# Respondent experience and willingness to pay: Reconciling stated preference data with scientific evidence

Zhenyu Yao, Klaus Moeltner
Department of Agricultural and Applied Economics
Virginia Tech, Blacksburg, VA

Jan 2021

# Introduction

- Harmful algal blooms (HABs), known as Florida Red Tide (RT) have severe economic effects on fisheries, seafood, tourism, property price and human health.
  - Produce toxins killing fish and making shellfish dangerous to eat.
  - Lead to respiratory illness for humans via aerosolized toxins.

# Introduction

- Harmful algal blooms (HABs), known as Florida Red Tide (RT) have severe economic effects on fisheries, seafood, tourism, property price and human health.
  - Produce toxins killing fish and making shellfish dangerous to eat.
  - Lead to respiratory illness for humans via aerosolized toxins.
- A survey/Discrete Choice Experiment was implemented to access WTP for a hypothetical new forecast system to predict RT airborne contaminants.

# Introduction

- Harmful algal blooms (HABs), known as Florida Red Tide (RT) have severe economic effects on fisheries, seafood, tourism, property price and human health.
  - Produce toxins killing fish and making shellfish dangerous to eat.
  - Lead to respiratory illness for humans via aerosolized toxins.
- A survey/Discrete Choice Experiment was implemented to access WTP for a hypothetical new forecast system to predict RT airborne contaminants.
- Respondents' past experience can be captured in two fundamental ways: (i) directly from the respondents, as part of the survey; (ii) scientific sources that are extraneous to the survey.

# Introduction

Compared to survey-elicited experience, objective scientific information is generally more desirable.

- Survey-elicited experience has potential recall problem.

# Introduction

Compared to survey-elicited experience, objective scientific information is generally more desirable.

- Survey-elicited experience has potential recall problem.
- Survey-elicited information can lead to strategic bias.

# Introduction

Compared to survey-elicited experience, objective scientific information is generally more desirable.

- Survey-elicited experience has potential recall problem.
- Survey-elicited information can lead to strategic bias.
- Survey-elicited experience can introduce endogeneity problems.

# Introduction

Compared to survey-elicited experience, objective scientific information is generally more desirable.

- Survey-elicited experience has potential recall problem.
- Survey-elicited information can lead to strategic bias.
- Survey-elicited experience can introduce endogeneity problems.
- Using outside scientific information, we can predict WTP estimates at future points in time without having to do another survey.

# Introduction

Rationale for outside scientific information:

- Check the validity of self-reported RT impacts from survey.

# Introduction

Rationale for outside scientific information:

- Check the validity of self-reported RT impacts from survey.
- Incorporate scientific information in choice model as a truly exogenous measure/instrument for impacts.

# Introduction

Rationale for outside scientific information:

- Check the validity of self-reported RT impacts from survey.
- Incorporate scientific information in choice model as a truly exogenous measure/instrument for impacts.
- Refine WTP predictions by intensity of RT pressure as captured by outside scientific information.

# Introduction

Rationale for outside scientific information:

- Check the validity of self-reported RT impacts from survey.
- Incorporate scientific information in choice model as a truly exogenous measure/instrument for impacts.
- Refine WTP predictions by intensity of RT pressure as captured by outside scientific information.
- Predict WTP under future RT conditions without new survey-based impact data.

# Forecast system

- Comparison between existing and new system:

| | time frame | spatial resolution | updating |
|---|---|---|---|
| BCRS | current conditions | 22 specific beaches | twice a day |
| RTCS | past week | 20-30 specific sampling points | once a week |
| HABF | 3-4 days ahead | 22 broad regions | once a week |
| New system | 24 hours ahead | each square mile within coverage area | hourly |

# Forecast system

- Comparison between existing and new system:

| | time frame | spatial resolution | updating |
|---|---|---|---|
| BCRS | current conditions | 22 specific beaches | twice a day |
| RTCS | past week | 20-30 specific sampling points | once a week |
| HABF | 3-4 days ahead | 22 broad regions | once a week |
| New system | 24 hours ahead | each square mile within coverage area | hourly |

- Much higher resolution

# Forecast system

- Comparison between existing and new system:

| | time frame | spatial resolution | updating |
|---|---|---|---|
| BCRS | current conditions | 22 specific beaches | twice a day |
| RTCS | past week | 20-30 specific sampling points | once a week |
| HABF | 3-4 days ahead | 22 broad regions | once a week |
| New system | 24 hours ahead | each square mile within coverage area | hourly |

