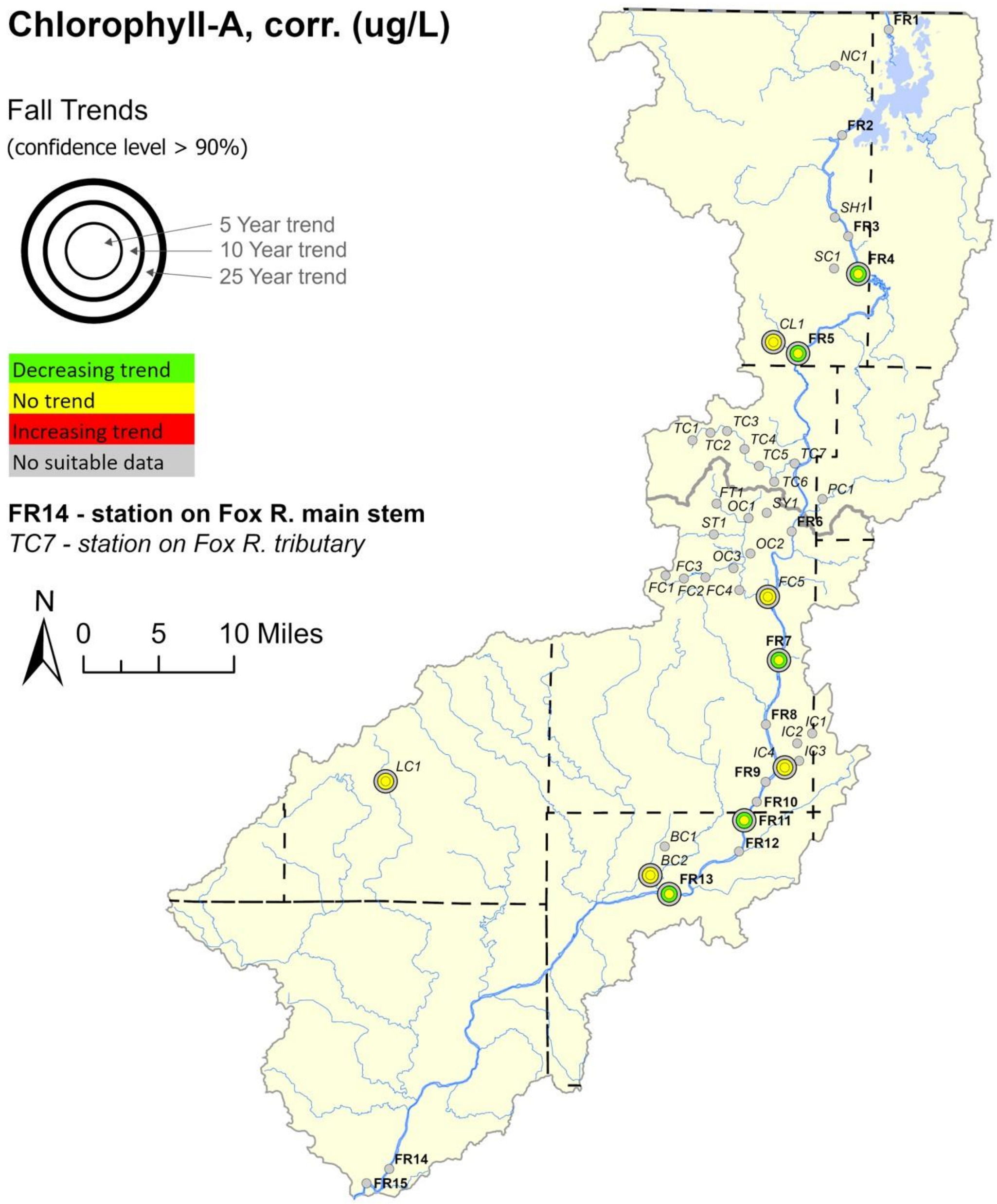
Spring trend slopes for chlorophyll-A, corrected (µg/L per year)

Trend year	SC1	LC1
	Monitoring sites	
5	-	-
10	< 0.01	1.30
25	-	-



Summer trend slopes for chlorophyll-A, corrected (µg/L per year)

Trend year	FR5	FR6	FR7	FR11	BC2	LC1
	Monitoring sites					
5	13.15	23.65	-	-	-	-
10	-	-	-10.61	-8.00	0.60	0.34
25	-2.48	-	-	-	-	-



Fall trend slopes for chlorophyll-A, corrected (µg/L per year)

Trend year	Monitoring sites				
	FR4	FR5	FR7	FR11	FR13
5	-	-	-	-	-
10	-3.63	-8.00	-7.08	-8.40	-8.86
25	-	-	-	-	-

Appendix C: Trends in Annual and Seasonal Flow-normalized Concentration and Fluxes for Chloride and Chlorophyll-A

List of Figures

Page

Figure C1. Mean and flow-normalized chloride concentration for Polar Creek at Elgin 1

Figure C2. Total and flow-normalized chloride flux for Polar Creek at Elgin 2

Figure C3. Mean and flow-normalized chloride concentration for Fox River at Montgomery..... 3

Figure C4. Total and flow-normalized chloride flux for Fox River at Montgomery...................... 4

Figure C5. Mean and flow-normalized chlorophyll-A (corrected) concentration for Fox River at Montgomery 5

Figure C6. Total and flow-normalized chlorophyll-A (corrected) flux for Fox River at Montgomery 6

Figure C7. Mean and flow-normalized chloride concentration for Blackberry Creek at Rt. 47 near Yorkville...7

Figure C8. Total and flow-normalized chlorophyll-A (corrected) flux for Blackberry Creek at Rt. 47 near Yorkville... 8

