Welcome to the February 23 Nutrient Forum Meeting!

Thank you for joining us today!

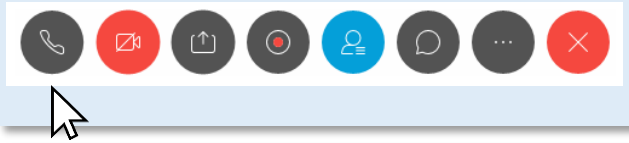
- ✓ Please make sure you are muted upon entering the webinar
- ✓ We will be starting shortly

Welcome

Please connect your audio using steps 1, 2, and 3

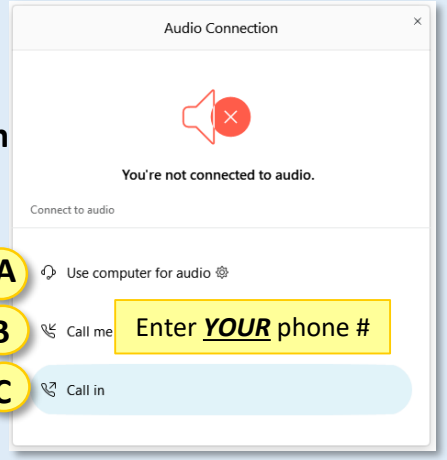
We will do a sound check shortly

1 **Move cursor to bottom of your screen to show Webex controls.**



2 **Select "Connect to Audio" icon.**

3 **Choose Audio Connection**



3 Options

A. Use computer for audio

B. Call me at (enter your phone number)

- WebEx calls you.
  - You listen through your phone

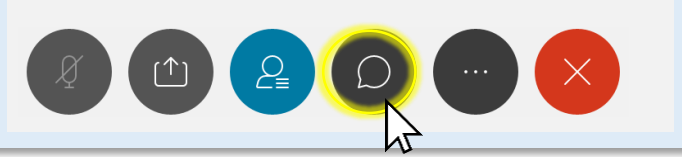
C. Call in (using your phone)

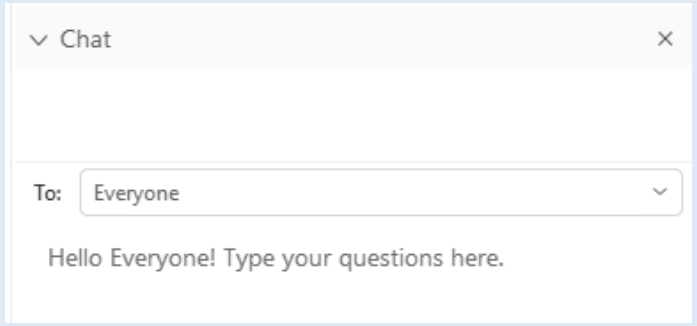
- Call toll free: 855-929-3239
- Enter meeting code

NOTHING WORKING? Use the chat box to send us a message.

How to Participate

You can ask questions via the chat function

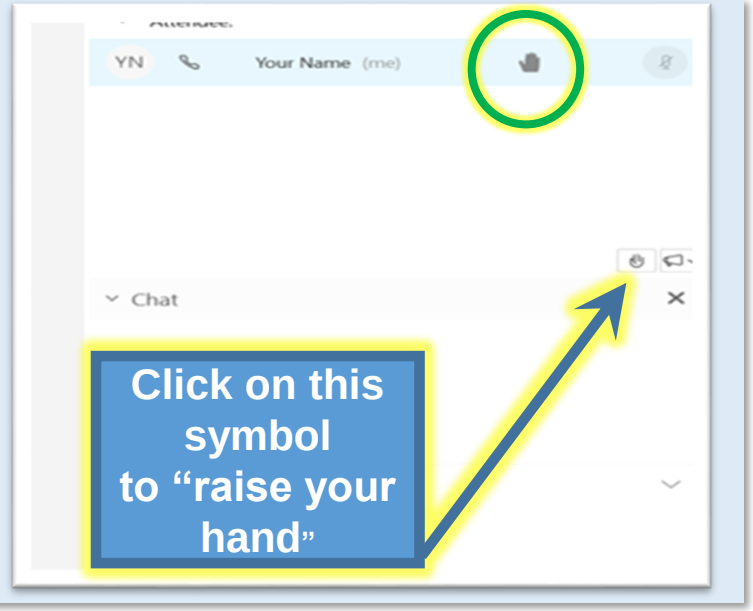


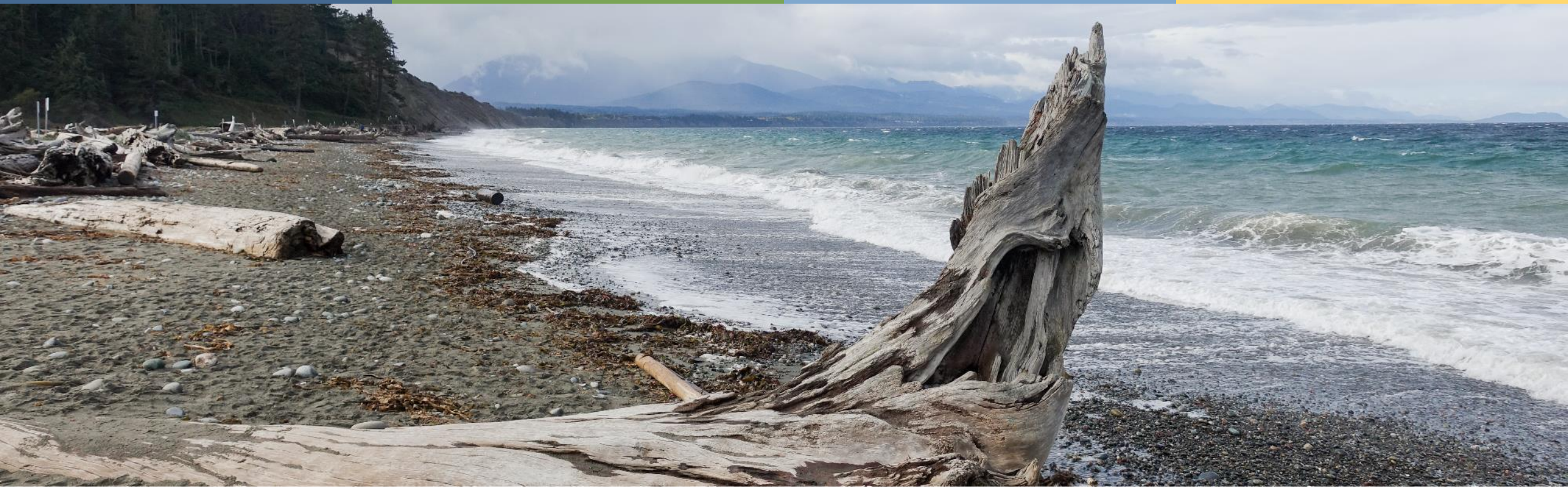


You can also ask questions by raising your hand so we can unmute you to participate

We ask that you:

1. **State your name** first before speaking.
2. **Mute your audio** unless speaking.
3. **Lower your hand** when you are done speaking



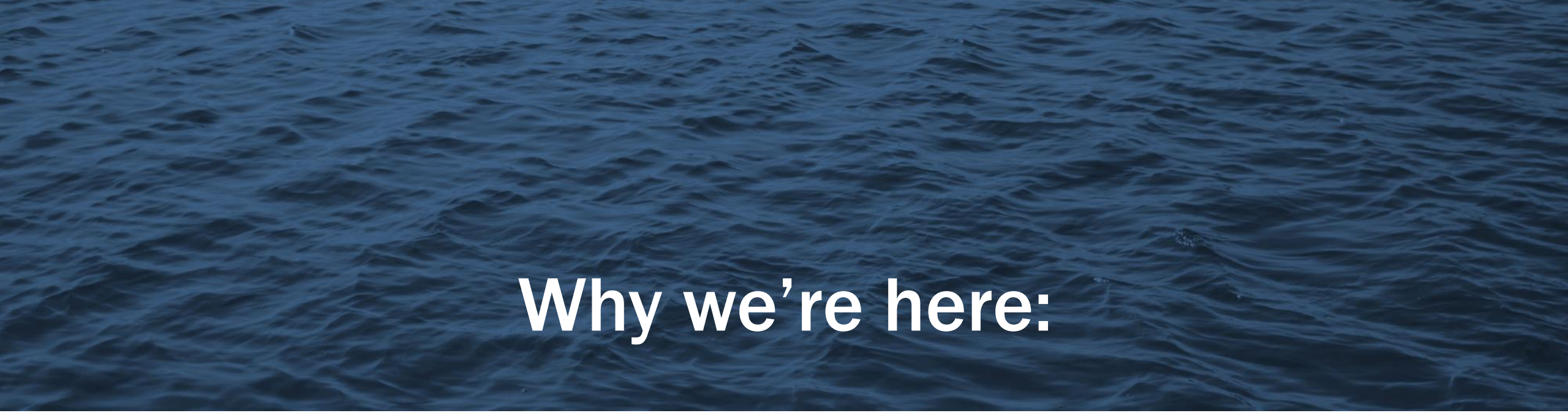


Puget Sound Nutrient Forum

Next phase of Salish Sea Modeling Scenarios

February 23, 2022

DEPARTMENT OF ECOLOGY
State of Washington



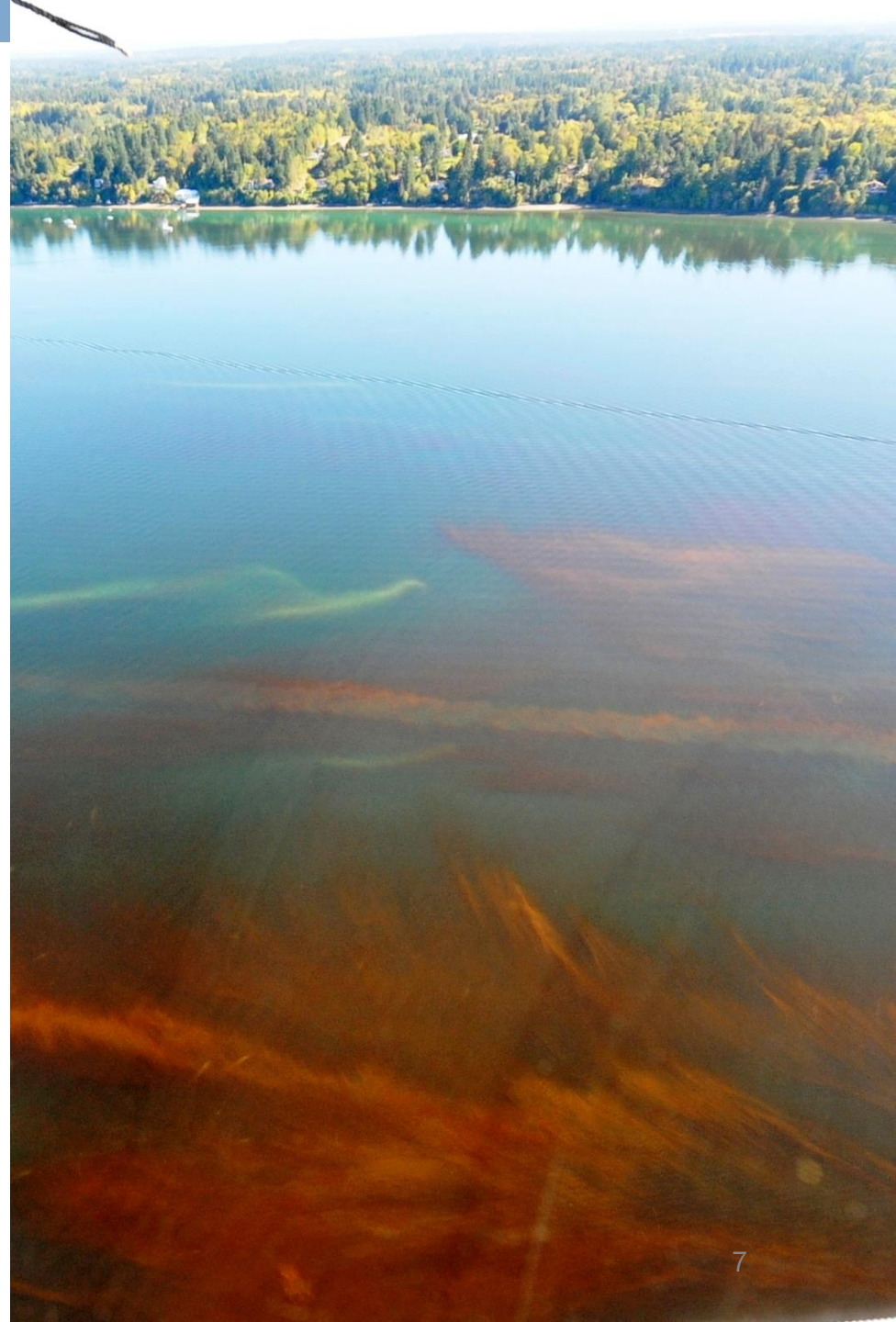
Why we're here:

to restore Puget Sound.

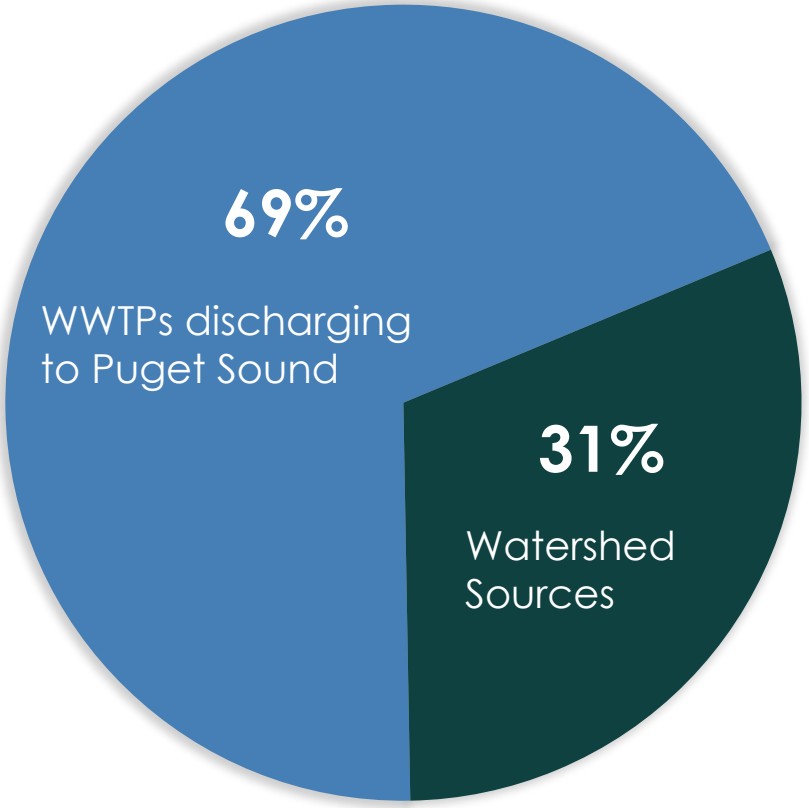
Table of Contents

Our strategy: reduce human sources of nutrients

- Focus on where we can make biggest and fastest impact to meet standards
- Continue modeling: identify areas most sensitive to human actions
- Define levels of reductions needed from WWTPs and watersheds