- Much higher resolution
- Much more frequent updating

# Forecast system

- Comparison between existing and new system:

| | time frame | spatial resolution | updating |
|---|---|---|---|
| BCRS | current conditions | 22 specific beaches | twice a day |
| RTCS | past week | 20-30 specific sampling points | once a week |
| HABF | 3-4 days ahead | 22 broad regions | once a week |
| New system | 24 hours ahead | each square mile within coverage area | hourly |

- Much higher resolution
- Much more frequent updating
- Reach further inland

# Survey

- A choice experiment (CE) survey was implemented in June and September 2020 in five Florida counties (Sarasota, Collier, Lee, Charlotte and Manatee).

# Survey

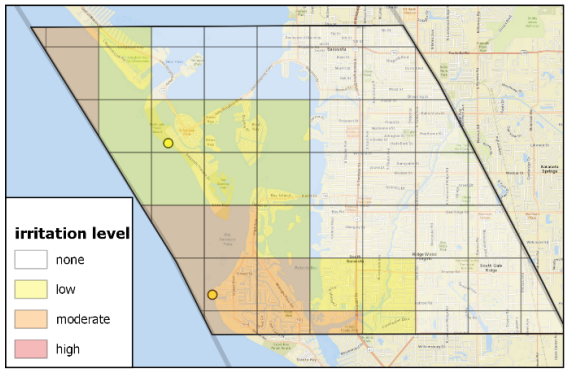
- A choice experiment (CE) survey was implemented in June and September 2020 in five Florida counties (Sarasota, Collier, Lee, Charlotte and Manatee).
- The new forecast system is a hypothetical but feasible better forecast system of RT air quality conditions.

# Survey

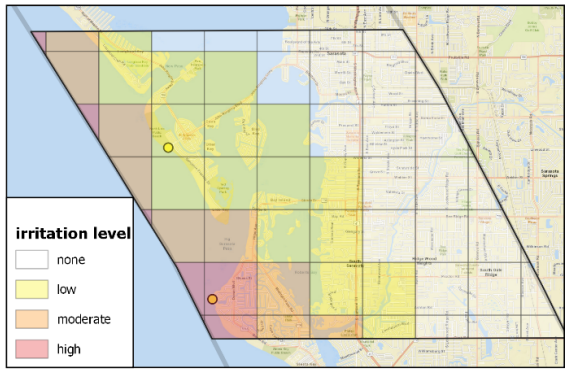
- A choice experiment (CE) survey was implemented in June and September 2020 in five Florida counties (Sarasota, Collier, Lee, Charlotte and Manatee).
- The new forecast system is a hypothetical but feasible better forecast system of RT air quality conditions.
- Three attributes: spatial coverage (6/12 miles), accuracy (50%/75%/100%) in the first/second 12-hour segment.

# Example of the planned forecast

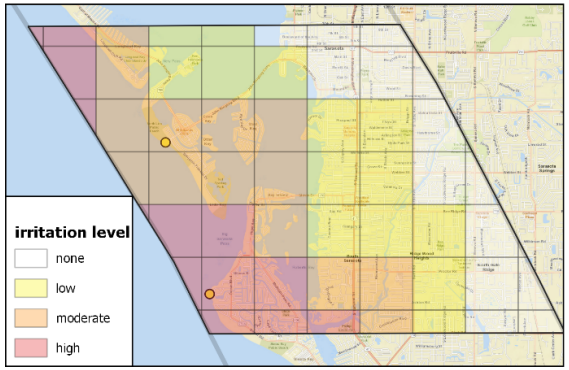
Sarasota 9 AM (6-mile band)



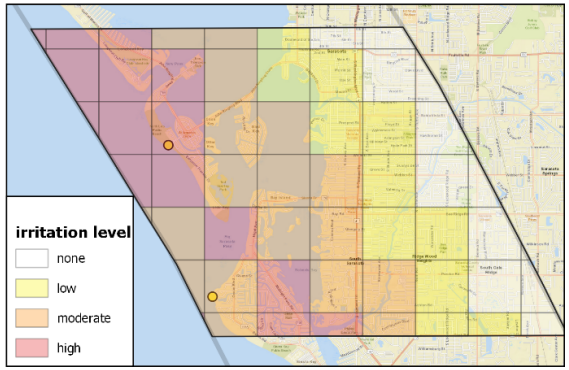

Sarasota 12 PM (6-mile band)