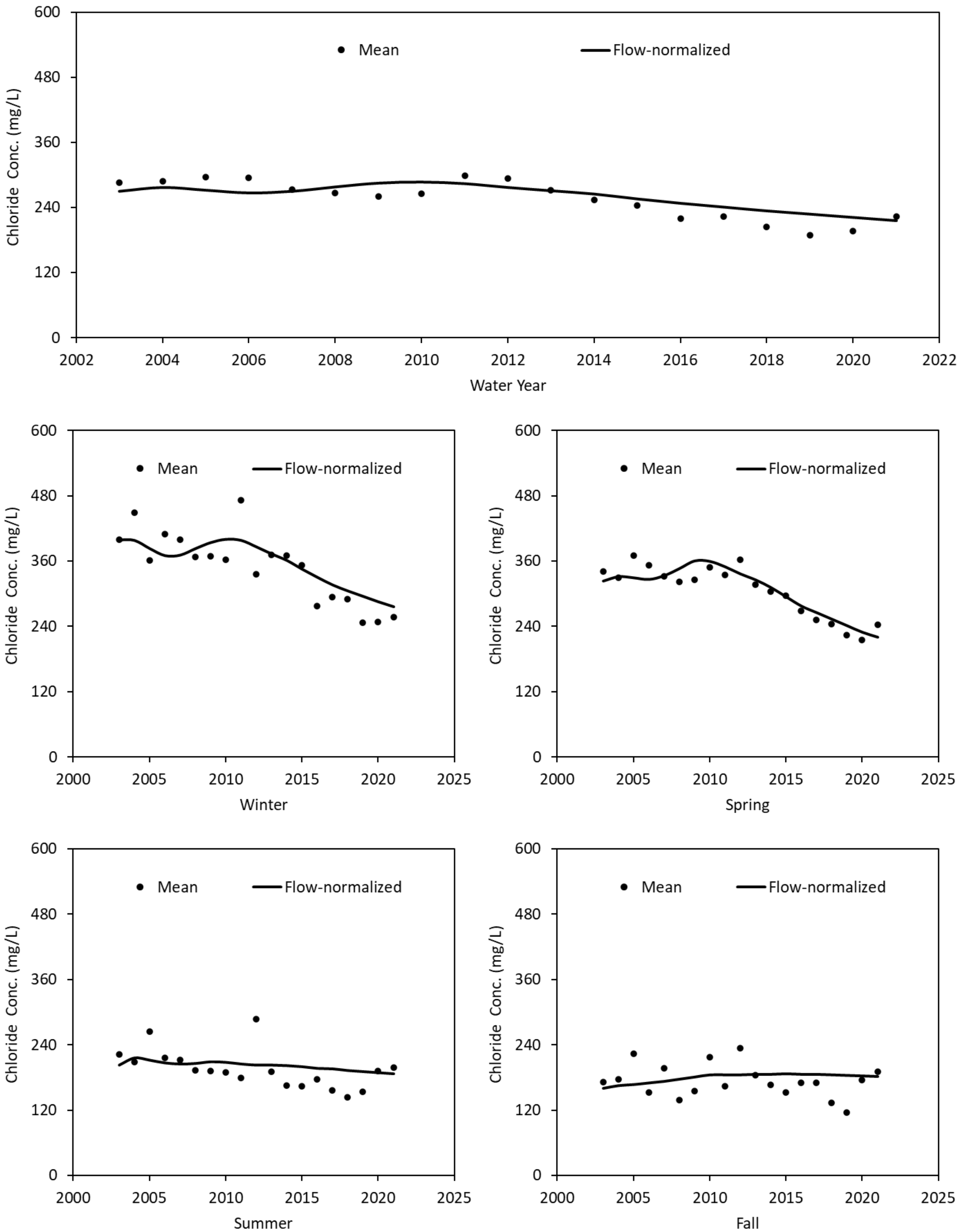


Figure C1. Mean and flow-normalized chloride concentration for Polar Creek at Elgin