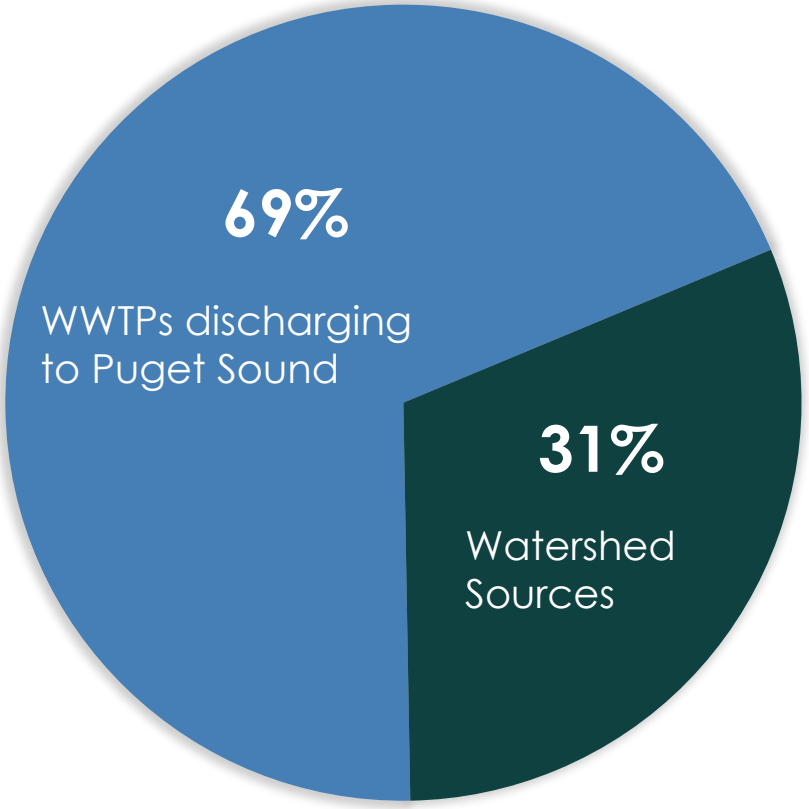


Focus on where we can make biggest and fastest impact to meet standards



Nitrogen load of human sources of nutrients

Focus on where we can make biggest and fastest impact to meet standards

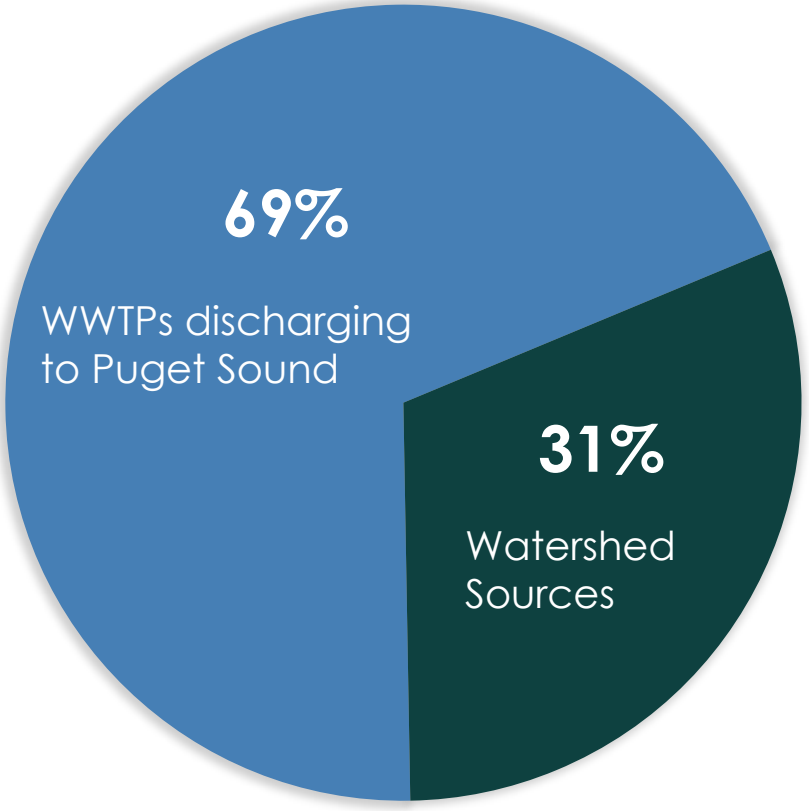


Nitrogen load of human sources of nutrients

What we learned from Bounding Scenarios Report (2019):

- Confirmed human sources of nutrients exacerbate low DO
- WWTP discharges contribute to low DO
- Watershed nutrient loads also contribute to low DO

Focus on where we can make biggest and fastest impact to meet standards



Nitrogen load of human sources of nutrients

What we learned from Bounding Scenarios Report (2019):

- Confirmed human sources of nutrients exacerbate low DO
- WWTP discharges contribute to low DO
- Watershed nutrient loads also contribute to low DO

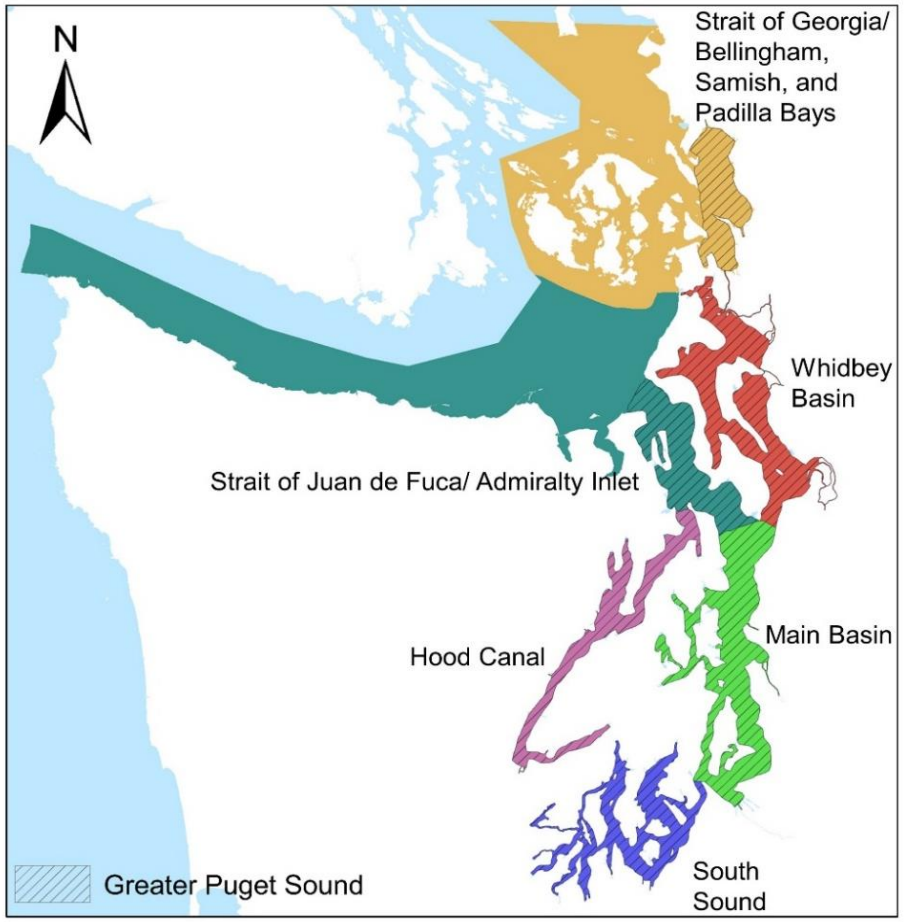
Clean Water Act Responsibility

Continue modeling: identify areas most sensitive to human actions

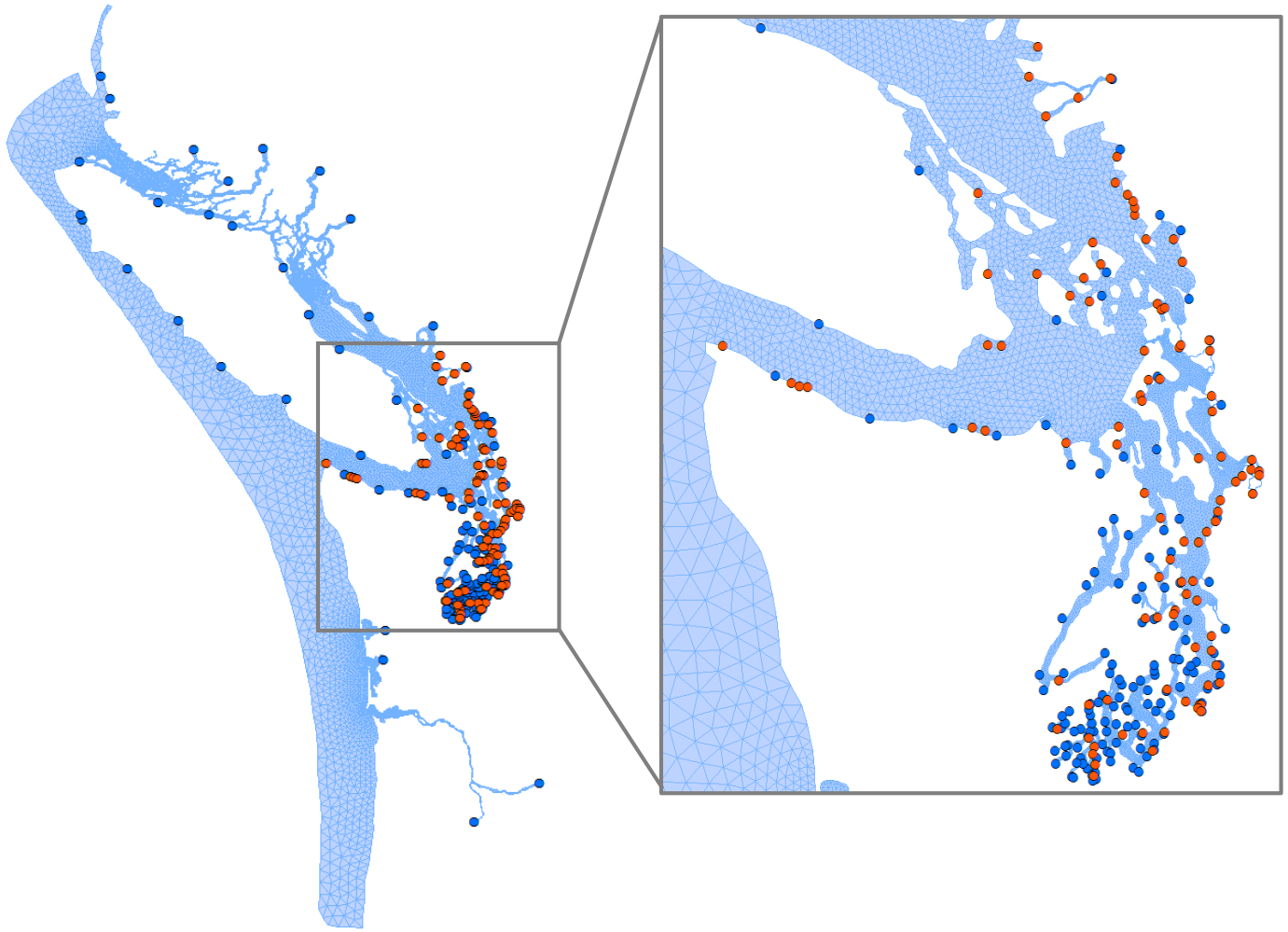
Evaluated different combinations of marine and watershed source reductions

Use results to design next set of modeling scenarios

Identify combination of reductions that leads to most improvement



Define levels of reductions needed to meet standards



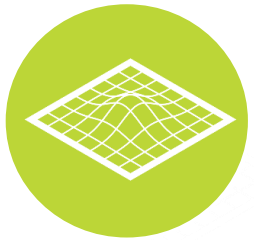
Marine point sources

→ NPDES permit limits

Watersheds

→ Point source targets
Nonpoint source targets

Puget Sound Nutrient Reduction Plan



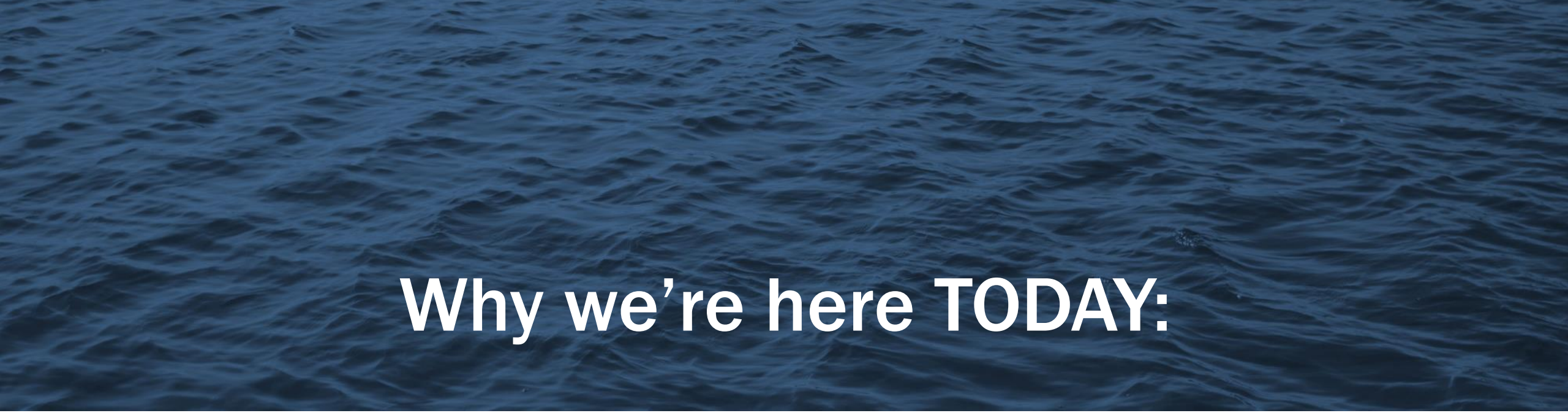
Modeling informs nutrient targets

Nutrient limits (NPDES) for WWTPs

Watershed targets and actions

Financial & technical assistance

Effectiveness monitoring & adaptive management



Why we're here TODAY:

to present on the next phase of Salish Sea modeling.

Brief Recap: Key things we learned from our most recent Salish Sea modeling

Key Terms

Scenario: refers to one model run or a set of model runs that when evaluated with the Salish Sea model informs the answers to a specific nutrient management question

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Key Terms

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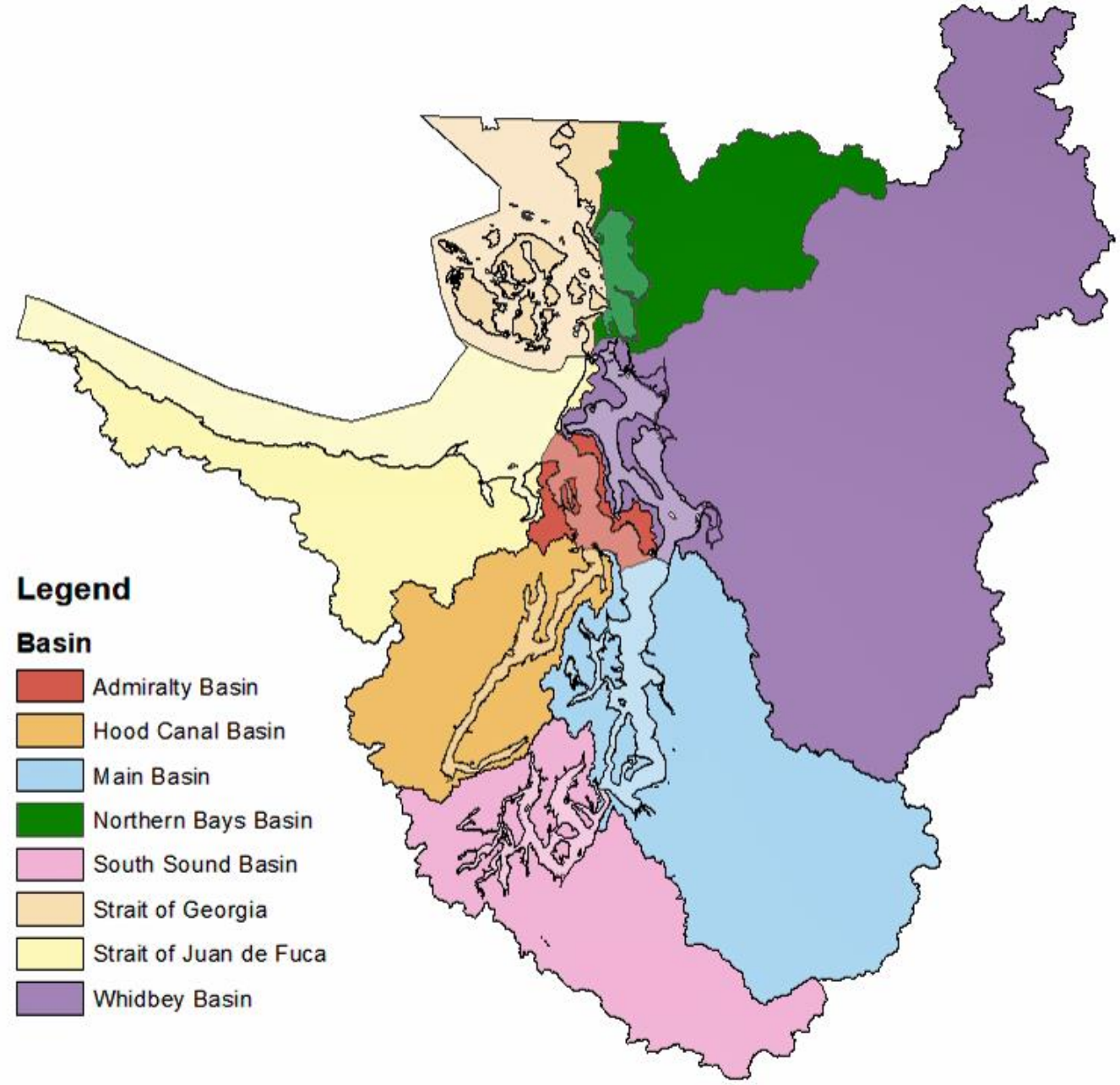
Watershed load: nutrient inputs that originate in a watershed and are discharged into the Salish Sea via rivers and streams, both point and nonpoint sources.

