

# **Application of Regionalized Benthic Indices of Biotic Integrity (IBI) in the Integrated Report for Clean Water Act Sections 305(b) and 303(d)**

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**Texas Commission on Environmental Quality  
Surface Water Quality Monitoring Team**

**Guidance Advisory Workgroup Meeting  
May 20, 2019**

# Integrated Report Bioassessments

- Presentation Outline:
  - Overview of bioassessment process
  - Example Datasets
  - Comparison of Statewide and Regionalized Benthic Index of Biotic Integrity (IBI) 2018 IR Results





# Bioassessment Process

- Locate and Review Data
  - Collectors include CRP Partners, TCEQ Regional Staff, TPWD
  - SWQMIS, Coordinated Monitoring Schedule
- What is required?
  - Fish assemblage
  - Benthic macroinvertebrate assemblage
  - Physical Habitat – Habitat Quality Index (HQI)
- Data considerations:
  - Sample dates within Period of Record
  - Adequate benthic kicknet effort
  - Minimum number of benthic individuals collected (approx. 140-210)
  - Sufficient fish shocking and seining effort (15 minutes/6 seine hauls – 60 meters)
  - Complete physical habitat assessment & HQI Score
  - Resolve taxonomic issues
  - Station/Assessment Unit (AU) relationship
  - Station representative of aquatic habitat in the AU



# Aquatic Life Use Categories

- Exceptional, High, Intermediate, Limited
  - Assigned to each classified and some unclassified water bodies
  - Appendix A and D in Texas Surface Water Quality Standards
- Presumed ALU for unclassified streams:
  - Perennial – High
  - Intermittent with Perennial Pools – Limited
  - Intermittent – Minimal



# Bioassessment Process – Index Period

- All bioassessment sampling for freshwater streams must be conducted during the index period
  - Exceptions are RWAs (carried out as needed) and special studies (specific seasonal objectives)
- The index period was established to:
  - Minimize year-to-year variability resulting from natural events
  - Maximize gear efficiency and accessibility of targeted assemblages
  - Ensure that a portion of the samples is collected during critical low-flow and temperature conditions
- Critical period: July 1–September 30 → minimum streamflows, maximum temperatures, and minimum dissolved oxygen concentrations
  - Collecting a portion of the samples during critical conditions helps determine if criteria set for the designated uses are being met and maintained when streamflow is at or above critical low flow
  - Assumption is that criteria met under these conditions would be met during other seasons when expected streamflow is greater and water temperatures are lower

			<i>Index Period</i>										
<i>Jan</i>	<i>Feb</i>		<i>Mar 15</i>	<i>Apr</i>	<i>May</i>	<i>Jun</i>	<i>Jul 1</i>	<i>Aug</i>	<i>Sep 30</i>	<i>Oct 15</i>		<i>Nov</i>	<i>Dec</i>
			<i>Non-Critical Period</i>				<i>Critical Period</i>			<i>Non-Critical Period</i>	5		

# Temporally Representative Samples

- **Two bioassessment events**

- Both should be collected in the index period
- One of the two events in critical period
- Ideally both samples from same index period
  - Reduces the probability of missing effects of disturbance in the latter portion of the index period

- **More than two bioassessment events**

- Study should be two or more years with two events or more per year
- More than two samples collected during the same year may be considered if:
  - All events should occur during the index period with 1/2 to 2/3 of the events occurring during critical period
  - At least one month between samples
  - Samples collected during periods of moderate to low flow

			<i>Index Period</i>										
<i>Jan</i>	<i>Feb</i>		<i>Mar 15</i>	<i>Apr</i>	<i>May</i>	<i>Jun</i>	<i>Jul 1</i>	<i>Aug</i>	<i>Sep 30</i>	<i>Oct 15</i>		<i>Nov</i>	<i>Dec</i>
			<i>Non-Critical Period</i>				<i>Critical Period</i>			<i>Non-Critical Period</i>	6		



# Bioassessment Process - CV

- Recalculate fish and benthic IBIs
  - Compare recalculated IBI values to reported values
  - Calculate average IBIs and apply Coefficient of Variation (CV) for each Assessment Unit
  - Compare resulting CV corrected average to Aquatic Life Use (ALU) point score ranges to determine if designated or presumed ALU is met