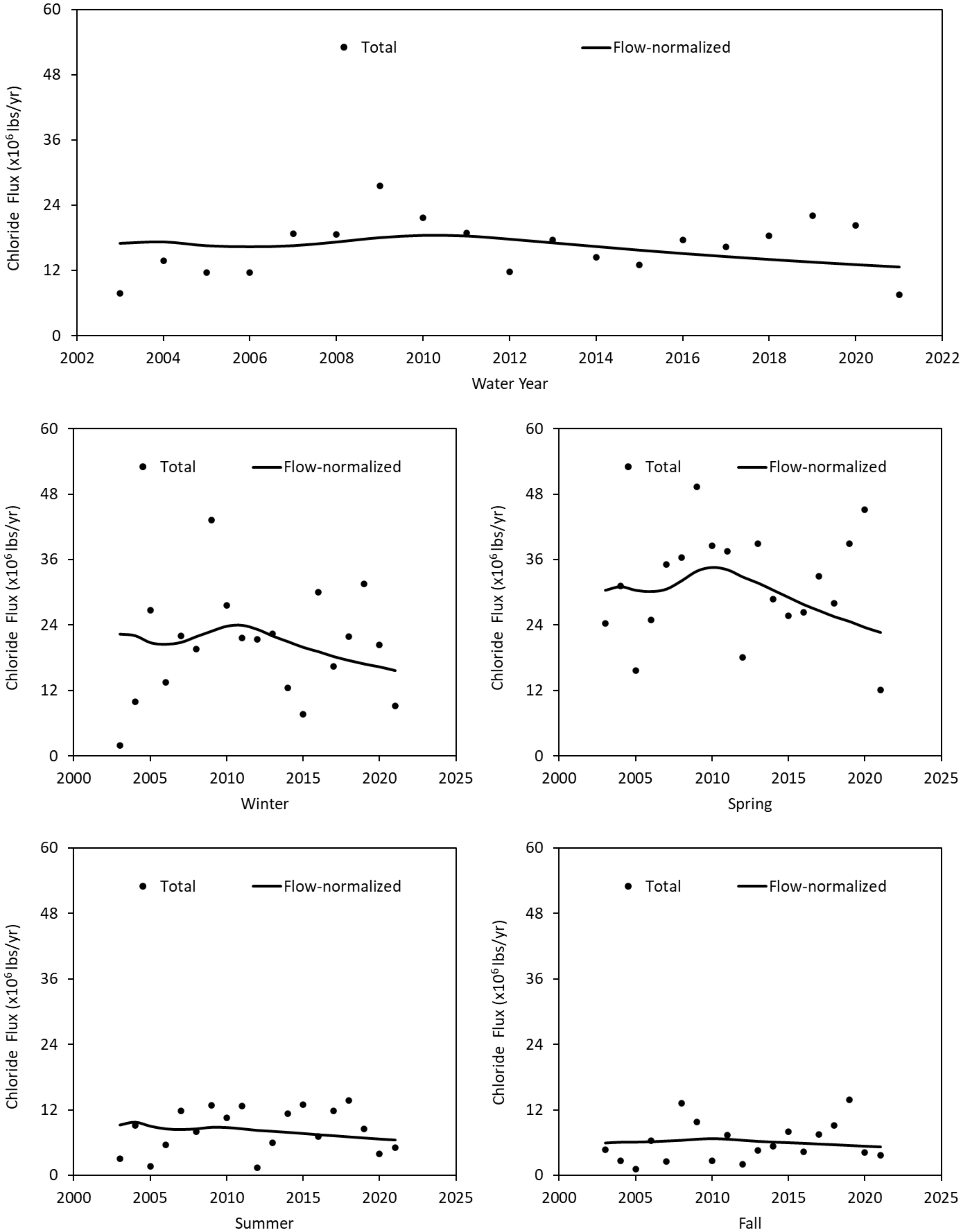


Figure C2. Total and flow-normalized chloride flux for Polar Creek at Elgin

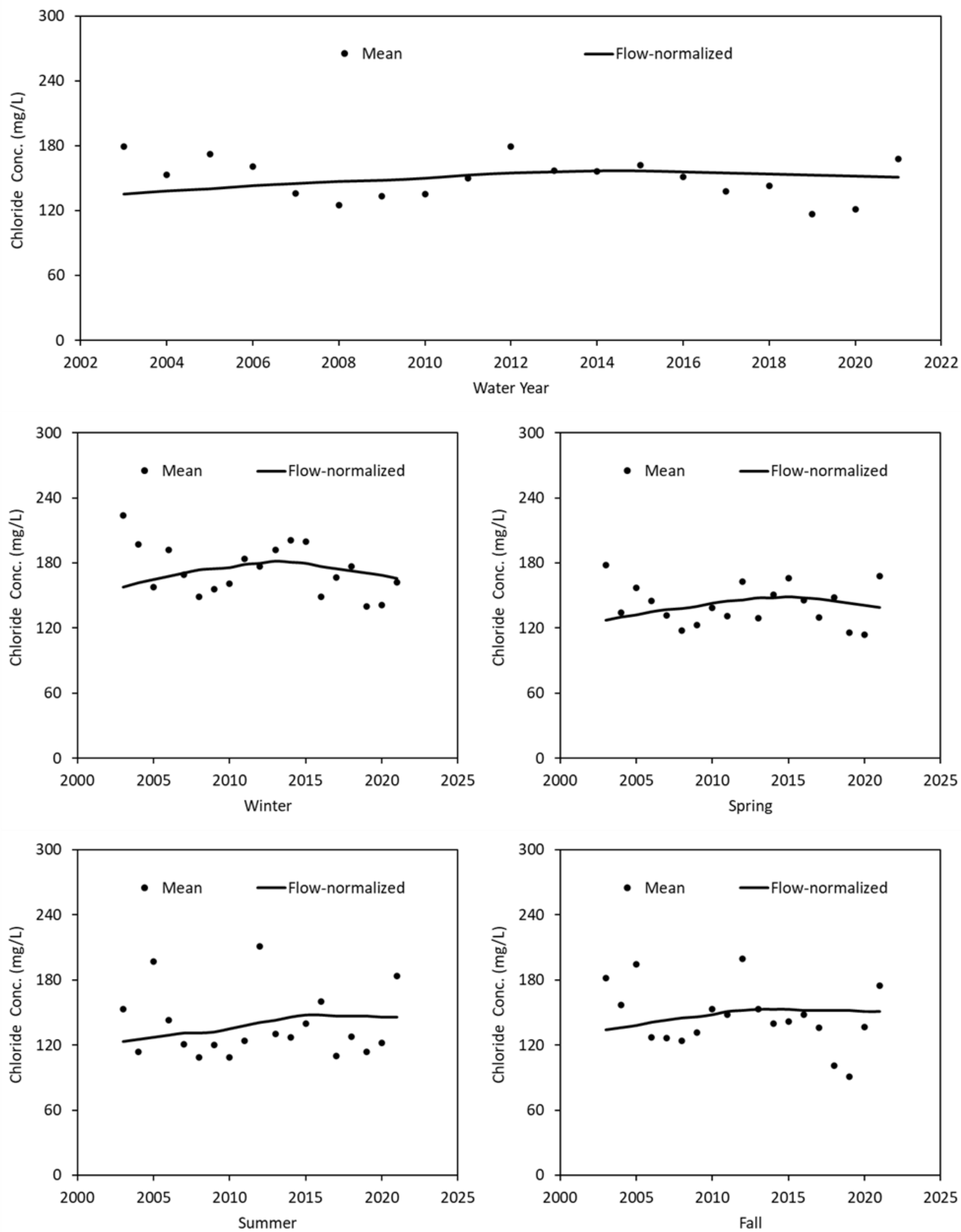


Figure C3. Mean and flow-normalized chloride concentration for Fox River at Montgomery