Wastewater treatment plant (WWTP): WWTPs that directly discharge to Puget Sound

Key Terms

Basin: Marine waters that share hydrodynamic characteristics and upland watersheds

Region: All basins combined in the WA waters the Salish Sea



Year 1 Optimization Scenarios

2019: developed 5 “scenarios” with Forum

- Watershed nutrient reductions by region
- Wastewater treatment plant (WWTP) reductions by region
- Annual vs. seasonal treatment at WWTPs
- Projected future population growth impacts
- Combinations of watershed and WWTP reductions

Recent modeling results highlights

We confirmed reductions in nutrients lead to significant improvement in water quality

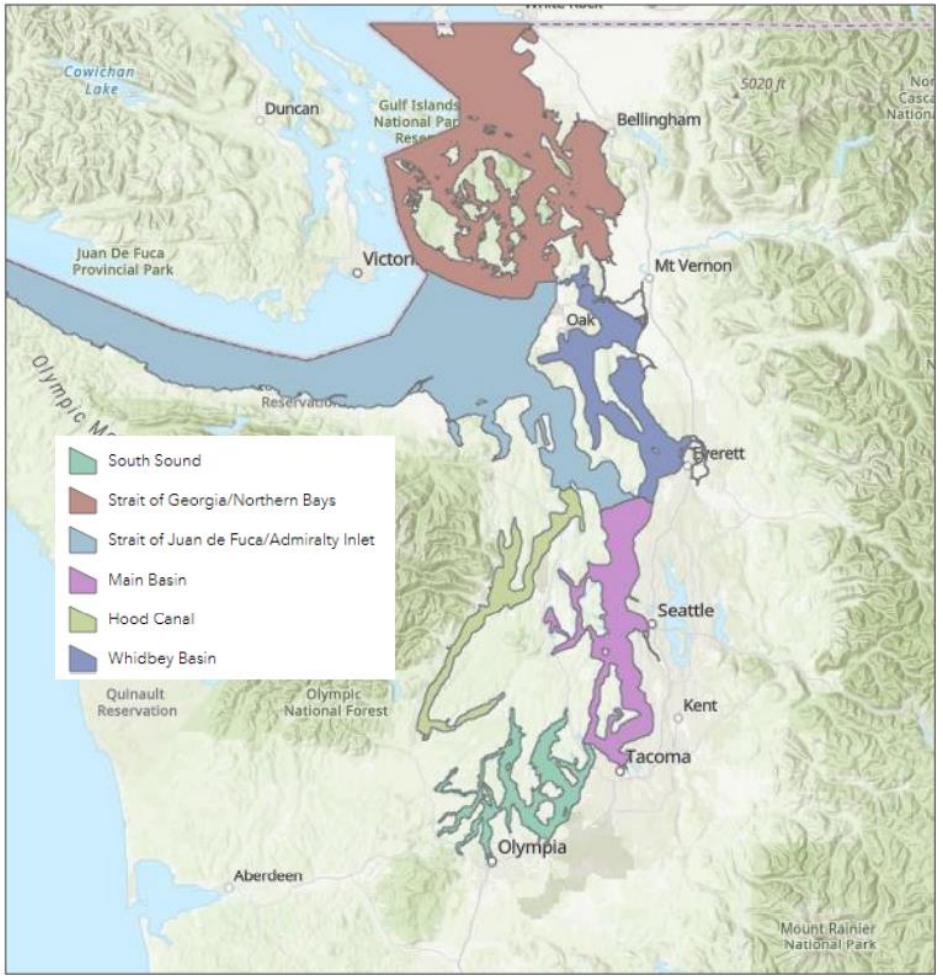
We need reductions from both WWTPs and watersheds to meet standards

Higher regional population will lead to even worse DO problems if no actions are taken

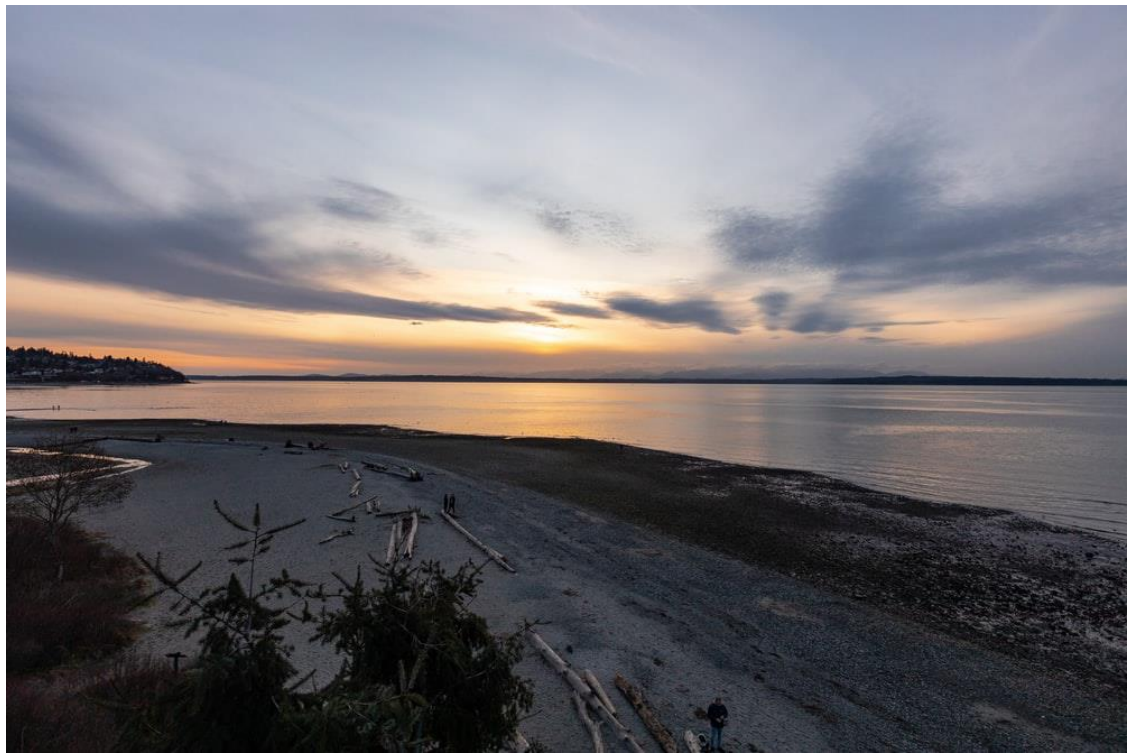
We need to test more nutrient reduction combinations

Scenario 1: Watershed reductions in certain basins led to improvement in basin and other regions

- South Sound
- Main Basin
- Whidbey Basin
- Strait of Georgia and Northern Bays



Scenario 2: WWTP reductions in certain basins led to improvement in basin and other regions



- South Sound
- Main Basin
- Whidbey
- Strait of Georgia & Northern Bays

Scenario 5: What combination of watershed and WWTP reductions are needed to meet DO standards?

Scenario 5 Combination	WWTP Treatment Level (mg/L)	Watershed Reduction
A	8mg/L	15%
B	8	40%
C	Balanced	40%
D	3	40%
E	3	65%

Nutrient reduction combinations led to most improvement

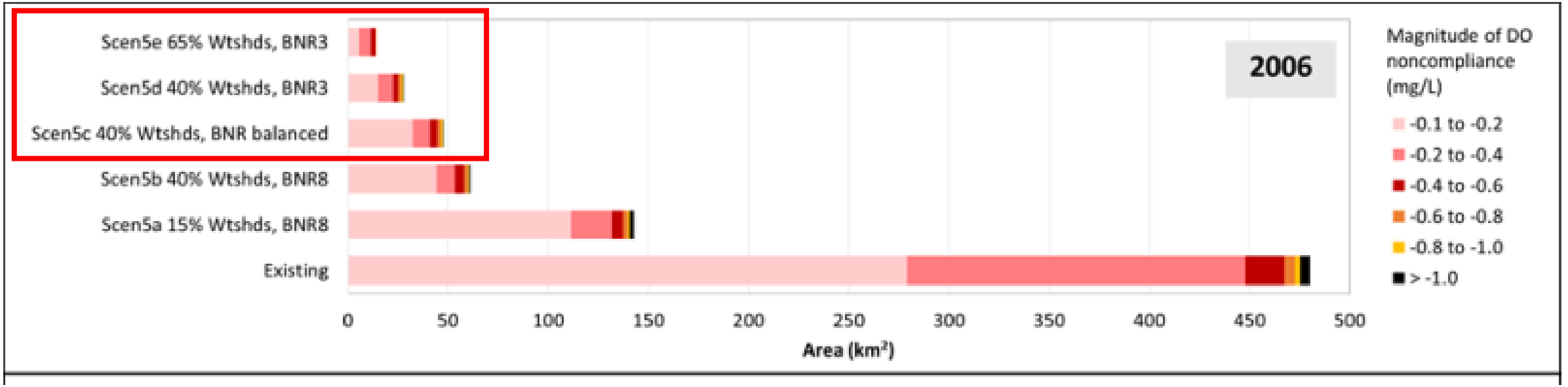


Figure 14. Distribution of magnitudes of predicted DO noncompliance within the total noncompliant area in WA waters of the Salish Sea across all Scenario 5 runs in 2006 (top) and 2014 (bottom).

*DO levels did not improve everywhere

Where we're going

Next phase of modeling: **defining the level of reduction needed** from all sources

2018 - 2019

Bounding Scenarios Report

2019 - 2021

Year 1 SSM tech memo

2022 - 2023

Next phase of modeling

More nutrient reduction combinations to develop reduction targets

2023 - 2024

Volume 2: Salish Sea Modeling Report

+

Puget Sound Nutrient Reduction Plan

High-Level Overview of Year 2 Optimization Scenario Proposal

Topics for Today

- How we designed and use Year 2 Scenarios
- WWTP Frameworks
- Watershed Frameworks
- Year 2 Scenario Proposal
- Q&A followed by a *short break*
- Deeper-dive into details along with Q&A

Year 2 Scenario Goal

Find the nutrient reduction scenario/s that result in the highest predicted attainment of DO standards in the Washington waters of the Salish Sea.

Reducing Total Human Nutrient Loads Improves DO

DEPARTMENT OF ECOLOGY
State of Washington

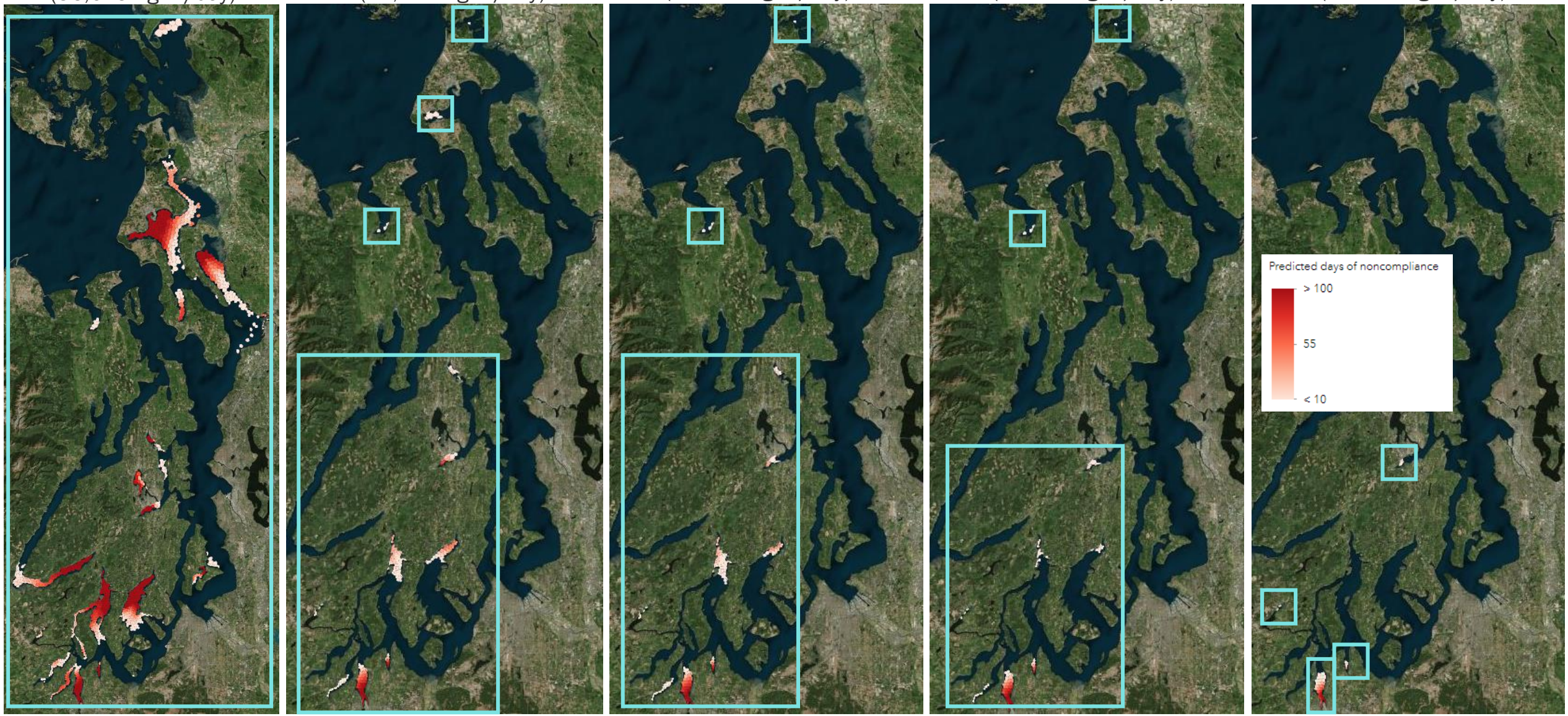
2006 Existing
(56,079 kgTN/day)

Scenario 5b
(27,682 kgTN/day)

Scenario 5c
(24,678 kgTN/day)

Scenario 5d
(20,717 kgTN/day)

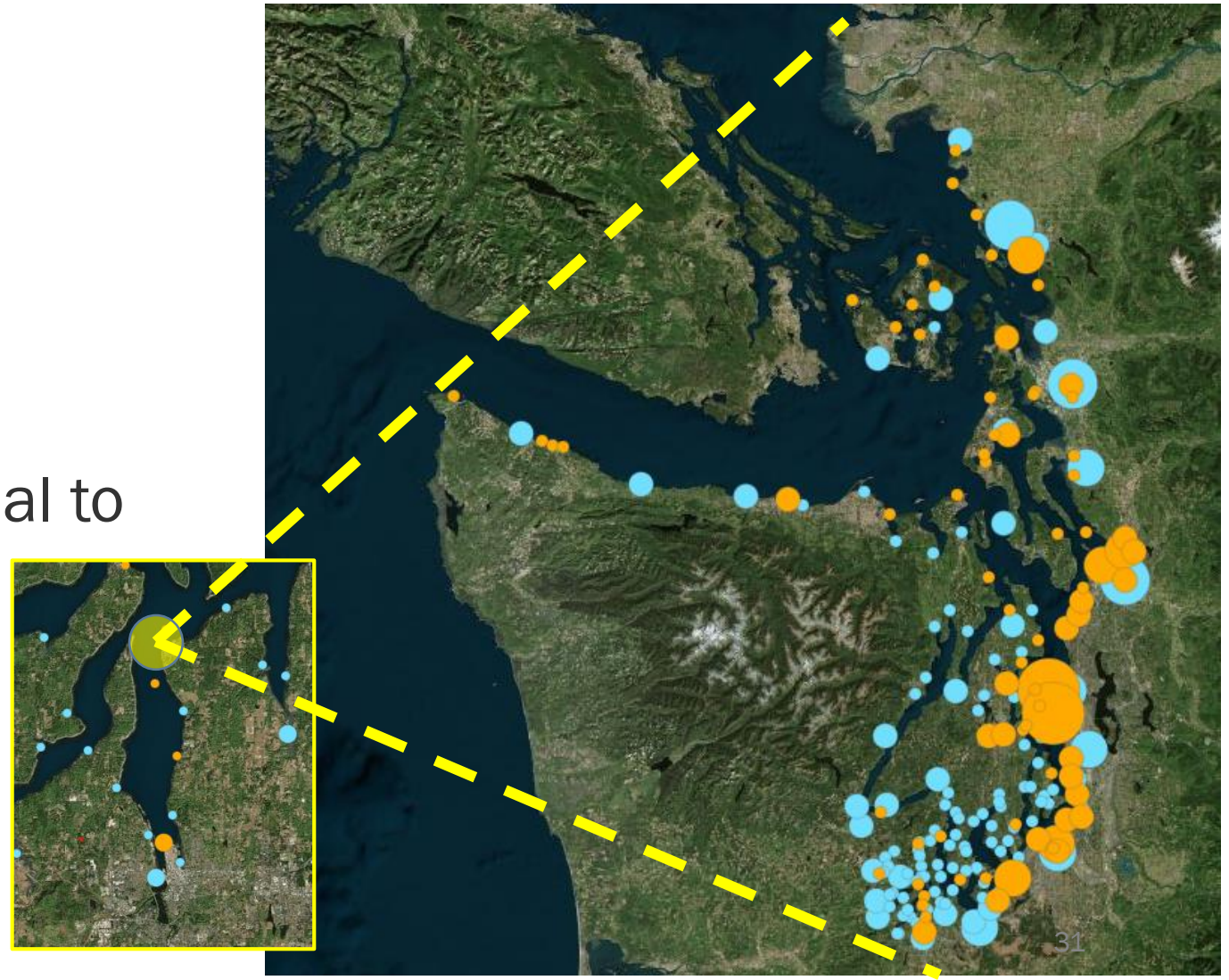
Scenario 5e
(15,956 kgTN/day)



Metrics for DO Improvement

1. Marine DO Water Quality Standards

2. Budd Inlet DO TMDL bubble allocation for regional anthropogenic sources external to Budd Inlet.



WWTPs reduce Nitrogen
Watersheds reduce Nitrogen & Carbon

What is the best way to meet DO Standards?