**Ecoregion/Aquatic Life Use Category Specific Coefficients of Variation (CV) for Use with Fish.**

Aquatic Life Use	Ecoregion						
	24	25,26	27,29,32	30	31	33,35	34
Exceptional	2.22% (2)	2.70% (1)	6.28% (6)	4.41% (9)	1.39% (4)	3.87% (6)	-
High	6.13% (46)	-	6.94% (115)	5.05% (138)	12.27% (4)	5.65% (276)	6.04% (9)
Intermediate	7.6% (25)	4.1% (5)	6.38% (164)	7.46% (41)		5.86% (211)	3.3% (6)
Limited	8.25% (42)	14.29% (1)	12.96% (75)	-		6.75% (87)	3.85% (1)

Samples are collected according to sampling protocols described in TCEQ Surface Water Quality Monitoring Procedures, Volume 2. Each CV represents the average of all ecoregion/Aquatic Life Use Category specific pairwise comparisons used to derive the CV's. The number of pairwise comparisons used to calculate the average is given in parentheses.

# Sample Size and Assessment Outcome

Assessment Method	Use Attainment or Concern Assessment	Data Qualifier					
		Inadequate Data (ID)		Limited Data (LD)		Adequate Data (AD)	
		Minimum Sample Size	Level(s) of Parameter Support	Minimum Sample Size	Level(s) of Parameter Support	Minimum Sample Size	Level(s) of Parameter Support
Habitat	Concern Assessment	0	Not Assessed (NA)	1	Screening Level Concern (CS) No Concern (NC)	2	Screening Level Concern (CS) No Concern (NC)
Macrobenthic community	Use Attainment	0	Not Assessed (NA)	1	Use Concern (CN) No Concern (NC)	2	Nonsupport (NS) Use Concern (CN) Fully Supporting (FS)
Fish community	Use Attainment	0	Not Assessed (NA)	1	Use Concern (CN) No Concern (NC)	2	Nonsupport (NS) Use Concern (CN) Fully Supporting (FS)



## Decision Matrix for Integrated Assessments of Aquatic Life Use (ALU) Support

Overall ALU Support based on Bioassessment, Dissolved Oxygen, Toxics in Water, and Ambient Toxicity in Water. For three or more lines of evidence, unless otherwise illustrated here, nonattainment of any line of evidence discussed here results in nonsupport of the ALU.

Bioassessment Data	Aquatic Life Use Support Attainment					
	Dissolved Oxygen Data		Toxics in Water Testing		Habitat Assessment	
	Meets Criteria**	DO Not Meet Criteria	All Meet Criteria	Do Not Meet Criteria	Meets Screening Criteria	Does Not Meet Screening Criteria (reported as a concern)
Benthic macroinvertebrate and fish bioassessments done and both attain designated ALU	Fully Supported	Not Supported*	Fully Supported	Not Supported	Fully Supported	Fully Supported *
Benthic macroinvertebrate and fish bioassessments done and one of the two does not attain designated ALU	Fully Supporting with a Concern for fish or benthics	Not Supported	Fully Supporting with a Concern for fish or benthics	Not Supported	Fully Supporting with a Concern for fish or benthics	Fully Supporting with a Concern for fish or benthics
Both benthic macroinvertebrate and fish bioassessment done and both indicate non-attainment of designated ALU	Not Supported	Not Supported	Not Supported	Not Supported	Not Supported	Not Supported
Only fish bioassessment done and indicates nonattainment of designated ALU	Not Supported	Not Supported	Not Supported	Not Supported	Not Supported	Not Supported
Only benthic macroinvertebrate bioassessment done and indicates nonattainment of designated ALU	Not Supported	Not Supported	Not Supported	Not Supported	Not Supported	Not Supported
Only fish bioassessment collected. Fish indicates attainment of designated ALU***	Fully Supported	Not Supported*	Fully Supported	Not Supported	Fully Supported	Fully Supported *
Only benthic macroinvertebrate bioassessment done and indicates attainment of designated ALU***	Fully Supported	Not Supported*	Fully Supported	Not Supported	Fully Supported	Fully Supported *
Bioassessment data not available	Fully Supported	Not Supported	Fully Supported	Not Supported	Fully Supported	Not Supported**

Both fish and macroinvertebrate samples are required to make an ALU attainment determination for 305(b)/303(d) assessment purposes. In certain cases where it is only possible to collect one or the other, the ALU determination may be made based on only fish or benthic macroinvertebrates according to the framework presented in this table. Proper justification is required for why only one type of community was sampled.