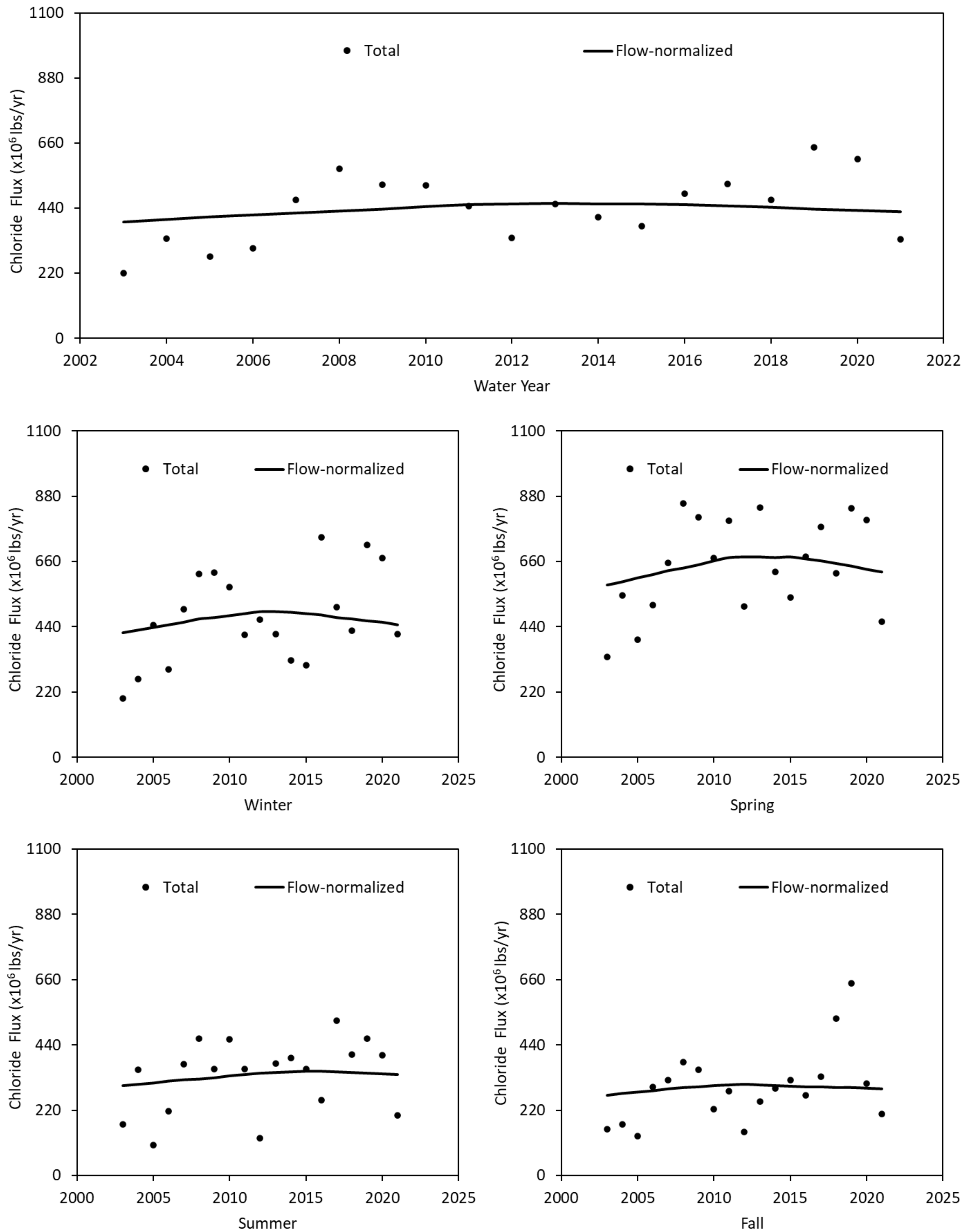


Figure C4. Total and flow-normalized chloride flux for
Fox River at Montgomery

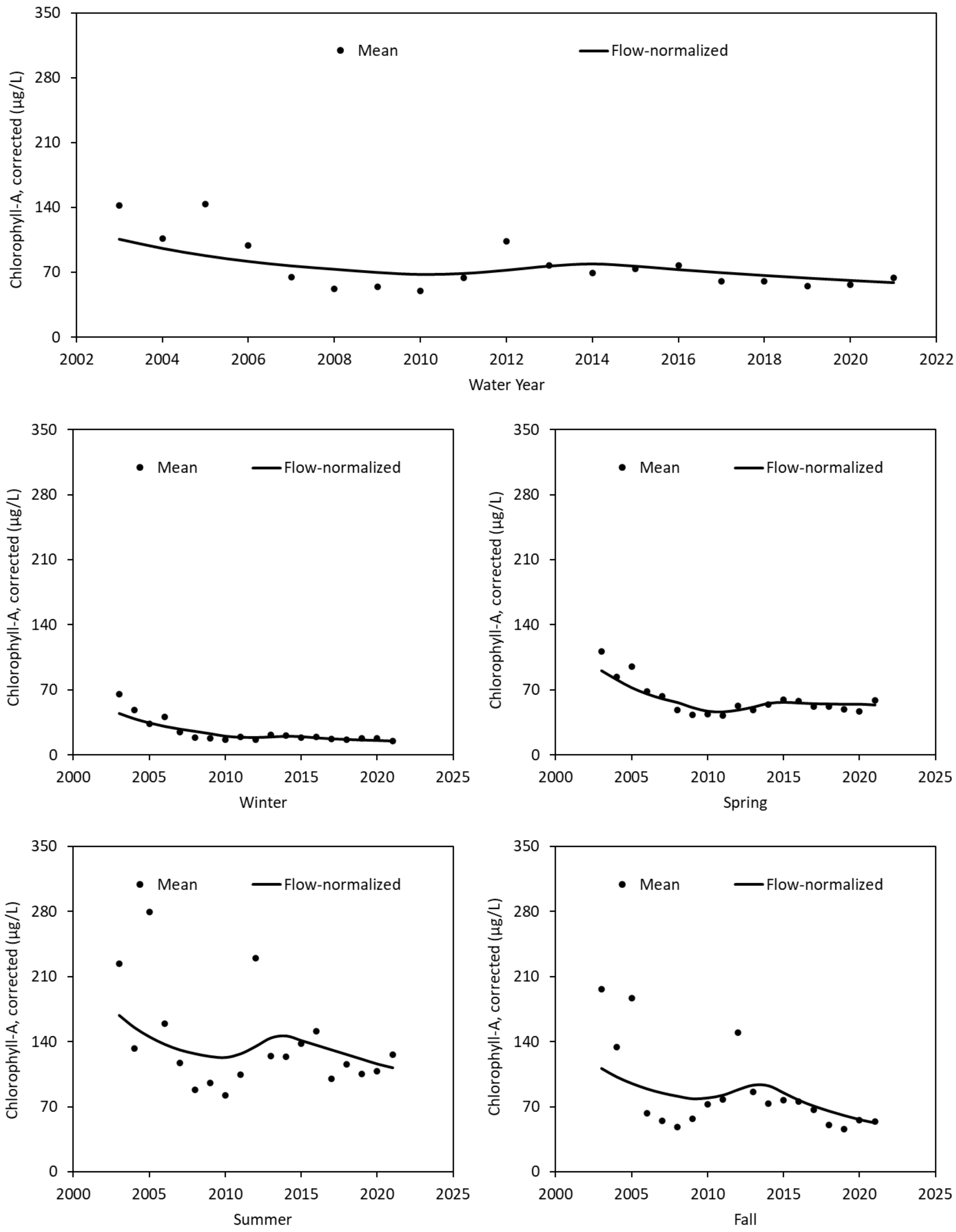


Figure C5. Mean and flow-normalized chlorophyll-A (corrected) concentration for Fox River at Montgomery