Scenario 5b

Scenario 5d

Year 2 Scenario

Target TN Load Range for Scenarios

	2006 EXISTING Anthropogenic TN load (kg/day)		2006 Scenario 5b Anthropogenic TN Load (kg/day)		2006 Scenario 5c Anthropogenic TN Load (kg/day)		2006 Scenario 5d Anthropogenic TN Load (kg/day)		2006 Scenario 5e Anthropogenic TN Load (kg/day)	
	Watersheds	WWTPs	Watersheds	WWTPs	Watersheds	WWTPs	Watersheds	WWTP	Watersheds	WWTPs
Regional TN Load Target (by major source category)	18,673	37,406	11,428	16,254	11,428	13,250	11,427	9,290	6,666	9,290
Total Regional TN Load Target	56,079		27,682		24,678		20,717		15,956	

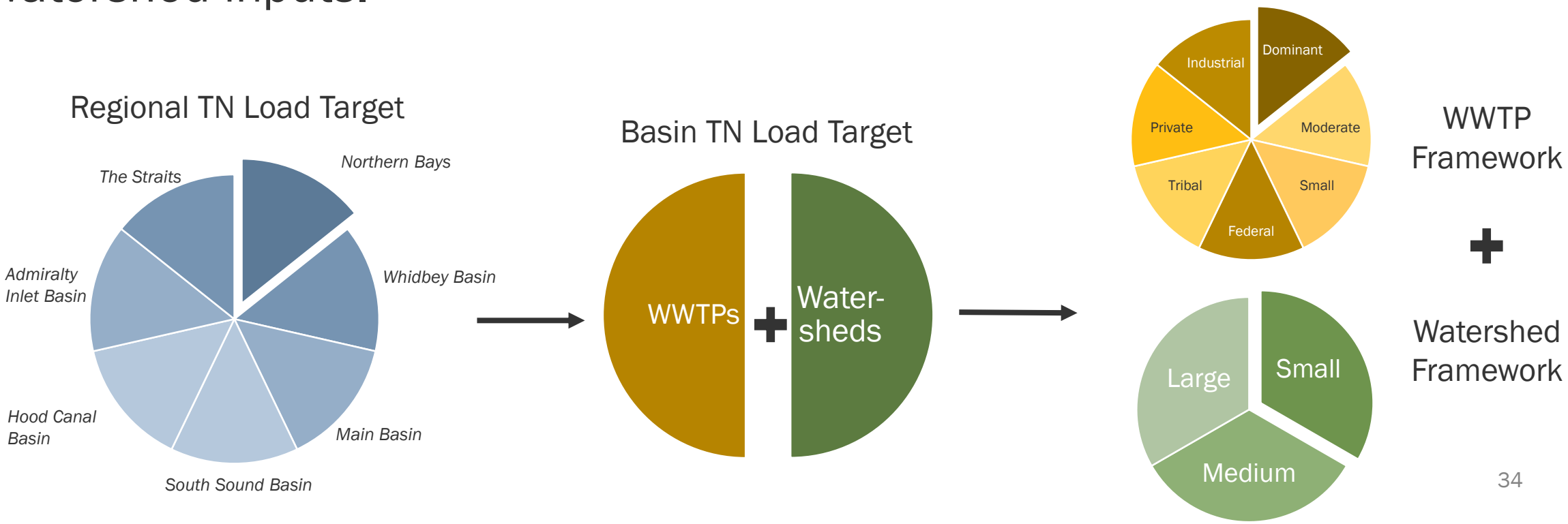
Testing scenarios within this range of TN loads

Proposed scenarios distribute loads in different ways while staying in the range defined by Scenarios 5b – 5e

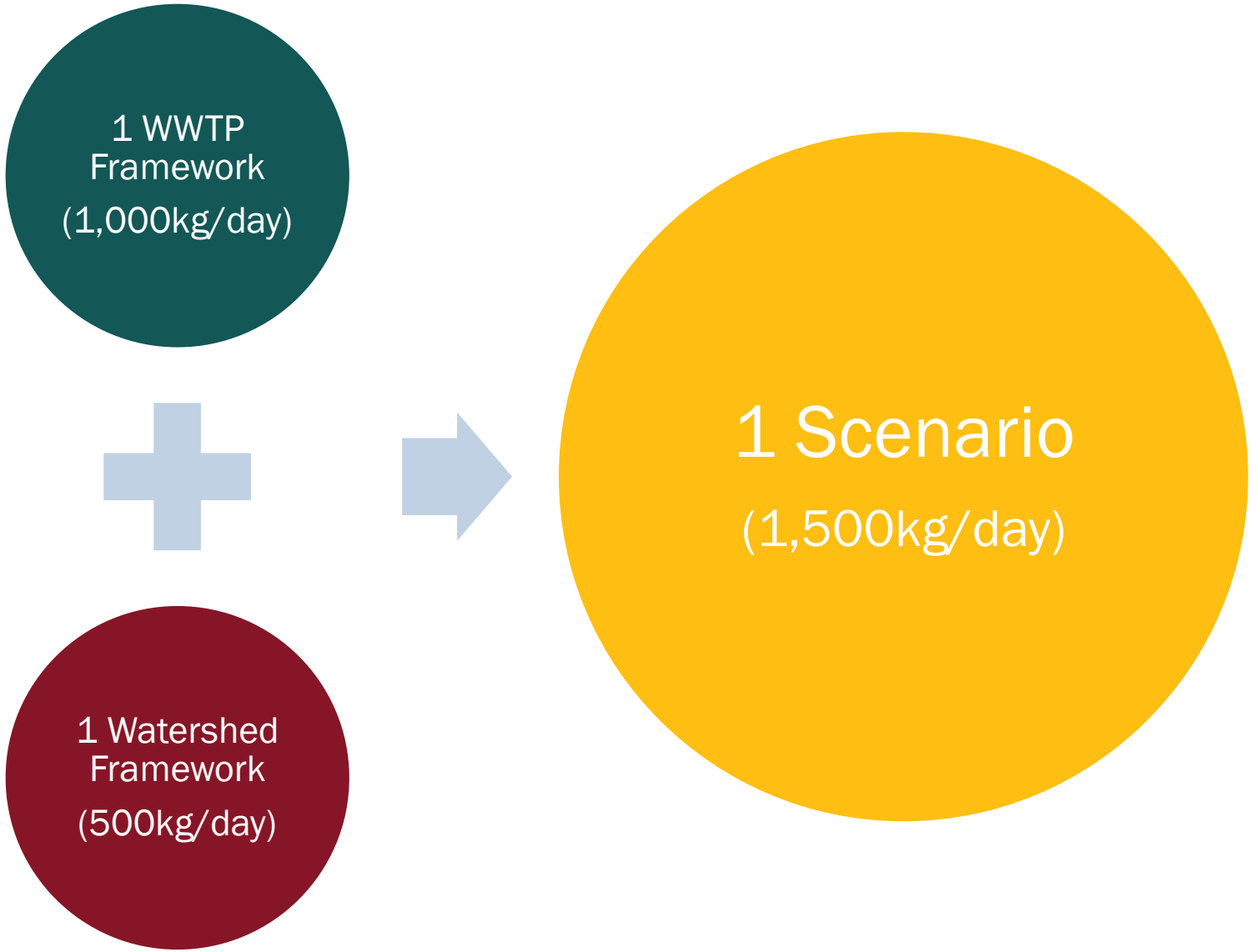
Key Terms

TN Load Target: the amount of total nitrogen (kgTN/day) allowed from anthropogenic sources

Frameworks: Alternative ways to distribute nutrient loads to WWTPs and watershed inputs.



What is a Scenario?



3 Scenario Questions

Will DO compliance improve if we make bigger reductions near predicted-noncompliant areas?

How much do smaller sources further away from predicted-noncompliant areas impact DO?

What are the DO improvements from different WWTP seasonal limits throughout the year?

Where should we focus bigger reductions?

More watershed nutrient reductions in:

- South Sound Basin
- Main Basin
- Whidbey Basin
- Northern Bays

Annual Reductions from WWTPs are important in:

- Whidbey Basin
- Main Basin
- South Sound Basin

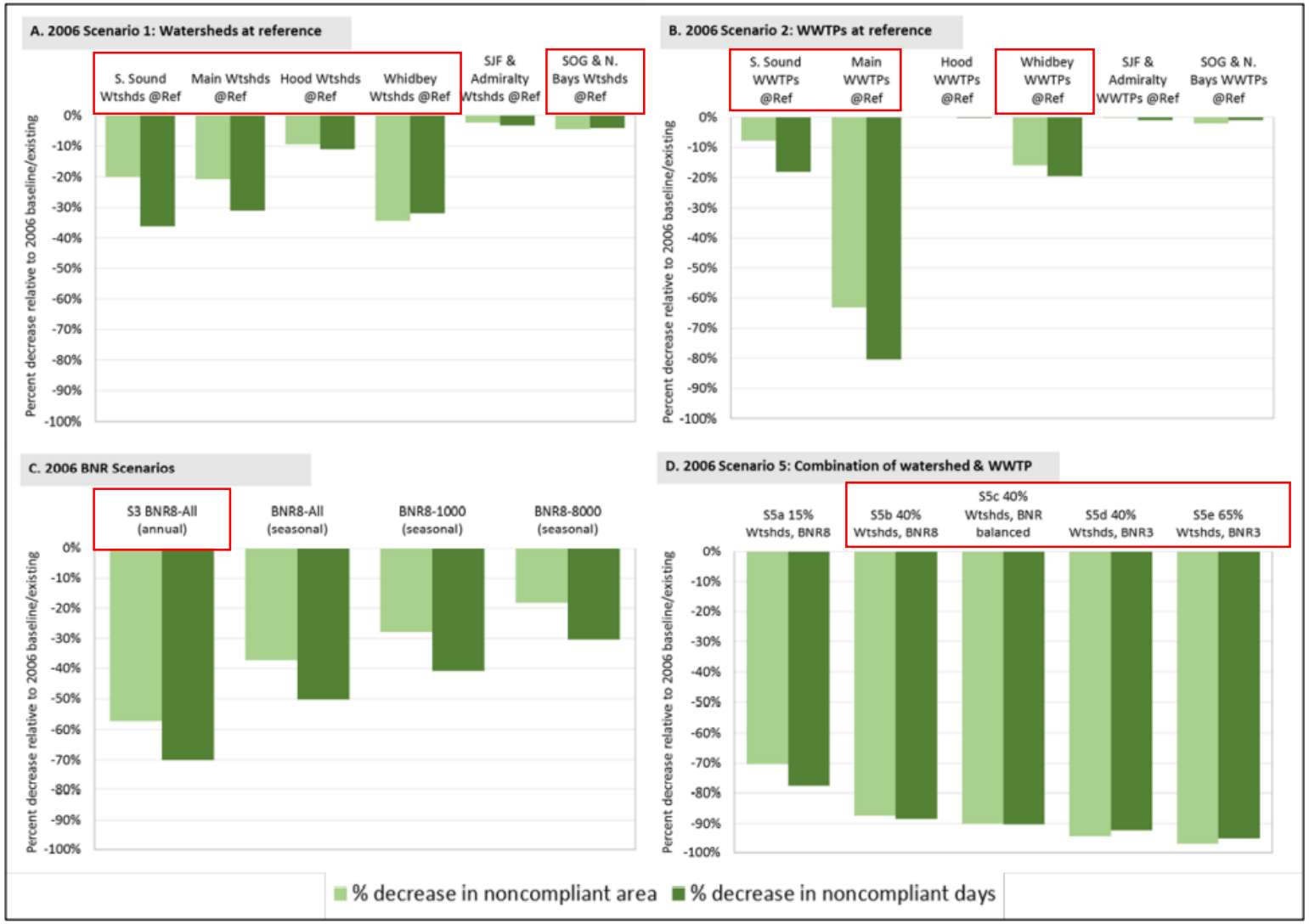


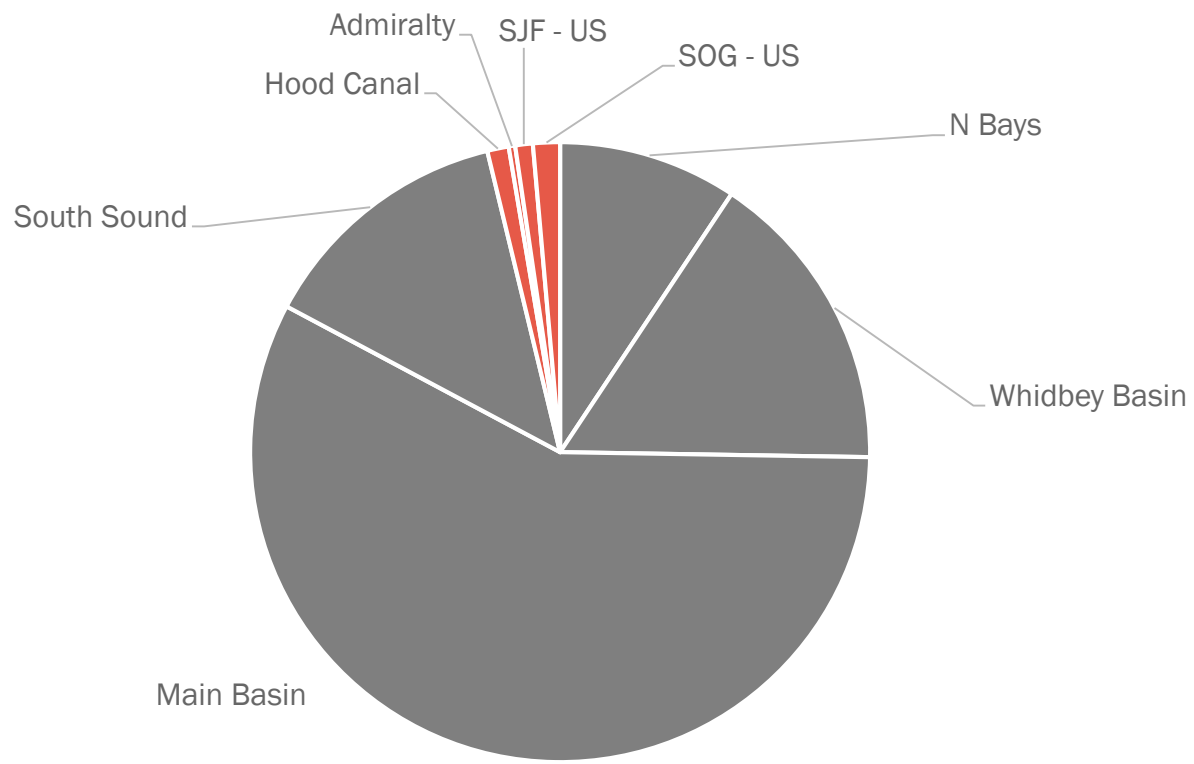
Figure 12. Percent change (decreases shown as negative values) in predicted noncompliant days and area in WA waters of the Salish Sea from all Optimization and BNR8 scenarios, relative to 2006 conditions.

What about smaller basin loads?

Relatively smaller loads in:

- Strait of Juan de Fuca
- Strait of Georgia
- Admiralty Inlet
- Hood Canal

Should we assign them the same level of reduction as basins with bigger loads?



Regional Anthropogenic TN Loads under Existing 2006 Conditions

What are the DO improvements from different WWTP seasonal limits throughout the year?

Annual BNR gets better DO improvement than critical season only

Biological Nitrogen Removal is temperature dependent

3-season approach for all WWTPs (cold, warm, and hot months)

Why 2006 and 2014 for Model Years?