\* Long-term bioassessment monitoring will be conducted to determine if adverse effects to the fish and/or benthic macroinvertebrates are detected.

\*\* When the habitat index indicates nonsupport, the habitat attainment status is reported as a concern.

\*\*\* When it is only possible, or appropriate (e.g. due to habitat limitations), to sample either the fish or benthic macroinvertebrate assemblage then the results will be evaluated for support. If samples are collected for only one assemblage but it would be possible or appropriate to sample both the fish and benthic macroinvertebrate assemblage then results will be evaluated as a concern.

# Example Dataset No. 1

Stn. ID	AU ID	Date	Presumed Use	Eco-region	Fish Regional IBI Score	ALU Indicated by Regional Fish IBI Score	Statewide Benthic IBI Score	ALU Indicated by Statewide Benthic IBI Score	N	HQI	ALU Indicated by HQI Score
00000	0000_01	9/15/2010	H	30	51	H	41	E	232	24	H
00000	0000_01	3/16/2010	H	30	50	H	35	H	155	24	H
00000	0000_01	3/16/2011	H	30	49	H	35	H	228	23.5	H
00000	0000_01	7/25/2011	H	30	48	H	35	H	132	21.5	H
<b>Presumed High ALU based on routine Flow Data</b>  <b>ER 30 High ALU Fish Criterion: <math>\geq 42</math></b> <b>Statewide High ALU Benthic Criterion: <math>\geq 29</math></b> <b>Statewide High ALU Habitat Criterion: <math>\geq 20</math></b>				Average	<b>49.5</b>	<b>H</b>	<b>36.5</b>	<b>E</b>		<b>23.3</b>	<b>H</b>
				CV	0.0505		0.0647				
				CV*AVG	2.49975		2.36155				
				(CV*AVG) + AVG	<b>51.99975</b>	<b>E</b>	<b>38.86155</b>	<b>E</b>			
				Sample Std. Dev.	1.2909944		3				
				Sample CV	0.0260807		0.08219				

Ecoregion/Aquatic Life Use Category Specific Coefficients of Variation (CV) for Use with Fish.								
Aquatic Life Use	Ecoregion							
	24	25,26	27,29,32	30	31	33,35	34	
Exceptional	2.22% (2)	2.70% (1)	6.28% (6)	4.41% (9)	1.39% (4)	3.87% (6)	-	
High	6.13% (46)	-	6.94% (115)	5.05% (138)	12.27% (4)	5.65% (276)	6.04% (9)	
Intermediate	7.6% (25)	4.1% (5)	6.38% (164)	7.46% (41)		5.86% (211)	3.3% (6)	
Limited	8.25% (42)	14.29% (1)	12.96% (75)	-		6.75% (87)	3.85% (1)	
Presumed High ALU based on routine Flow Data		Average	49.5	H	36.5	E		23.3
		CV	0.0505		0.0647			
		CV*AVG	2.49975		2.36155			
		(CV*AVG) + AVG	51.99975	E	38.86155	E		
		Sample Std. Dev.	1.2909944		3			
		Sample CV	0.0260807		0.08219			
ER 30 High ALU Fish Criterion: ≥42 Statewide High ALU Benthic Criterion: ≥29 Statewide High ALU Habitat Criterion: ≥ 20								



Ecoregion/Aquatic Life Use Category Specific Coefficients of Variation (CV) for Use with Benthic Macroinvertebrates.							HQI	ALU Indicated by HQI Score		
Aquatic Life Use	Ecoregion									
	27, 29, 32	30	31	33, 35	34					
Exceptional	-	6.47% (6)	-	4.45% (6)	-					
High	5.22% (24)	5.95% (40)	6.90% (1)	6.28% (56)	5.09% (9)		24	H		
Intermediate	6.06% (23)	6.43% (13)	8.76% (2)	8.98% (76)	6.31% (7)		24	H		
Limited	9.78% (5)	-	-	7.42% (12)	-		23.5	H		
							21.5	H		
Presumed High ALU based on routine Flow Data  ER 30 High ALU Fish Criterion: $\geq 42$ Statewide High ALU Benthic Criterion: $\geq 29$ Statewide High ALU Habitat Criterion: $> 20$		Average	49.5	H	36.5	E		23.3	H	
		CV	0.0505			0.0647				
		CV*AVG	2.49975			2.36155				
		(CV*AVG) + AVG	51.99975		E	38.86155	E			
		Sample Std. Dev.	1.2909944			3				
		Sample CV	0.0260807			0.08219				