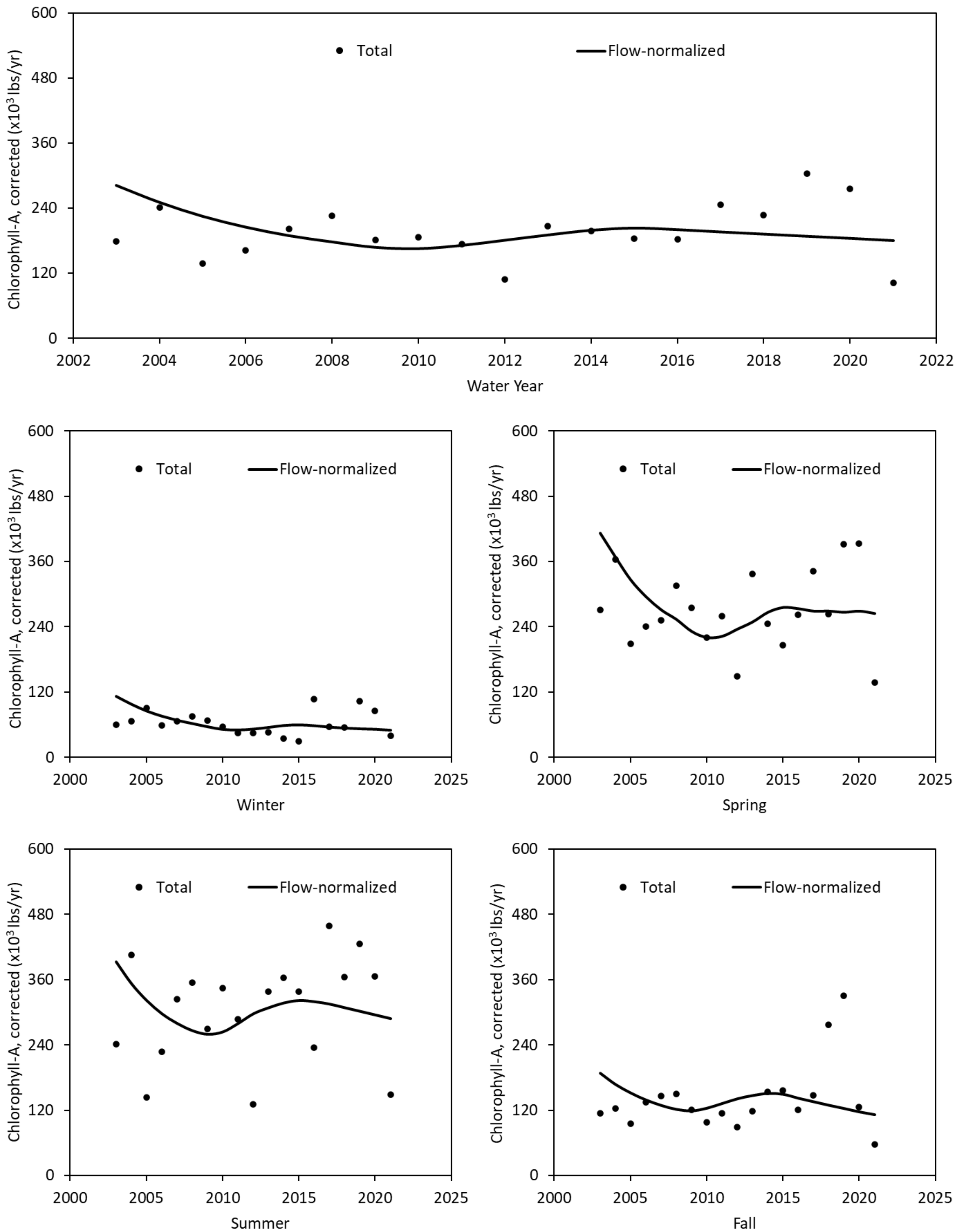


Figure C6. Total and flow-normalized chlorophyll-A (corrected) flux for Fox River at Montgomery