Residence time is an important driver of DO in terminal inlets and bays

Higher residence time more impacts from anthropogenic nutrients

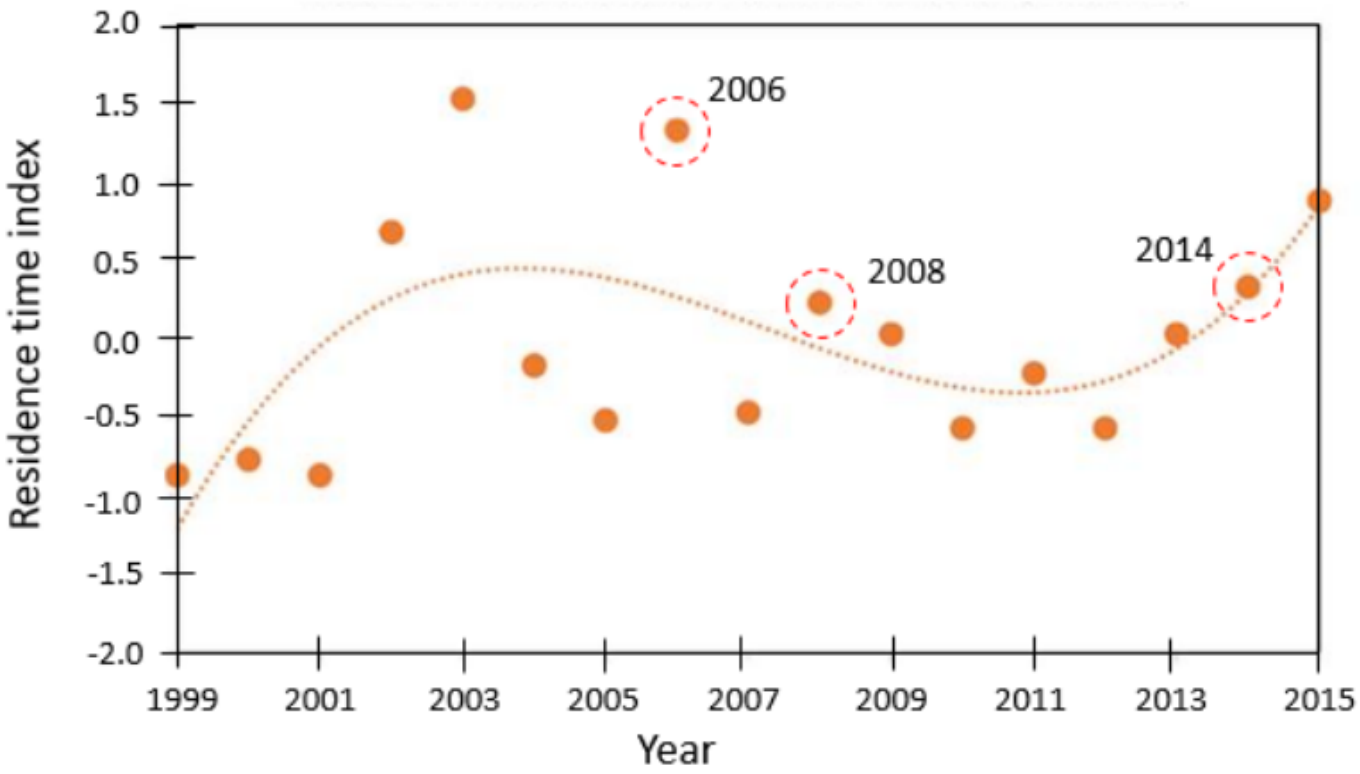
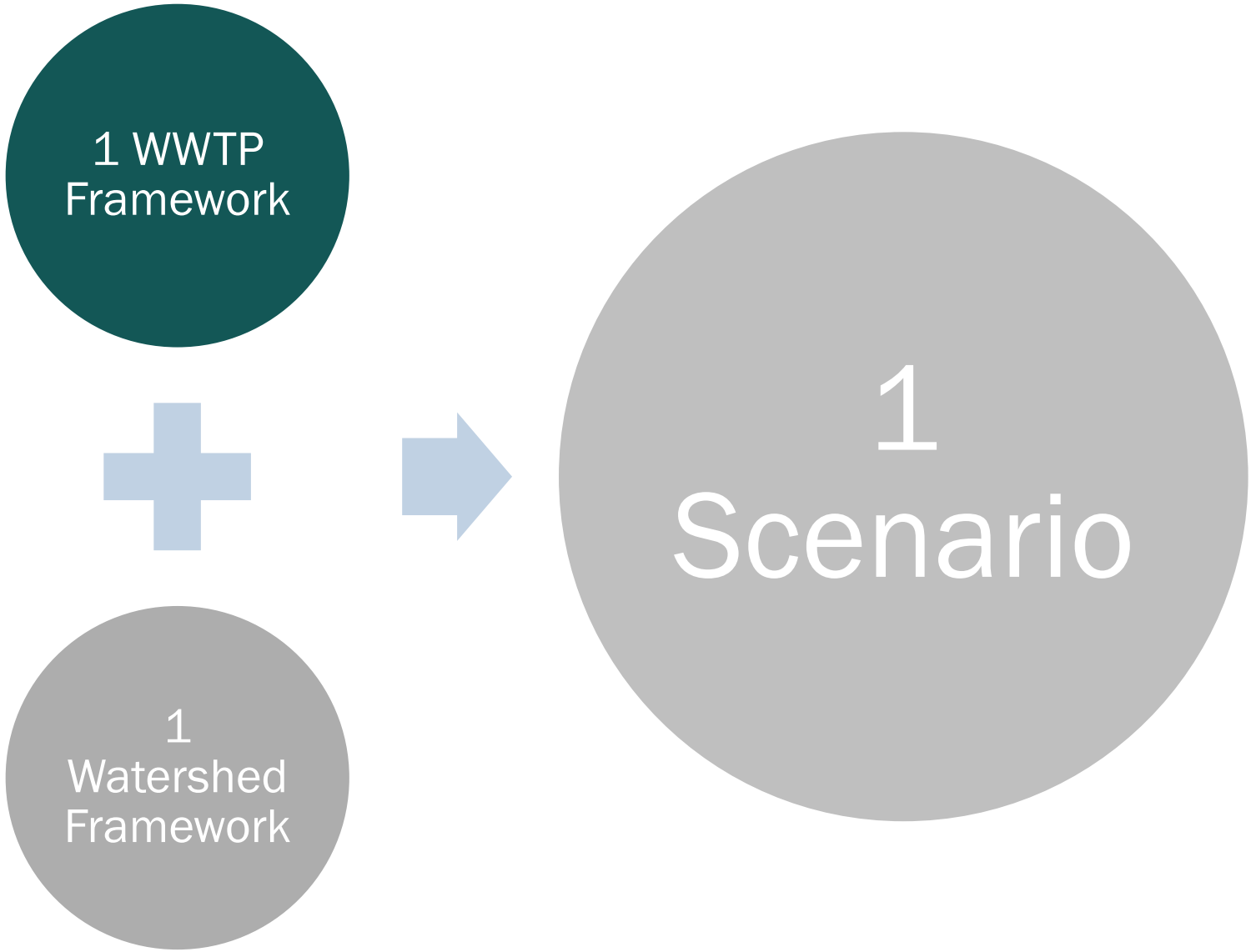


Figure 12. Index of residence time relative to normal in the top 0–30 m in Central Puget Sound, 1999–2015 (PSEMP, 2016).

Developing WWTP Frameworks



WWTP Frameworks Help Us Test

The size the regional WWTP TN load can be and still meet our water quality goals

How different seasonal TN loads impact DO throughout the year

How much reduction is needed from WWTPs in basins with relatively small TN loads

WWTP Framework Assumptions

Nutrient loads are calculated using actual effluent flows

Same carbon reductions assumptions used for previous WWTP scenarios

BNR levels apply to every facility within a basin or WWTP type according to the frameworks, unless a facility is already lower than the scenario level

Reflect the Budd Inlet DO TMDL wasteload allocations

3-Season Approach for WWTPs

- Biological nitrogen removal process works better in Warm and Hot months
- Biggest concerns for low DO are during Hot summer months
- Need Cool season reductions to achieve annual TN load target

WWTP TN Reduction Frameworks

Seasonal only

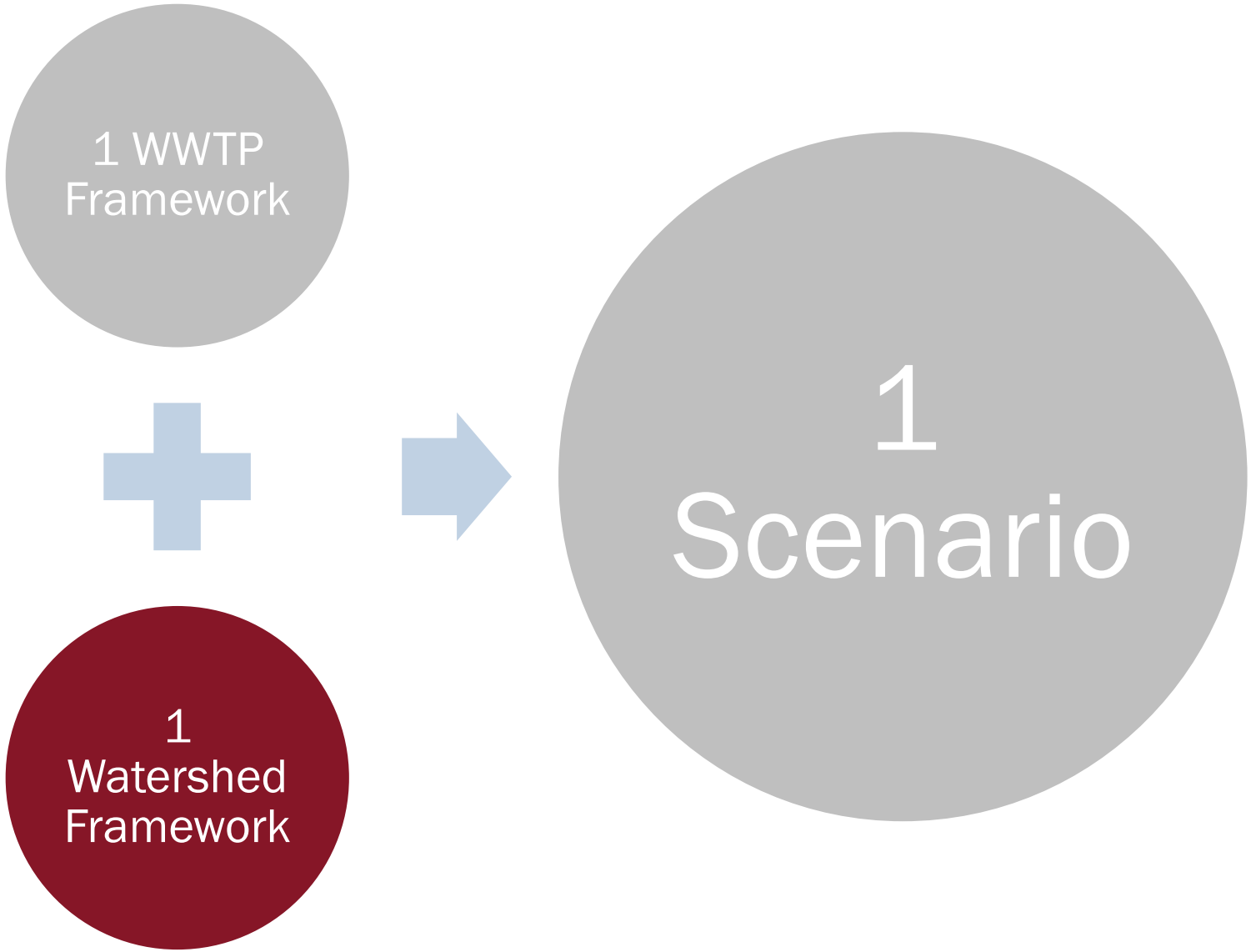
	Framework A	Framework B	Framework C
Description	Estimated minimum end of TN Load range	Estimated minimum end of range with smaller reductions during cold season	Estimated maximum end of TN load range
BNR Levels Used for Load Estimates	Cool= 8 mg/L Warm= 8 Hot= 5	Cool= *Remainder* Warm= 5 mg/L Hot= 3	Cool= *8 mg/L* Warm= 5 Hot= 3
Total WWTP Load (reduction from 2006)	**16,203 kg TN/day** (56.6% reduction)	**16,203 kg TN/day** (56.6%)	**14,473 kg TN/day** (61.2%)

WWTP TN Reduction Frameworks

Spatial +

	Framework D	Framework E
Description	Improvement without WWTP reductions in basins with small loads	Cool season impact from Combined Storm/Sewer WWTPs
BNR Levels Used for Load Estimates	Uses estimated maximum TN reductions for basins 1-4 & **WWTP loads in basins 5-8 at existing**	Uses estimated maximum TN reductions for all basins but **Combined systems at existing levels during cool months**
Total WWTP Load (percent reduction from 2006)	**14,636 kg TN/day** (60.3% reduction)	**18,541 kg TN/day** (50.4% reduction)

Developing Watershed Frameworks



Watershed Frameworks Help Us Test

How much DO improves by reducing more nutrients from watersheds closer to predicted-noncompliant basins vs. evenly distributing reductions across all basins

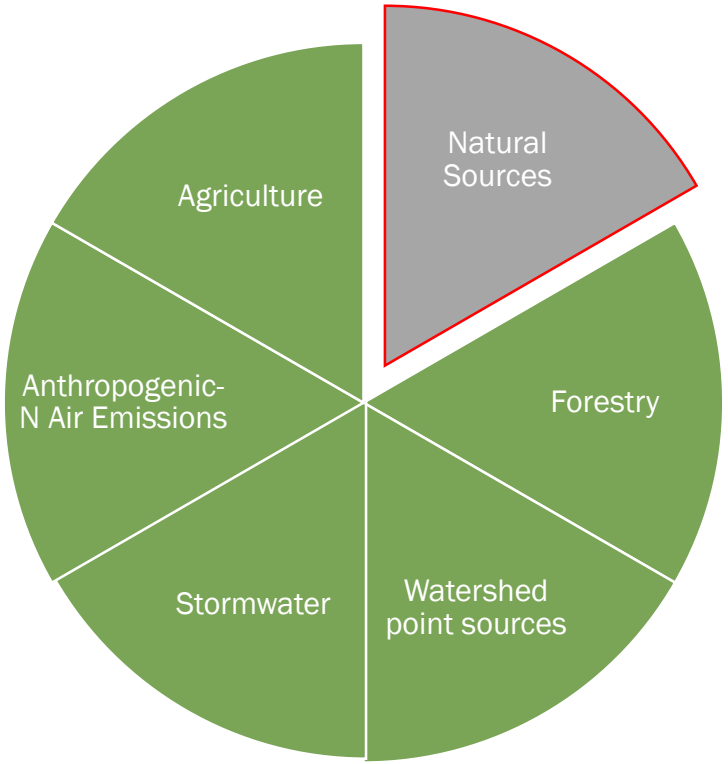
The impact of two different regional watershed TN loads on DO

Watershed Frameworks

Only reduces the total human load fraction of watershed loads

Percent reductions apply to nitrogen and carbon

Annual reductions



Examples of nitrogen sources in watershed TN loads

Watershed TN Reduction Frameworks

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Big Basin Loads

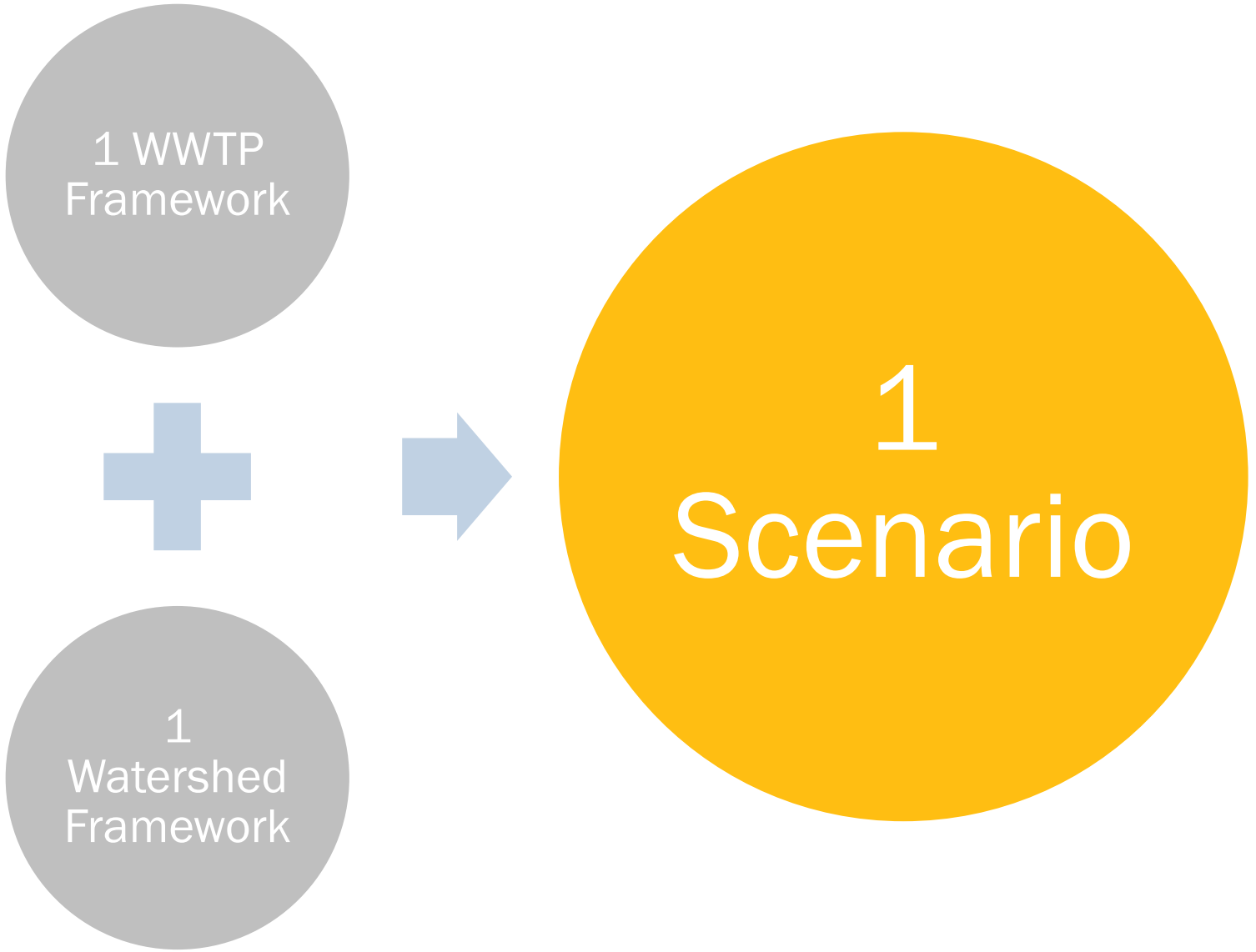
	Framework F#	Framework G#
Description	Estimated minimum load reduction with spatial variation	Estimated maximum load reduction with spatial variation
Framework Variations	**F1:** Higher reductions in basins with biggest impacts (1-4) **F2:** F1 + extra reductions in South Sound Basin **F3**: F1 + extra reductions in Whidbey Basin	**G1**: Higher reductions in basins with biggest impacts (1-4) **G2:** G1 + extra reductions in South Sound Basin **G3**: G1 + extra reductions in Whidbey Basin
Total Watershed Load (reduction from 2006 load)	**9,000 kgTN/day** (51.8 %)	**6,666 kgTN/day** (64.3%)