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00000	0000_01	9/15/2010	H	30	51	H	41	E	232	24	H
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				CV	0.0505		0.0647				
				CV*AVG	2.49975		2.36155				
				(CV*AVG) + AVG	51.99975	E	38.86155	E			
				Results: Fully supporting fish, Fully supporting benthics, No concern for habitat							

13

Example Dataset No. 2

Stn. ID	AU ID	Date	Designated Use	Eco-region	Fish Regional IBI Score	ALU Indicated by Regional Fish IBI Score	Statewide Benthic IBI Score	ALU Indicated by Statewide Benthic IBI Score	N	HQI	ALU Indicated by HQI Score
00001	0000_02	3/30/2010	I	33	44	H	19	L	204	19.5	H
00001	0000_02	7/14/2010	I	33	48	H	20	L	219	17.5	I
00002	0000_02	3/30/2010	I	33	40	I	16	L	214	19.5	H
00002	0000_02	7/14/2010	I	33	45	H	21	L	219	18	I
<div>Designated Intermediate ALU based on TSWQS Appendix D</div> <div>ER 33 Intermediate ALU Fish Criterion: <math>\geq 36</math></div> <div>Statewide Intermediate ALU Benthic Criterion: <math>\geq 22</math></div> <div>Statewide Intermediate ALU Habitat Criterion: <math>\geq 14</math></div>				Average	44.25	H	19	L		18.6	I
				CV	0.0565		0.0742				
				CV*AVG	2.500125		1.4098				
				(CV*AVG) + AVG	46.75013	H	20.4098	L			
				Sample Std. Dev.	3.304038		2.160247				
				Sample CV	0.074667		0.113697				14



Ecoregion/Aquatic Life Use Category Specific Coefficients of Variation (CV) for Use with Fish.							
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	CV	0.0565		0.0742				
	CV*AVG	2.500125		1.4098				
	(CV*AVG) + AVG	46.75013	H	20.4098	L			
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Ecoregion/Aquatic Life Use Category Specific Coefficients of Variation (CV) for Use with Benthic Macroinvertebrates.							HQI	ALU Indicated by HQI Score	
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		CV	0.0565		0.0742				
		CV*AVG	2.500125		1.4098				
		(CV*AVG) + AVG	46.75013	H	20.4098	L			
		Sample Std. Dev.	3.304038		2.160247				
		Sample CV	0.074667		0.113697				16