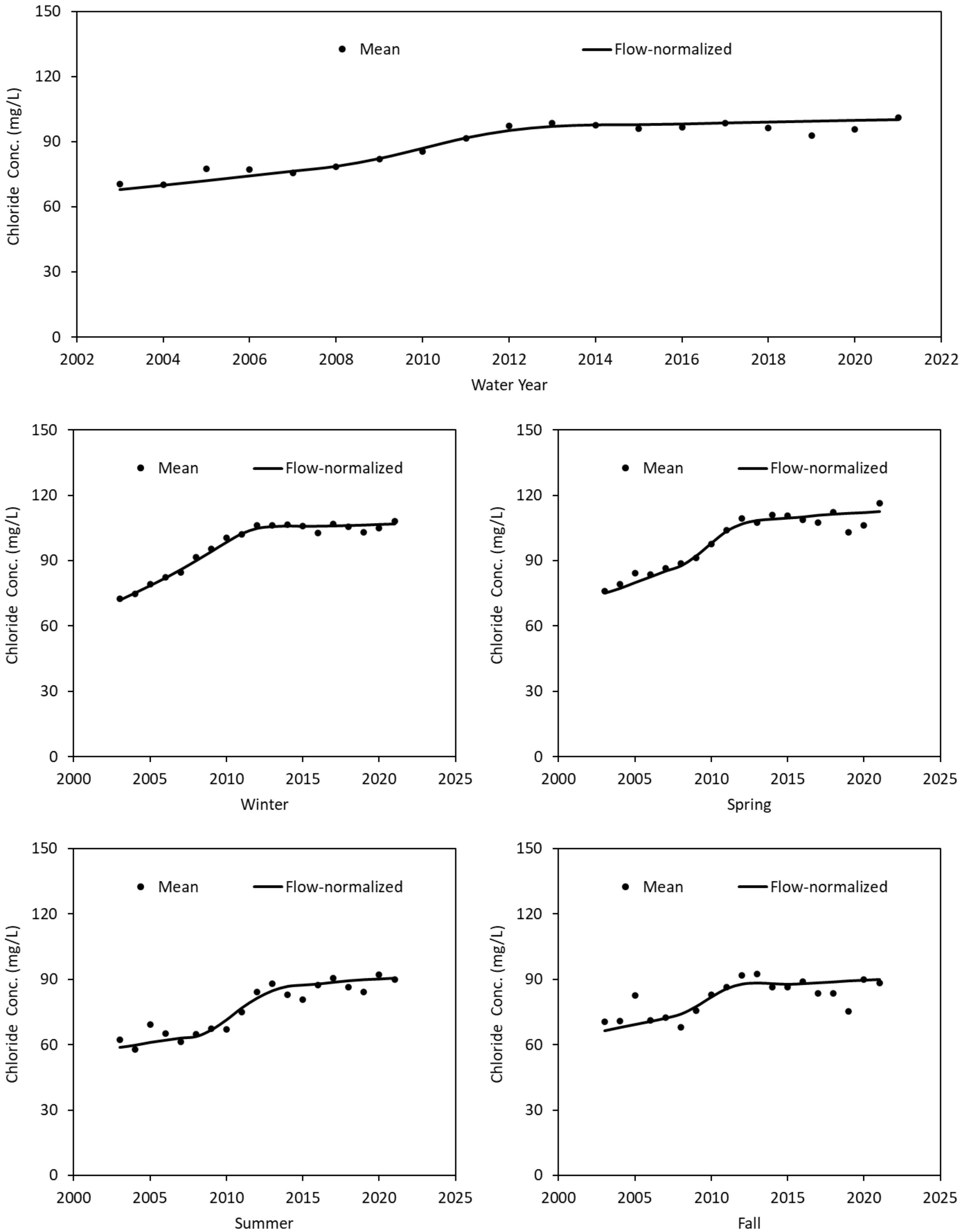


Figure C7. Mean and flow-normalized chloride concentration for Blackberry Creek at Rt. 47 near Yorkville

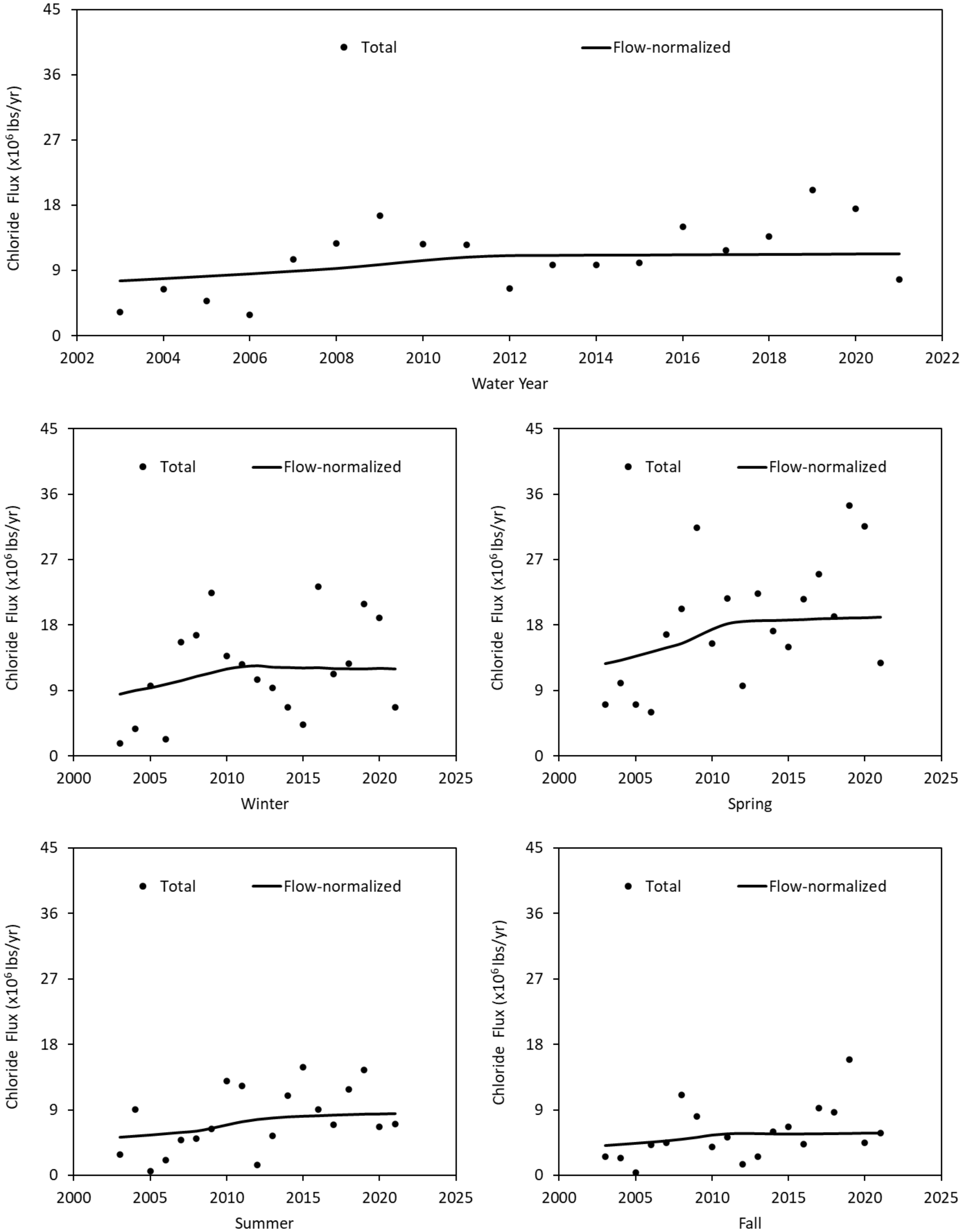


Figure C8. Total and flow-normalized chlorophyll-A (corrected) flux for Blackberry Creek at Rt. 47 near Yorkville

Appendix D: Organizational Chart of Fox River Environmental Database (FoxDB)

Fox River Environmental Database (FoxDB)

The purpose of the Fox River Environmental Database (FoxDB) is to organize and present the water quality data from the Fox River and its tributaries in Illinois. The database's structure, including its tables, fields, and relations, is shown in Figure D1.