Watershed TN Reduction Frameworks

Small Basin Loads

	Framework H#
Description	DO sensitivity to loads in the Straits, Hood Canal, and Admiralty Inlet
Framework Variations	**H1:** Uses G1 for basins 1-6, but puts basins Straits (7-8) at existing load **H2**: Uses G1 for basins 1-4 but puts basins Straits, Hood Canal, and Admiralty Inlet (5-8) at existing load
Total Watershed Load (reduction from 2006 load)	**7,036 kgTN/day** **7,453 kgTN/day** (62.3 and 60.1% reduction)

Combining Frameworks into Scenarios



Possible Combinations (Scenarios)

5 WWTP Frameworks

8 Watershed Frameworks

40 possible combinations for each model year

Find the combination/s that result in the most DO improvement

Step 1: Find the best predicted improvement from watershed reductions

Watershed Framework F (9,000 kgTN/day)

F1 –biggest reductions in basins with biggest impacts

F2 – add extra reduction from South Sound Basin

F3 – add extra reduction from Whidbey Basin

WWTP Framework (14,473 kgTN/day)

C – estimated maximum TN reduction

Watershed Framework G (6,666 kgTN/day)

G1 –biggest reductions in basins with biggest impacts

G2 – add extra reduction from South Sound Basin

G3 – add extra reduction from Whidbey Basin

WWTP Framework (14,473 kgTN/day)

C – estimated maximum TN reduction

6 Scenarios (2006)

Step 2: Find the best-predicted improvement from WWTP reductions

Watershed Frameworks

Best G# variation from Step 1
(6,666 kgTN/day)

WWTP Framework

A – estimated minimum TN reduction with treatment (16,203 kgTN/day)

B - estimated minimum that allows more load during cool months (16,203 kgTN/day)

C - estimated maximum TN reduction (14,473 kgTN/day)

3

Scenarios (2006)

Step 3a: Test impact from sources in the Straits, Admiralty Inlet, and Hood Canal

DEPARTMENT OF ECOLOGY
State of Washington

Watershed Framework

H1 - Uses G1 for basins 1-6, but puts basins Straits (7-8) at existing load (7,036 kg TN/day)

H2 - Uses G1 for basins 1-4 but puts basins Straits, Hood Canal, and Admiralty Inlet (5-8) at existing load (7,453 kg TN/day)

+

WWTP Framework

D - Uses estimated maximum TN reductions for basins 1-4 & WWTPs in the **Straits, Hood Canal, and Admiralty Inlet at existing levels** (14,636 kg TN/day)

2

Scenarios (2006)

Step 3b: Test impact from Combined Storm/Sewer Systems

Watershed Frameworks

Best G# variation from Step 1 - (6,666 kg TN/day)

+

WWTP Framework

E – Uses estimated maximum TN reductions for all basins but **Combined systems at existing levels** during cool months (18,541 kg TN/day)

1 Scenario (2006)

Step 4: Test best WWTP/Watershed Framework combo for 2014

Watershed Frameworks

Best G# variation from Step 1 -
(6,666 kg TN/day)

+

WWTP Framework

Best WWTP Framework from Step 2

1

Scenario (2014)

Step 5: Any combo we haven't tested yet but could be useful

Reserve work capacity for:

- Testing previous combinations during model year 2014
- Another combination of frameworks we haven't tested yet

0-8

Scenarios (2014 or 2006)

Step 6: Increase Scenario 5e DO improvement

Can we fully meet DO standards if we redistribute the total loads from Scenario 5e with more targeted watershed reductions?

Watershed Frameworks

Watershed Framework G2
(6,666 kg TN/day)

WWTP Load from Scenario 5e

All WWTPs discharge loads equivalent to hypothetical TN load reduction from biological nitrogen reduction concentrations of 3mg/L, annually
(9,290 kg TN/day)

2 Scenarios (2006 & 2014)

Draft Year 2 Optimization Scenario List and Suggested Sequence

	Number of Possible Runs for each Option
Step 1: Find the best-predicted improvement from watersheds. Test all 6 Watershed Frameworks against each other by pairing each with the WWTP framework with the lowest regional load baseline (model year 2006) ○ WWTP Framework C + Watershed Framework F1 (additional run with Watershed G1) ○ WWTP Framework C + Watershed Framework F2 (additional run with Watershed G2) ○ WWTP Framework C + Watershed Framework F3 (additional run with Watershed G3)	6
Step 2: Find the best-predicted improvement from WWTPs. Test 3 similar WWTP baselines against each other using the best performing watershed framework; one of the following will have already been run in Step 1 (model year 2006) ○ Best Watershed Framework + WWTP Framework A ○ Best Watershed Framework + WWTP Framework B ○ Best Watershed Framework + WWTP Framework C	2
Step 3: Test impacts from sources in the Straits and Hood Canal, and from combined storm/sewer systems (model year 2006) ○ WWTP Framework D + Watershed Framework H1 ○ WWTP Framework D + Watershed Framework H2 ○ WWTP Framework E + Best Watershed Framework	3
Step 4: Test best WWTP Framework & Watershed Framework combo for 2014	1
Step 5: Capacity to test additional combinations. Final runs of any framework combination we haven't tested yet or run for model year 2006 or 2014 but want to test	0-8
Step 6: Increase Scenario 5e improvement. DO Standards attainment test with modified Scenario 5e framework (model years 2014 and 2006) designed to increase DO improvement compared to Scenario 5e predictions ○ Uses Watershed Framework G1 + Scenario 5e WWTP loads (BNR3-all annual)	2
Total Model Runs	**15-23**

How We Can Use Scenario Results

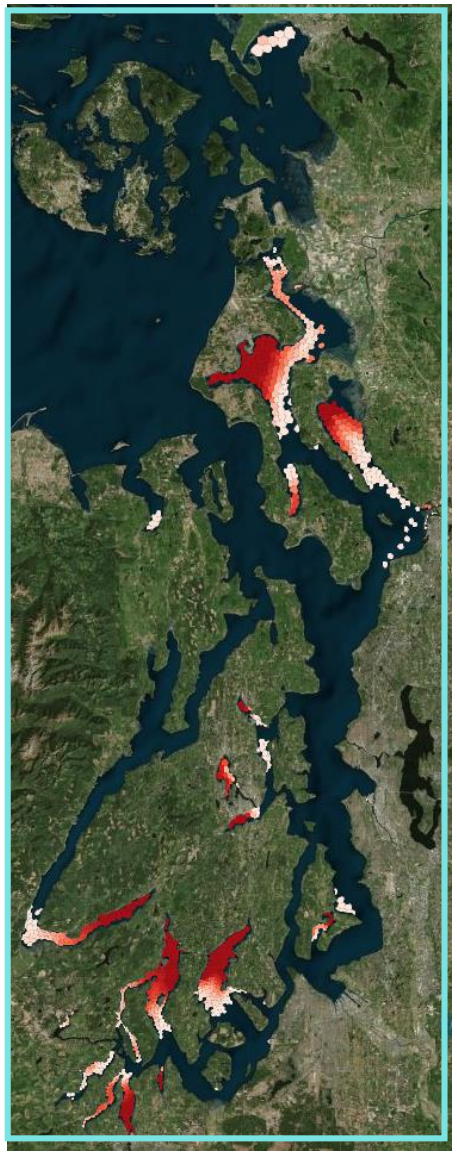
Scenarios (WWTP Framework & Watershed Framework)	Total Regional TN Load (kg/day)	Percent Reduction from Total	Total Noncompliant Days	Total Noncompliant Area	Maximum Magnitude of DO Depletion
Increase Scenario 5e DO improvement	15,959	72%			
Scenario 5e	*15,959*	*72%*			
Scenario 5d	*20,717*	*63%*			
WWTP-C & Watershed-G#	21,139	62%			
WWTP-D & Watershed-H1	21,672	61%			
WWTP-D & Watershed-H2	22,089	61%			
WWTP-A & Watershed-G#	22,869	59%			
WWTP-B & Watershed-G#	22,869	59%			
WWTP-C & Watershed-F#	23,473	58%			
Scenario 5c	*24,678*	*56%*			
WWTP-A & Watershed-F#	25,203	55%			
WWTP-B & Watershed-F#	25,203	55%			
WWTP-E & Watershed-G#	25,207	55%			
WWTP-D & Watershed-F#	25,207	51%			
Scenario 5b	*27,682*	*51%*			

Find scenarios have very similar outcomes for meeting standards

Will there be more than one way to achieve standards in remaining noncompliant model grid cells?

Combo Scenario Results Plot a Course to Meet Standards

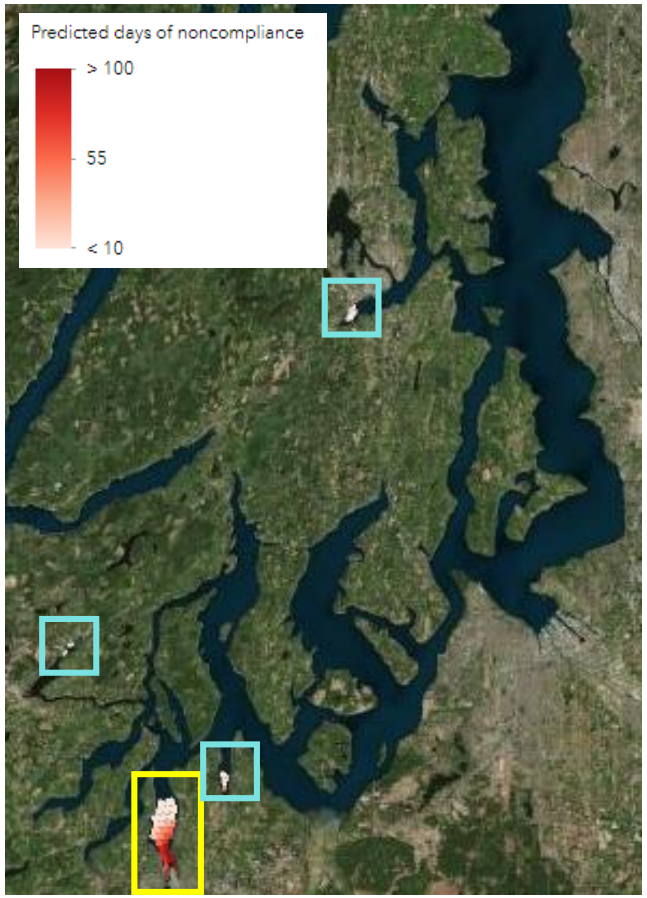
2006 Existing



Scenario 5c

Scenario 5d

Scenario 5e



Questions?

Please type your questions in the chat box to “All Panelists”

~ 5-10 minute break ~

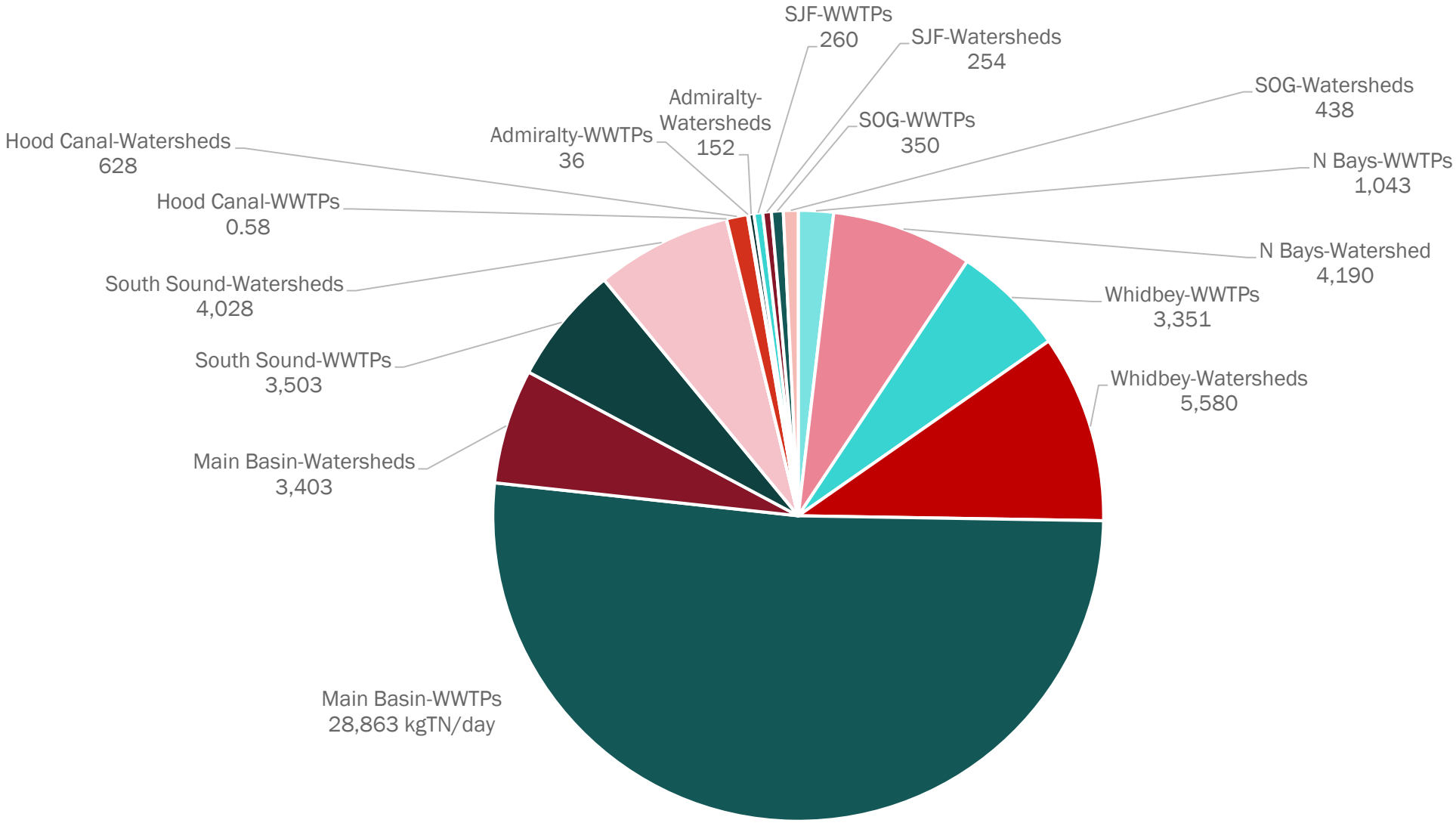
Then a deep-dive into details

On Break

Be back at 00:00

Deep-Dive Into Details

2006 Existing Regional TN Load



Regional TN Load: 2006 Existing Anthropogenic TN Daily Load (kg/day)