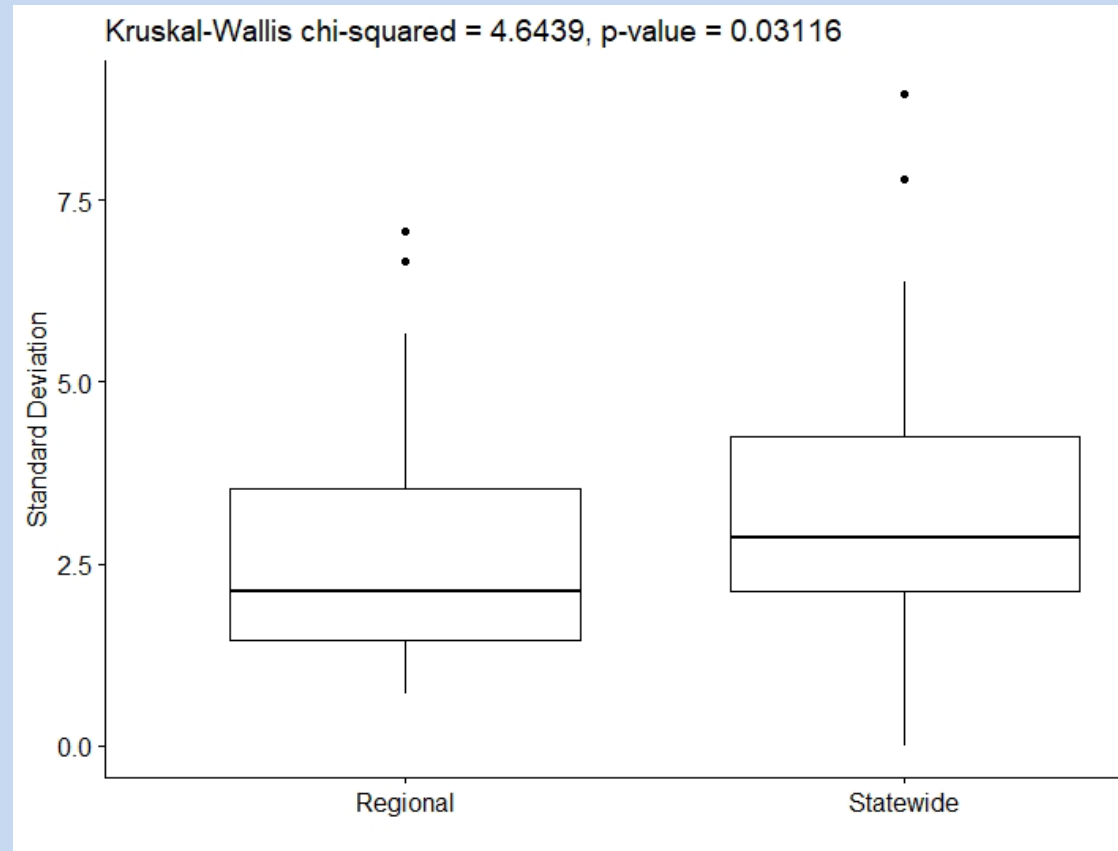
Example Dataset No. 2

Stn. ID	AU ID	Date	Designated Use	Eco-region	Fish Regional IBI Score	ALU Indicated by Regional Fish IBI Score	Statewide Benthic IBI Score	ALU Indicated by Statewide Benthic IBI Score	N	HQI	ALU Indicated by HQI Score
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Designated Intermediate ALU based on TSWQS Appendix D				Average	44.25	H	19	L		18.6	I
				CV	0.0565		0.0742				
				CV*AVG	2.500125		1.4098				
				(CV*AVG) ± AVG	46.75013	H	20.4098	L			
				Results: Fully supporting fish, Not supporting benthics (reported as a concern, rather than non-support because fish are FS), No concern for habitat							
ER 33 Intermediate ALU Fish Criterion: ≥ 36											
Statewide Intermediate ALU Benthic Criterion: ≥22											
Statewide Intermediate ALU Habitat Criterion: ≥ 14											