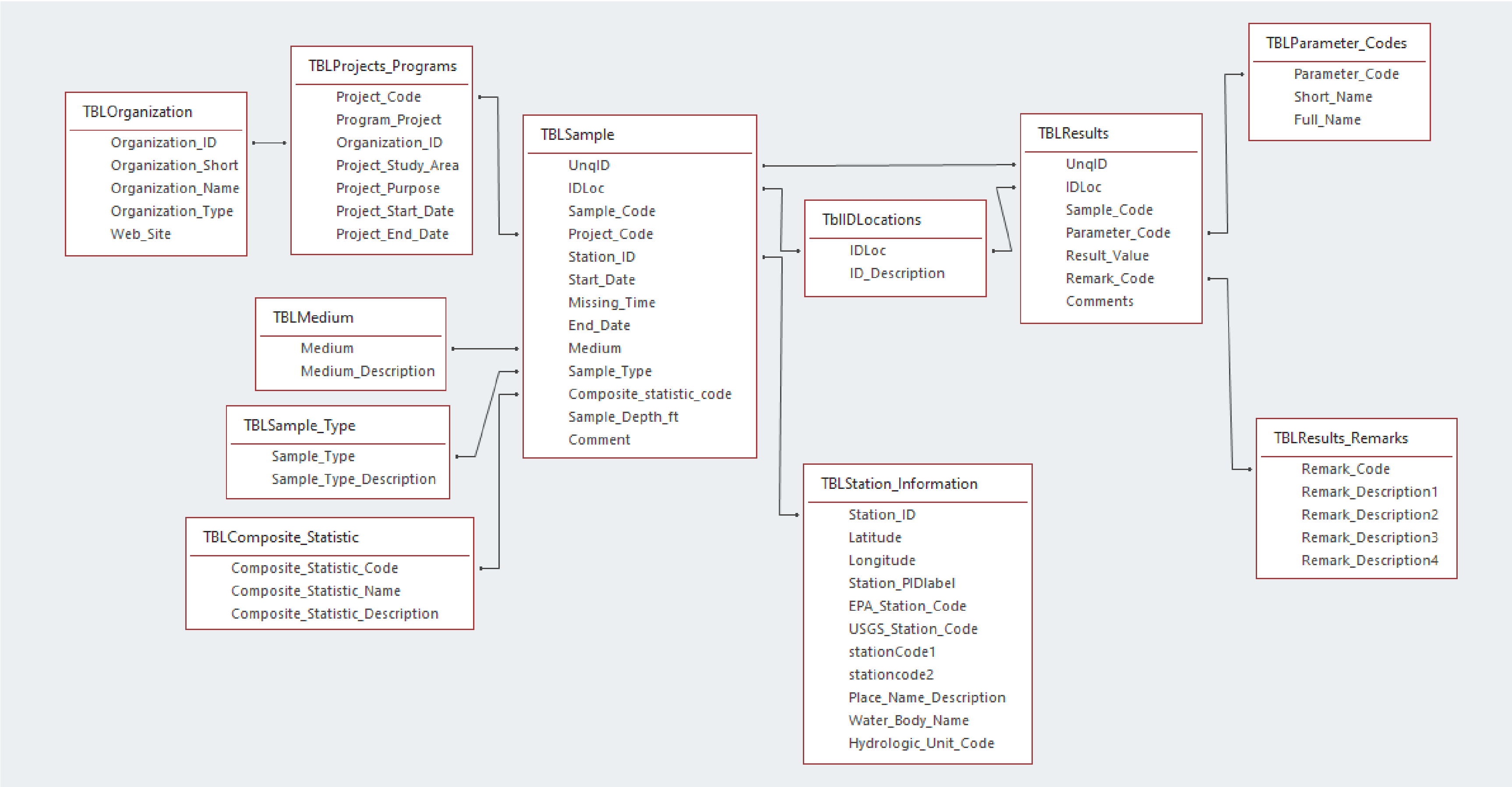


Figure D1. Organizational Chart of Fox Environmental Database (FoxDB)

Description of FoxDB Tables, Fields, and Relations

FoxDB has eleven tables that are related to each other through fields in each table. The description of the tables, fields, and their relations are provided below.

1. **TBLComposite_Statistic:** This table is related to the **TBLSample** table and provides the statistics used to describe the results of a Composite Sample.

   - *Composite_Statistic_Code* (text) – a single letter or symbol code that relates to **TBLSample.**

   - *Composite_Statistic_Name* (text) – a two to three letter abbreviation for a composite statistic.

   - *Composite_Statistic_Description* (text) – a brief description of a composite statistic such as average or standard deviation.

2. **TBLIDLocations**: This table is used to identify a given dataset in the FoxDB.

   - *IDLoc* (text) – an alphanumeric code relating information in **TBLIDLocations** to **TBLSample** and **TBLResults** tables.

   - *ID_Description* (text) – a brief description or name of the dataset.

3. **TBLMedium:** This table includes the type of data sampling medium such as water, sediment, or air.

   - *Medium* (text) – a single letter code relating **TBLMedium** to **TBLSample.**

   - *Medium_Description* (text) – a brief description of the sampling medium.

4. **TBLOrganization**: This is a lookup table, and it provides pertinent information about the organizations that collected the various datasets.

   - *Organization* (integer) – a numeric code relating this table to **TBLProject_Programs** to identify organizations responsible for a particular project or program.

   - *Organization_Short* (text) – a shortened name of an organization.

   - *Organization_Name* (text) – a full name of an organization.

   - *Organization_Type* (text) – type of organization such as federal, state, or other

- *Web_Site* (text) – the URL for an organization's website if any.

5. **TBLParameter_Codes:** This is a lookup table that provides a description of the parameters in the FoxDB.

   - *Parameter_Code* (integer) – a numeric code relating this table to **TBLSample** to identify each unique environmental parameter in the FoxDB.
   - *Short_Name* (text) – a brief description of each parameter in the database.
   - *Full_Name* (text) – a full description of each parameter in the database.

6. **TBLProjects_Programs:** This is a lookup up table with pertinent information about the different projects and sampling programs for the data in the FoxDB.

   - *Project_Code* (text) – a code relating this table to a corresponding field in **TBLSample** to identify the project to which a given water quality in FoxDB belongs. It is either assigned by the Illinois State Water Survey or inherited from the organization that provided the data.
   - *Program_Project* (text) – a name or brief description of the project or program.
   - *Organization_ID* (integer) – a numeric code relating this table to **TBLOrganization** to identify an organization responsible for a particular project or program.
   - *Project_Study_Area* (text) – identifies the geographic region of a project or program.
   - *Project_Purpose* (text) – a brief description of a project or a program's purpose.
   - *Project_Start_Date* (datetime) – the date a project or program started.
   - *Project_End_Date* (datetime) – the date a project or program ended.