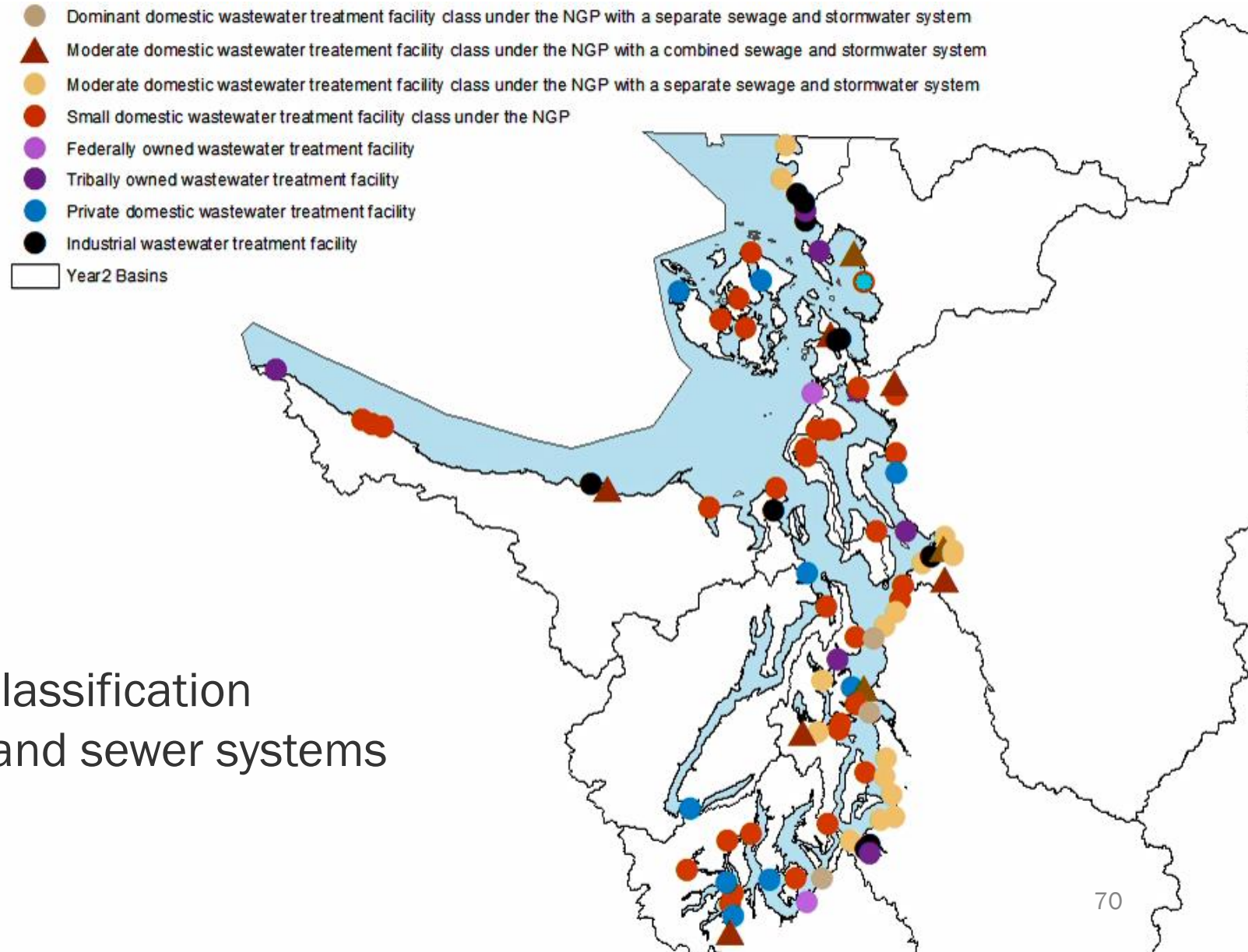
WWTP Framework Load Calculation

- ✓Calculated for each WWTP
- ✓Actual Effluent Flows
- ✓BNR level applied as a monthly average TN concentration

$$TN\ Load = Effluent\ flow\ x\ (BNR\ level)$$

$$Daily\ TN\ Load = \frac{Total\ Annual\ TN\ Load}{365}$$

WWTP Type Categories



Categorized by:

- Who the facility serves
- Nutrient General Permit size classification
- Combined vs separate storm and sewer systems

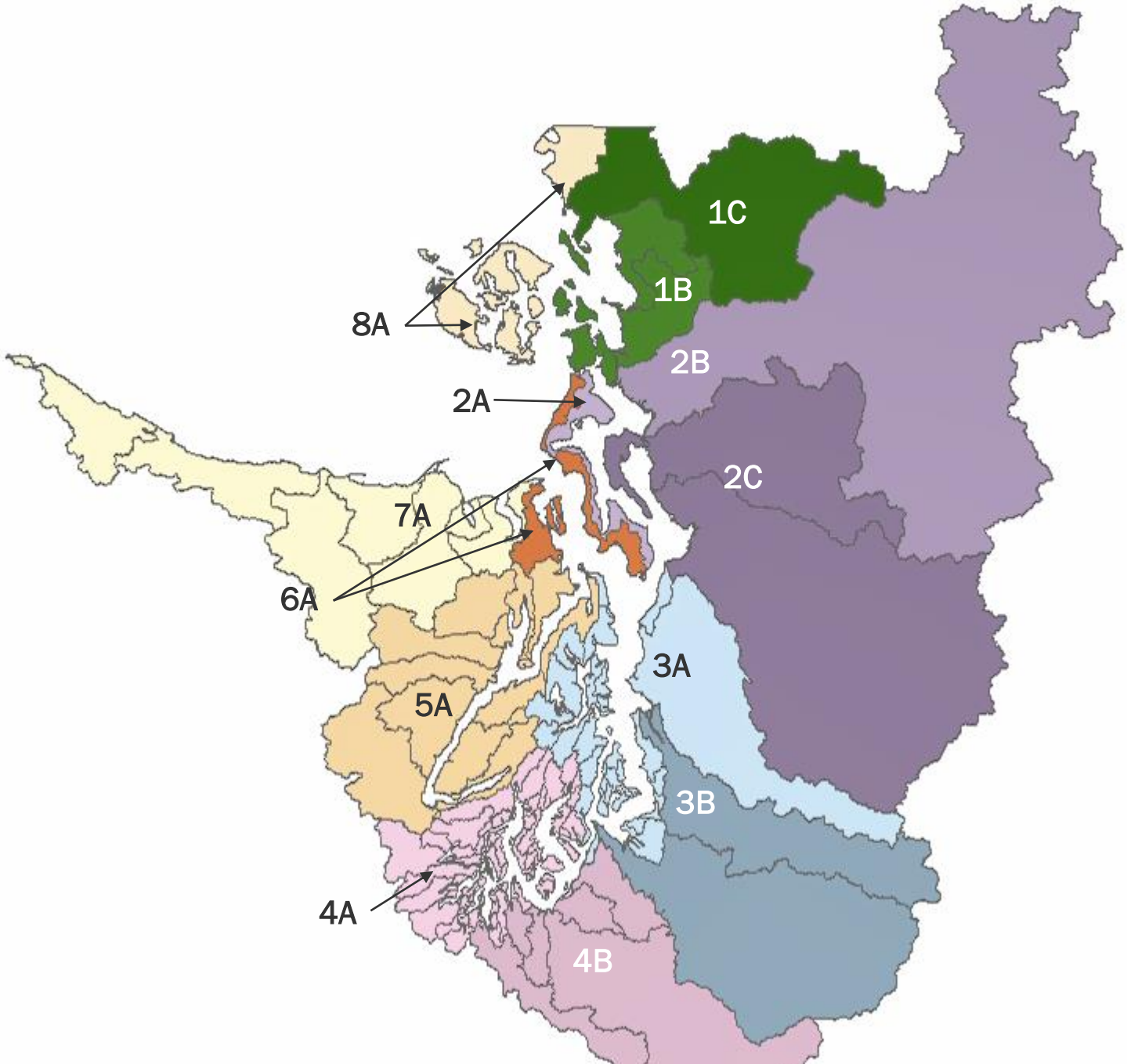
WWTP Framework Load Summary

Basin	Basin #	2006 Basin WWTP Avg. Daily TN Loads (kg/day)					
		Existing WWTP TN Load	Framework A	Framework B	Framework C	Framework D	Framework E
Bellingham, Samish, & Padilla Bays	1	1,043	500	504	441	441	603
Whidbey Basin	2	3,351	2,314	2,122	1,962	1,962	2,297
Main Basin	3	28,863	10,985	11,174	9,769	9,769	13,244
South Sound	4	3,503	1,930	1,923	1,811	1,811	1,811
Hood Canal	5	1	1	1	1	1	1
Admiralty	6	36	36	36	36	36	36
SJF - US	7	260	137	142	143	260	201
SOG - US	8	350	300	301	310	350	348
Regional WWTP TN Load		**37,406**	**16,203**	**16,203**	**14,473**	**14,636**	**18,541**
Total Percent Reduction		**-**	**56.6%**	**56.6%**	**61.2%**	**60.3%**	**50.4%**
Seasonal Biological Nitrogen Reduction Levels Tested		2006 Existing load from WWTP marine discharges	Cool= BNR8 Warm= BNR8 Hot= BNR5	Cool= Remainder Warm= BNR5 Hot= BNR3	Cool= BNR8 Warm= BNR5 Hot= BNR3	Uses estimated maximum TN reductions for basins 1-4 & **cap WWTP loads in basins 5-8 at existing**	Uses estimated maximum TN reductions for all basins but **Combined systems at existing levels during cool months**
Description		Existing load that must be reduced	Estimated minimum TN reduction with treatment	Estimated minimum that allows more load during cool months	Estimated maximum TN reduction	Improvement without WWTP reductions in basins 5-8	Cool season impact from Combined Storm/Sewer WWTPs
Seasonality		-	Cool Months = Nov-Mar | Warm Months = Apr-Jun, Oct | Hot Months = Jul-Sep				

Watershed Categories

Basin	Basin #
Northern Bays (Bellingham, Samish, & Padilla)	1
Whidbey Basin	2
Main Basin	3
South Sound Basin	4
Hood Canal	5
Admiralty Inlet	6
Strait of Juan de Fuca (SJF)	7
Strait of Georgia (SOG)	8

Category	Watershed Average Daily TN Load (kg/day)
Small (A)	0 – 200
Medium (B)	201 – 1,000
Large (C)	1,001 – 4,000



Watershed Framework Load Summary

DEPARTMENT OF ECOLOGY
State of Washington

Basin	Basin #	2006 Basin Watershed Avg. Daily TN Loads (kg/day)							
		Existing Watershed TN Load	Framework F#			Framework G#			Framework H#	
			F1	F2	F3	G1	G2	G3	H1	H2
Bellingham, Samish, & Padilla Bays	1	4,190	1,919	2,059	2,040	1,421	1,454	1,481	1,421	1,421
Whidbey Basin	2	5,580	2,491	2,673	2,081	1,845	1,945	1,538	1,845	1,845
Main Basin	3	3,403	1,556	1,669	1,653	1,152	1,236	1,201	1,152	1,152
South Sound	4	4,028	2,110	1,606	2,243	1,563	1,190	1,629	1,563	1,563
Hood Canal	5	628	395	424	420	292	314	305	292	628*
Admiralty	6	152	96	103	102	71	95	92	71	152*
Strait of Juan de Fuca - US	7	254	159	171	169	118	158	154	254*	254*
Strait of Georgia - US	8	438	275	295	292	204	273	265	438*	438*
Regional Watershed TN Load		**18,673**	**9,000**			**6,666**			**7,036**	**7,453**
Total Percent Reduction		-	**51.8%**			**64.3%**			**62.3%**	**60.1%**
Framework Variations		2006 Existing load from anthropogenic (point and nonpoint sources) in watersheds	**F1**: Increased reductions in basins with biggest impact (1-4) **F2**: start with F1, with extra reduction in South Sound Basin **F3**: start with F1, with extra reduction in Whidbey Basin			**G1**: Increased reductions in basins with biggest impact (1-4) **G2**: start with G1, with extra reduction in South Sound Basin **G3**: start with G1, with extra reduction in Whidbey Basin			**H1**: Uses G1 for basins 1-6, but puts basins 7-8 at existing load **H2**: Uses G1 for basins 1-4 but puts basins 5-8 at existing load	
Description		Existing load that reductions are based on	Estimated minimum TN load reduction with spatial variation			Estimated maximum load reduction with spatial variation			DO sensitivity to loads in the Straits, Hood Canal, and Admiralty Inlet	

Watershed Framework F Detail

DEPARTMENT OF ECOLOGY State of Washington

Basin	Basin #	Framework F# Basin Loads (units are Anthropogenic TN kg/day)											
		F1: more reductions in basins 1-4 and for largest watersheds				**F2:** more reductions in basins 1-4 with extra South Sound Basin load reductions				**F3:** more reductions basins 1-4 with extra Whidbey Basin load reductions			
		Percent Reduction from Existing			Total Basin Load	Percent Reduction from Existing			Total Basin Load	Percent Reduction from Existing			Total Basin Load
		Sm*	Md*	Lg*		Sm*	Md*	Lg*		Sm*	Md*	Lg*	
Bellingham, Padilla, & Samish Bays	1	-	47.6%	56.3%	1,919	-	43.8%	53.2%	2,059	-	44.3%	53.6%	2,040
Whidbey	2	47.6%	47.6%	56.3%	2,491	43.8%	43.8%	53.2%	2,673	55.5%	62.9%	62.9%	2,081
Main	3	47.6%	-	56.3%	1,556	43.8%	-	53.2%	1,669	44.3%	-	53.6%	1,653
South Sound	4	47.6%	47.6%	-	2,110	55.0%	62.5%	-	1,606	44.3%	44.3%	-	2,243
Hood Canal	5	37.1%	-	-	395	32.6%	-	-	424	33.2%	-	-	420
Admiralty	6	37.1%	-	-	96	32.6%	-	-	103	33.2%	-	-	102
SJF-US	7	37.1%	-	-	159	32.6%	-	-	171	33.2%	-	-	169
SOG-US	8	37.1%	-	-	275	32.6%	-	-	295	33.2%	-	-	292
Total Load					**9,000**				**9,000**				**9,000**

**Watershed Load Size Category*

Watershed Framework G Detail

DEPARTMENT OF ECOLOGY
State of Washington

Basin	Basin #	Framework G# (units are Anthropogenic TN kg/day)											
		G1: more reductions in basins 1-4 and for largest watersheds				**G2:** more reductions in basins 1-4 with extra South Sound Basin load reductions				**G3:** more reductions basins 1-4 with extra Whidbey Basin load reductions			
		Percent Reduction from Existing			Total Basin Load	Percent Reduction from Existing			Total Basin Load	Percent Reduction from Existing			Total Basin Load
		Sm*	Md*	Lg*		Sm*	Md*	Lg*		Sm*	Md*	Lg*	
Bellingham, Padilla, & Samish Bays	1	-	61.2%	67.7%	1,421	-	65.3%	65.3%	1,454	-	59.6%	66.3%	1,481
Whidbey	2	61.2%	61.2%	67.7%	1,845	58.7%	65.3%	65.3%	1,945	67.6%	67.6%	73.0%	1,538
Main	3	61.2%	-	67.7%	1,152	58.7%	-	65.3%	1,236	59.6%	-	66.3%	1,201
South Sound	4	61.2%	61.2%	-	1,563	66.7%	72.2%	-	1,190	59.6%	59.6%	-	1,629
Hood Canal	5	53.4%	-	-	292	50.0%	-	-	314	51.5%	-	-	305
Admiralty	6	53.4%	-	-	71	37.5%	-	-	95	39.3%	-	-	92
SJF-US	7	53.4%	-	-	118	37.5%	-	-	158	39.3%	-	-	154
SOG-US	8	53.4%	-	-	204	37.5%	-	-	273	39.3%	-	-	265
Total Load					**6,666**				**6,666**				**6,666**

**Watershed Load Size Category*

Watershed Framework H Detail

Basin	Basin #	Watershed Framework H# (units are Anthropogenic TN kg/day)			
Bellingham, Padilla, & Samish Bays	1	**H1**: Framework G1 loads for basins 1-6; existing loads for basins 7-8	1,421	**H2**: Framework G1 loads for basins 1-4; existing loads for basins 5-8	1,421
Whidbey	2		1,845		1,845
Main	3		1,152		1,152
South Sound	4		1,563		1,563
Hood Canal	5		292		628*
Admiralty	6		71		152*
SJF-US	7		254*		254*
SOG-US	8		438*		438*
Total Load			**7,036**		**7,453**

**Existing load for model year*

What are we aiming for?

How do we know if a scenario's TN load will get us close to the target?

What about remaining areas of noncompliance?