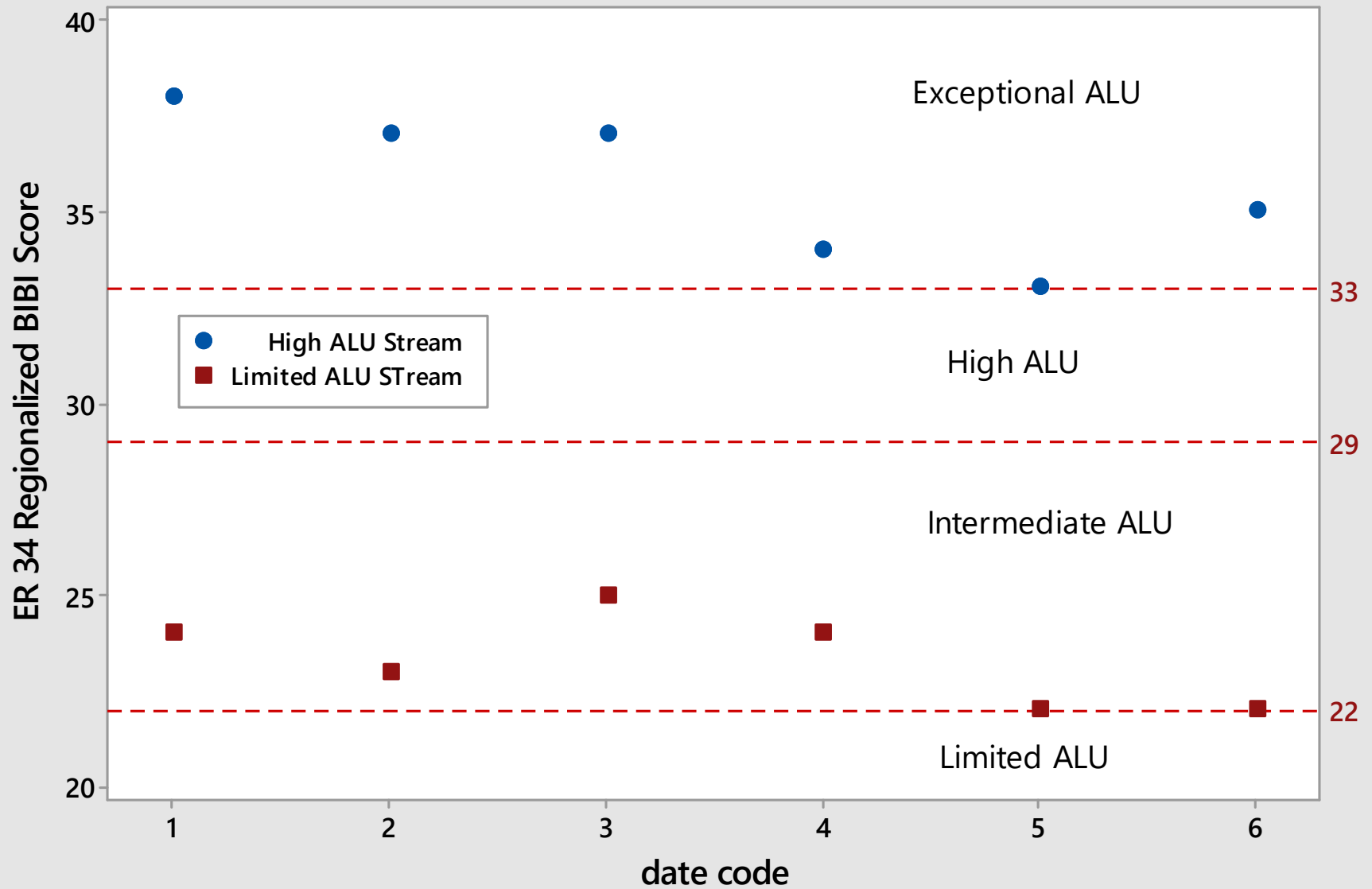


# Application of Regionalized Benthic IBIs

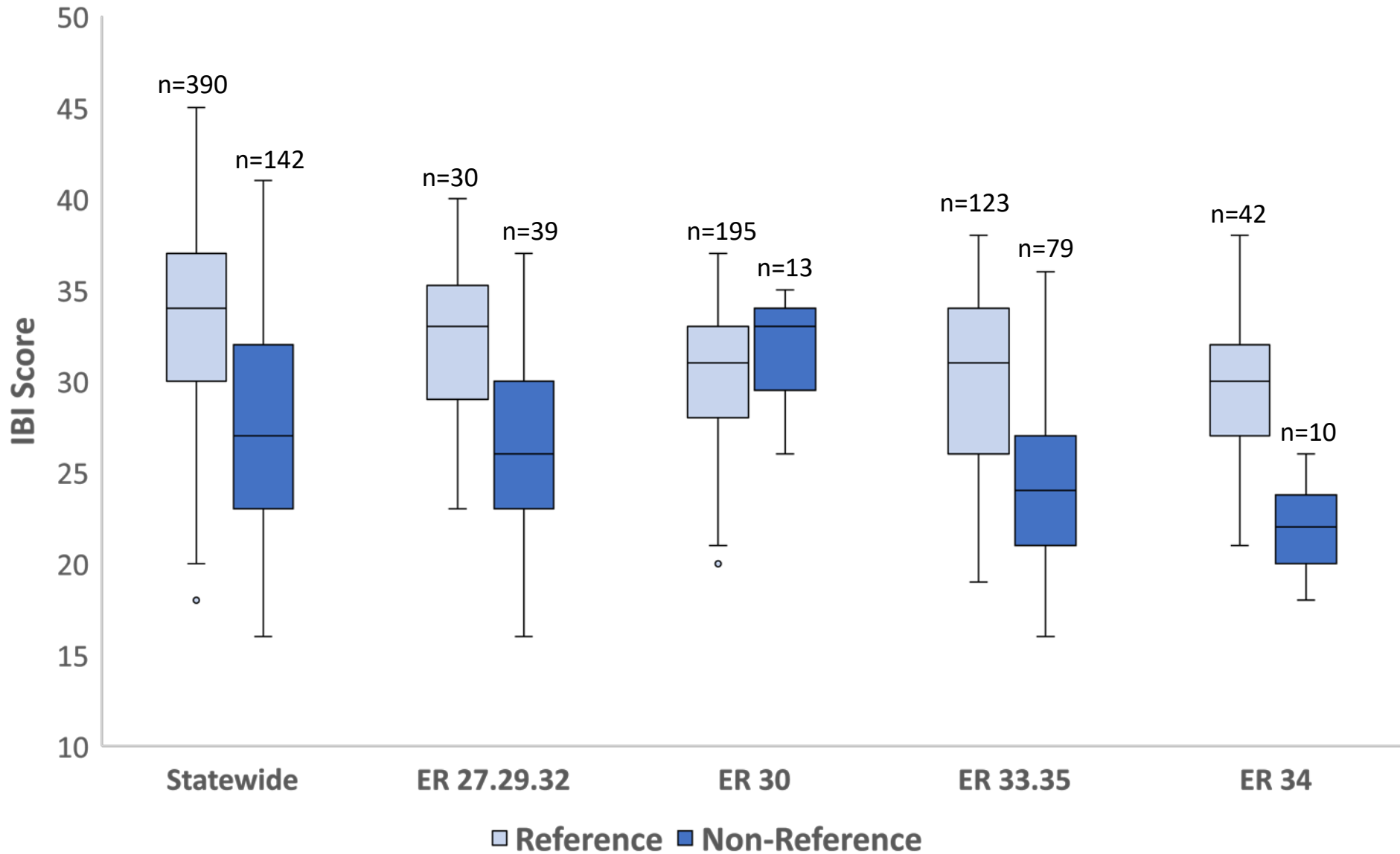
- Comparison using 2018 IR results
  - Recalculated each IBI score using regionalized metric sets
  - Applied CV correction to resulting mean IBI score and compared to ALU point score ranges
- Results:
  - 13 new use concerns
    - 6 are within the 2020 IR Period of Record
  - 1 new non-supporting
  - 1 new fully supporting
  - Generally lower variability in regionalized datasets



Scatterplot of ER 34 Regionalized IBI scores for 6 sample events at a stream with designated High ALU and a stream with a designated Limited ALU as example of the ability of the regionalized IBI to distinguish between streams of differing classes.