7. **TBLResults**: This table works together with the **TBLSample** table to display the results for all data samples in FoxDB. Each result has its own record, which varies depending on the laboratories that report their results, and is very useful for data analysis as it is scalable. This is achieved by linking a sampling event to a record in the **TBLSample** table that contains relevant information about the time, place, and method of the sample collection. Therefore, if multiple parameters were measured during that sampling event, each parameter will have its own record that is connected to the **TBLSample** through the *UnqID* field.

- *UnqID* (text) – a code that connects records in the **TBLResults** table to records in the **TBLSample** table that correspond to sampling events. The UnqID field is a combined field that consists of the *IDLoc* and *Sample_Code* fields.

- *IDLoc (text)*: a one or two-letter code that links to the **TBLIDLocations** table, where the source of the data sample is recorded.

- *Sample_Code* (integer): a number that shows the order of the data sample in its dataset.

- *Parameter_Code* (integer): a value that connects **TBLResults** to **TBLParameters**, which has details on each parameter in the FoxDB.

- *Result_Value* (double): contains the measured numerical value of a result.

- *Remark_Code* (text): a value that refers to the **TBLResult_Remarks** table. Remark Codes, usually given by the data provider, explain the data quality or how the sampling event was different from normal conditions.

- *Comments* (text): a field for adding extra information about a result that does not fit in any of the other fields.

8. **TBLResults_Remarks**: This table lists the codes that indicate why a sample deviated from the normal conditions of the Standard Operating Procedure.

   - *Remark_Code* (text) - This field links this table to the **TBLResults** table. It contains the codes, usually assigned by the reporting organization, that explain the data quality or the sampling event variation.
   - *Remark_Description1* (text) - This field defines the meaning of a single *Remark_Code*.

   - *Remark_Description2* (text) - This field defines the meaning of the second *Remark_Code*, if more than one code is combined.

   - *Remark_Description3* (text) - This field defines the meaning of the third *Remark_Code*, if more than one code is combined.

   - *Remark_Description4* (text) - This field defines the meaning of the fourth Remark_Code, if more than one code is combined.

9. **TBLSample**: This table contains essential information about each sampling event as a record in the FoxDB and connects to most of the other tables in the database.

- *UnqID* (text) - A code that is unique to each record when it is added to the FoxDB and acts as the main key in the **TBLSample** table that links each *Result_Value* of the **TBLResults** table to a specific sampling event. The UnqID field is a merged field that consists of the *IDLoc* and *Sample_Code* fields.

- *IDLoc* (text) - a one or two-character code that refers to the **TBLIDLocations** table, which tracks the source of the data sample.

- *Sample_Code* (integer) – a number that is assigned ordinally identifying the data sample in the dataset.

- *Project_Code* (text) – a code that shows the project that the water quality or related data in the FoxDB belongs to. Project details can be found in the **TBLProjects_Programs** with the matching *Project_Code*.

- *Station_ID* (integer) – a code that connects to **TBLStation_Information**, which has location and station name information for each sampling site.

- *Start_Date* (datetime) – contains the date and time of a sampling event.

- *Missing_Time* (text) – a field that shows whether the *Start_Date* has the time-of-day information or not (i.e., “Y” for yes or “N” for no).

- *End_Date* (datetime) – a field that shows when a Sample was completed for cases where a sample was taken over a period of time, instead of a single time.

- *Medium* (text) – a field that connects to the **TBLMedium** table, showing the sampling medium, such as water, sediment, or air.

- *Sample_Type* (text) – a field with a code that connects to the **TBLSample_Type** table, which shows the sampling method used. Mainly includes data collected using grab samples, automatic data recording and a spatial composite. A spatial composite data sample is taken when a sample is collected from multiple locations in an area and from combined methods.

- *Composite_statistic_code* (text) - a text field that connects to the **TBLComposite_Statistic** table for cases where multiple samples are combined, and the result is a statistic such as average, maximum, etc.

- *Sample_Depth_ft* (double) - a value that gives the depth a sample was taken in feet.

- *Comment* (text) - A field for adding extra information about the data that does not fit in any of the other fields.

10. TBLSample_Type: This is a lookup table that lists the methods that were used to collect a sample.

- *Sample_Type* (text) – a field with a code that connects to the TBLSample table, which shows the sampling method used. It mainly includes data collected using grab samples, automatic data recording and a spatial composite. A spatial composite data sample is collected when a sample is taken from multiple locations in an area.

- *Sample_Type_Description* (text) – a field that explains the sampling method

11. *TBLStation_Information*: This table stores location information about a sampling site or station.

- *Station_ID* (integer) – a code that links to **TBLSample**, which has information about sampling events.

- *Latitude* (double) – the Latitude Coordinate for a Site.

- *Longitude* (double) – the Longitude Coordinate for a Site.

- *Station_PIDlabel* (text) – an alphanumeric plotting label used for stations in Illinois State Water Survey reports.

- *EPA_Station* (text) – a coded station name given to Environmental Protection Agency (EPA) sites.

- *USGS_Station* (integer) – a coded station name given to United States Geological Survey (USGS) sites.

- *stationCode* (text) – an internal naming convention for a reporting agency.

- *stationcode2* (text) – an internal naming convention for a reporting agency. This field is only used if *stationCode* is also in use.

- *Place_Name_Description* (text) – a text description of a station's location.

- *Water_Body* (text) – a name of the water body that the station is located in.

- *Hydrologic_Unit_Code* (integer) – a hydrologic unit code that matches the USGS's National Hydrographic Dataset.

SQL Scripts in FoxDB

For essential querying of the FoxDB, six basic Structured Query Language (SQL) scripts are included in the FoxDB:

All_Data - returns important fields extracted from multiple tables for the entire FoxDB data.

SelectBy_DateRange - filters the data by the user's chosen date range and returns the same fields as the **ALL_Data** query.

SelectBy_Organization_ID - filters the data by the user's selected *Organization_ID* and returns the same fields as the **ALL_Data** query.

SelectBy_Parameter_Code - filters the data by the user's selected *Parameter_Code* and returns the same fields as the **ALL_Data** query.

SelectBy_Project_Code - filters the data by the user's selected *Project_Code* and returns the same fields as the **ALL_Data** query.

SelectBy_Station_ID - filters the data by the user's selected *Station_ID* and returns the same fields as the **ALL_Data** query.