Scenario 5 Details

Table 2. Scenario 5 combined reductions in watersheds and WWTPs

Scenario 5	Anthropogenic Watershed reductions*	WWTP reductions
Scen5a	15%	Annual BNR8 at all WWTP (DIN = 8 mg/L, $CBOD_5$ = 8 mg/L)
Scen5b	40%	Annual BNR8 at all WWTP (DIN = 8 mg/L, $CBOD_5$ = 8 mg/L)
Scen5c	40%	1. Seasonal BNR3 for WWTPs in South Sound, Main and Whidbey Basin: • Apr - Oct: DIN = 3 mg/L; CBOD = 8 mg/L) • Jan-Mar and Nov - Dec: DIN = 8 mg/L; CBOD = 8 mg/L 2. Annual BNR at all other WWTP: DIN=8 mg/L; CBOD = 8 mg/L
Scen5d	40%	Annual BNR3 at all WWTP (DIN = 3 mg/L, CBOD = 8 mg/L)
Scen5e	65%	Annual BNR3 at all WWTP (DIN = 3 mg/L, CBOD = 8 mg/L)

*These percent reductions are applied only to the anthropogenic portion of watershed nutrient loads i.e. the difference between existing and estimated reference loads. For example, 15% means a 15% reduction in existing anthropogenic loads (equivalent to 85% of existing anthropogenic loads). The percent reductions are also applied across all forms of nitrogen and organic carbon (ammonia, nitrate, dissolved and particulate organic nitrogen, and dissolved and particulate organic carbon).

Scenario 5 Predicted DO Noncompliance

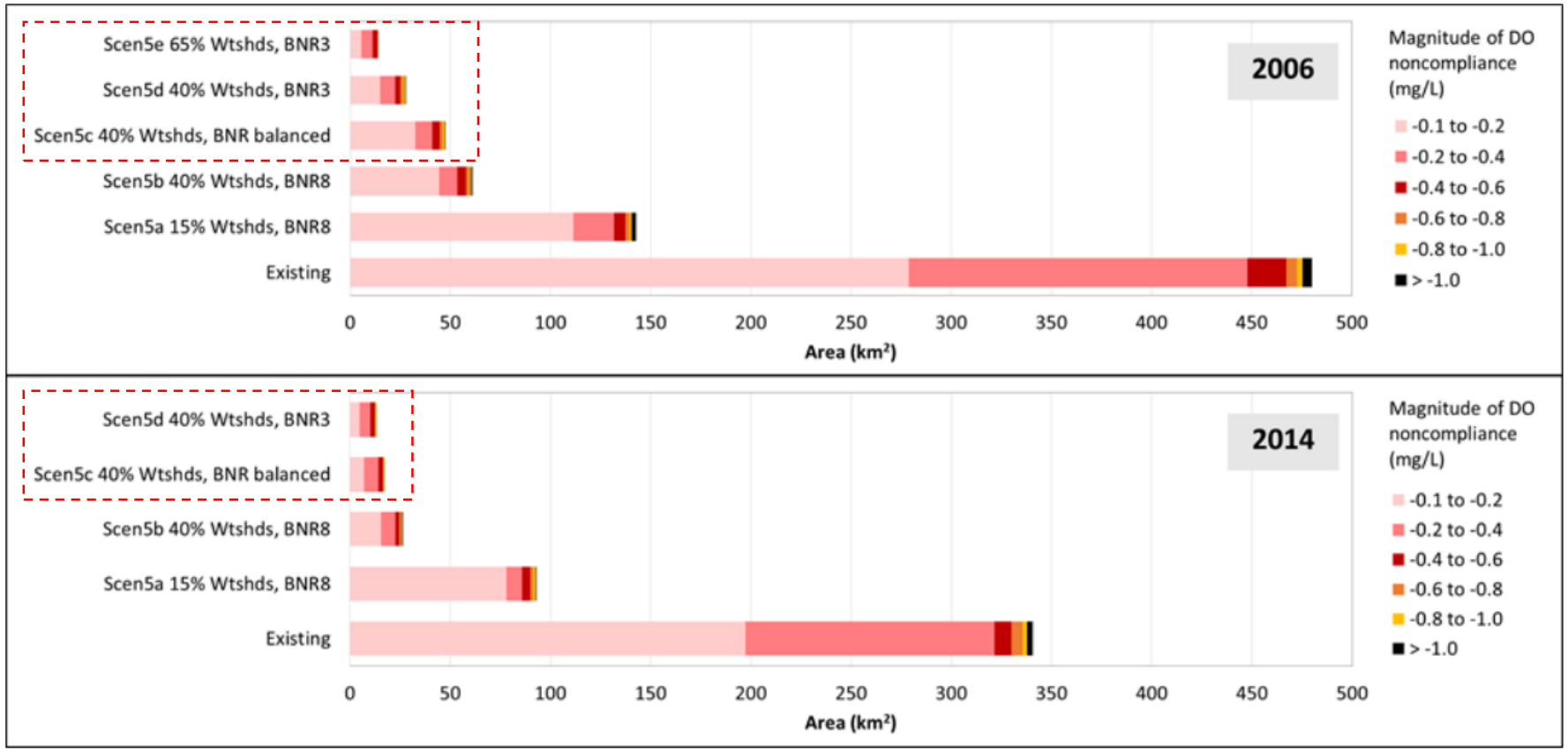
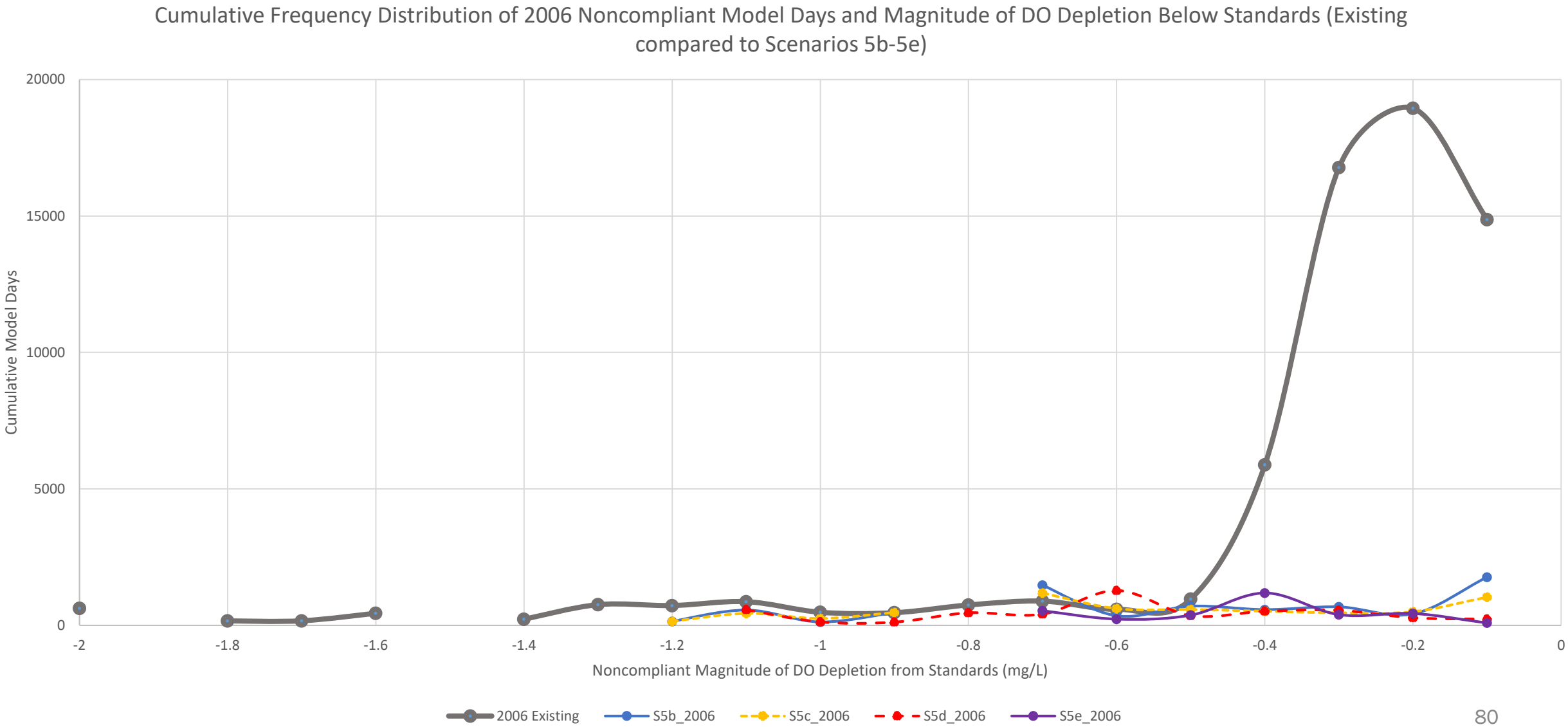
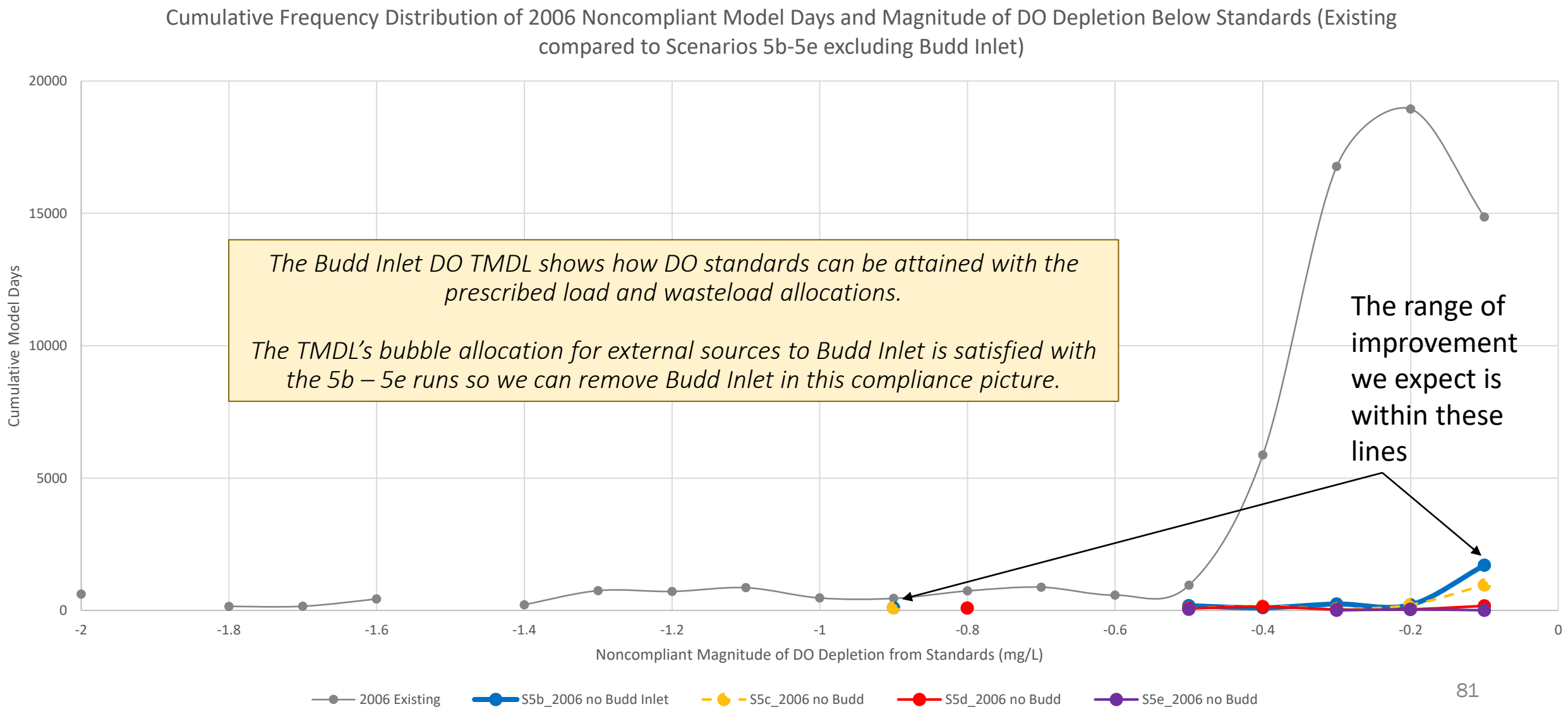


Figure 14. Distribution of magnitudes of predicted DO noncompliance within the total noncompliant area in WA waters of the Salish Sea across all Scenario 5 runs in 2006 (top) and 2014 (bottom).

Regional Look at Scenario 5 Results



Regional DO Attainment Expectations



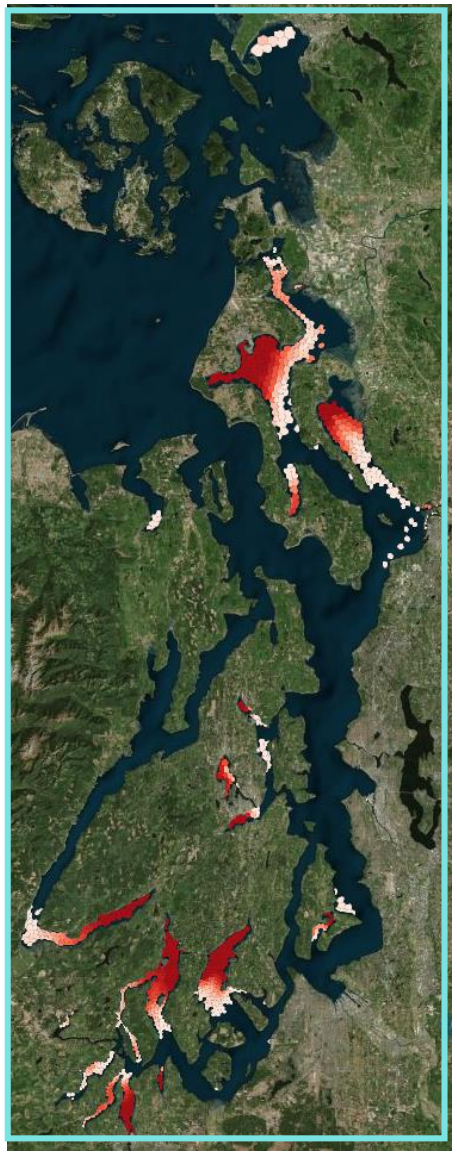
The Budd Inlet DO TMDL shows how DO standards can be attained with the prescribed load and wasteload allocations.

The TMDL's bubble allocation for external sources to Budd Inlet is satisfied with the 5b – 5e runs so we can remove Budd Inlet in this compliance picture.

The range of improvement we expect is within these lines

Combo Scenario Results Plot a Course to Meet Standards

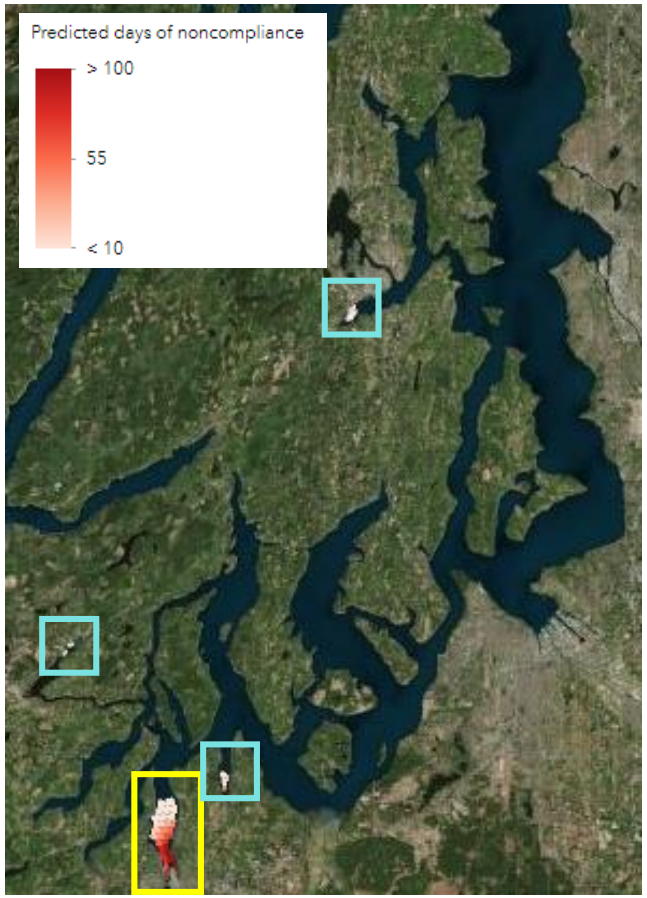
2006 Existing



Scenario 5c

Scenario 5d

Scenario 5e



Thank you!

Please send your questions & feedback to:

Dustin Bilhimer

Water Quality Program

Dustin.Bilhimer@ecy.wa.gov

Where we're going

Next phase of modeling: **defining the level of reduction needed** from all sources

2018 - 2019

Bounding Scenarios Report

2019 - 2021

Year 1 SSM tech memo

2022 - 2023

Next phase of modeling

More nutrient reduction combinations to develop reduction targets

2023 - 2024

Volume 2: Salish Sea Modeling Report

+

Puget Sound Nutrient Reduction Plan

Future Forum Topics

- Watershed Nutrient Strategy
- What's on the horizon for watershed nutrient modeling
- More on the Puget Sound Nutrient Reduction Plan