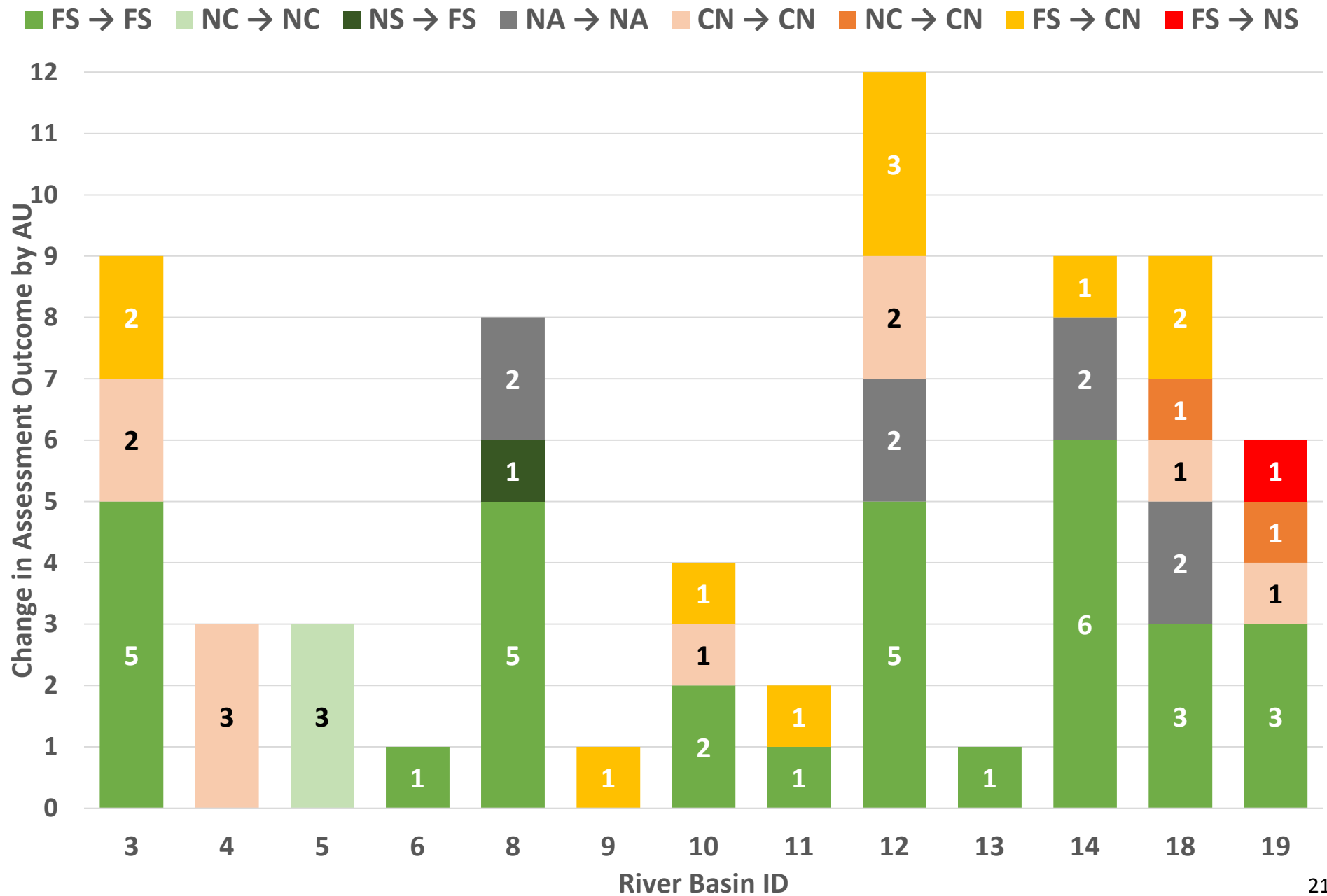


# Comparison of Regionalized and Statewide IBI Scores from Reference and Non-Reference Datasets





# Change in 2018 IR Assessment Outcome from Statewide to Regionalized Benthic IBI Summarized by River Basin



# Bioassessment Resources

- TCEQ Surface Water Quality Monitoring Procedures, Volume 2
  - <https://www.tceq.texas.gov/publications/rg/rg-416>
  - Chapter 2 – Biological monitoring requirements
  - Chapter 3 – Freshwater fish collection methods
  - Chapter 5 – Freshwater benthic macroinvertebrate collection methods
  - Chapter 9 – Physical habitat data collection methods
  - Appendix B – IBI metric sets for fish and benthic macroinvertebrates
  - Appendix C – Data collection forms and HQI metric set
  - Appendix D – Biological Monitoring Fact Sheets
- Draft 2018 Guidance for Assessing and Reporting Surface Water Quality in Texas
  - [https://www.tceq.texas.gov/assets/public/waterquality/swqm/assess/gawg/2018/2018\\_guidance.pdf](https://www.tceq.texas.gov/assets/public/waterquality/swqm/assess/gawg/2018/2018_guidance.pdf)
  - Chapter 3 – Fish and benthic community assessment methods
  - Appendix D – Application of the CV to determine aquatic life use attainment

# Next Steps

- Consider feedback from the 2020 Guidance Advisory Workgroup meeting
- Apply regionalized benthic IBIs to 2020 IR bioassessment data
  - Statewide metric set will be used for ER 25/26 and ER 31 – regionalized metrics still being developed for these ecoregions
- Questions, Comments, Concerns?
- [Lauren.Pulliam@tceq.texas.gov](mailto:Lauren.Pulliam@tceq.texas.gov)