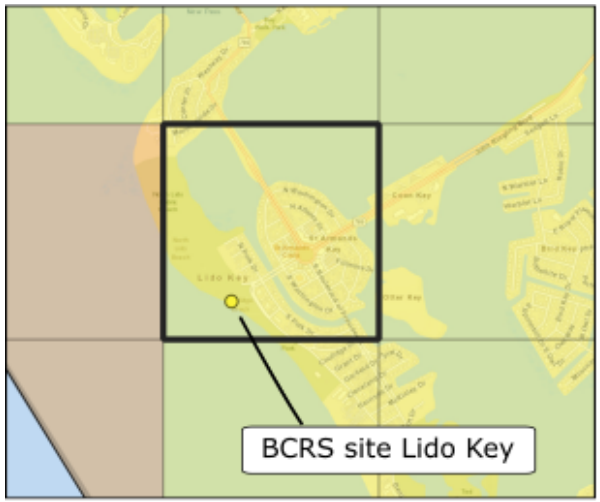

Sarasota 3 PM (6-mile band)




Sarasota 6 PM (6-mile band)



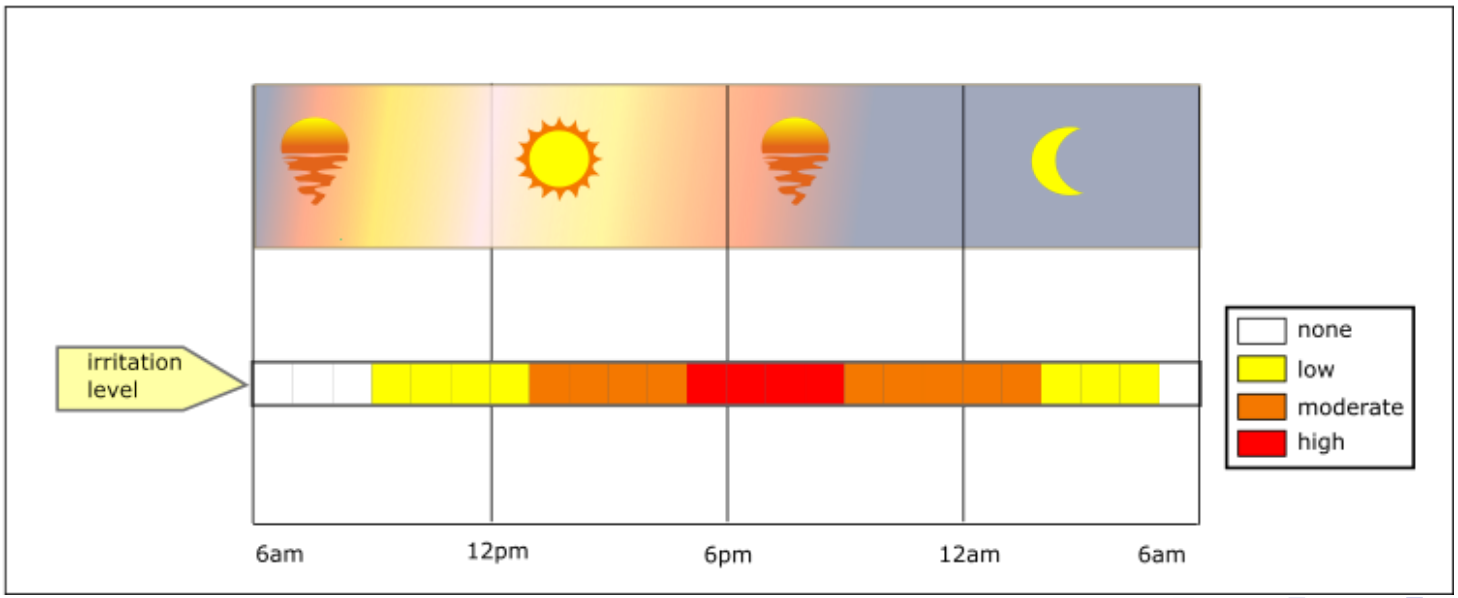
# Example of the planned forecast




St. Armands / Lido Beach

24 hour red tide irritation forecast

Last updated: Oct. 23, 2020, **6:00 AM**



# Spatial coverage

- Spatial coverage:

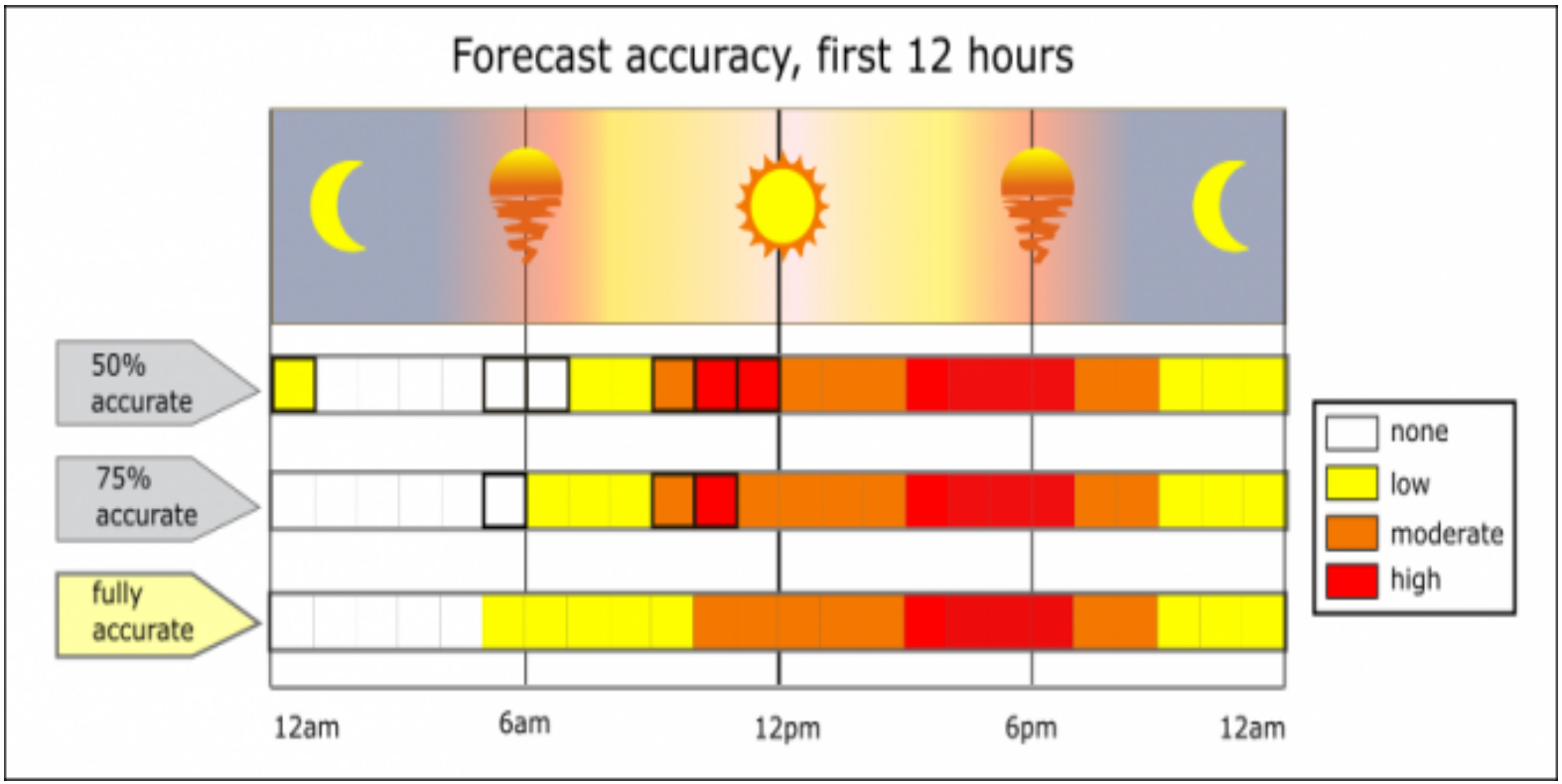

# Spatial coverage

- Spatial coverage:



- 6 miles band: about 1300 forecasting squares 12 miles band: about 2600 forecasting squares

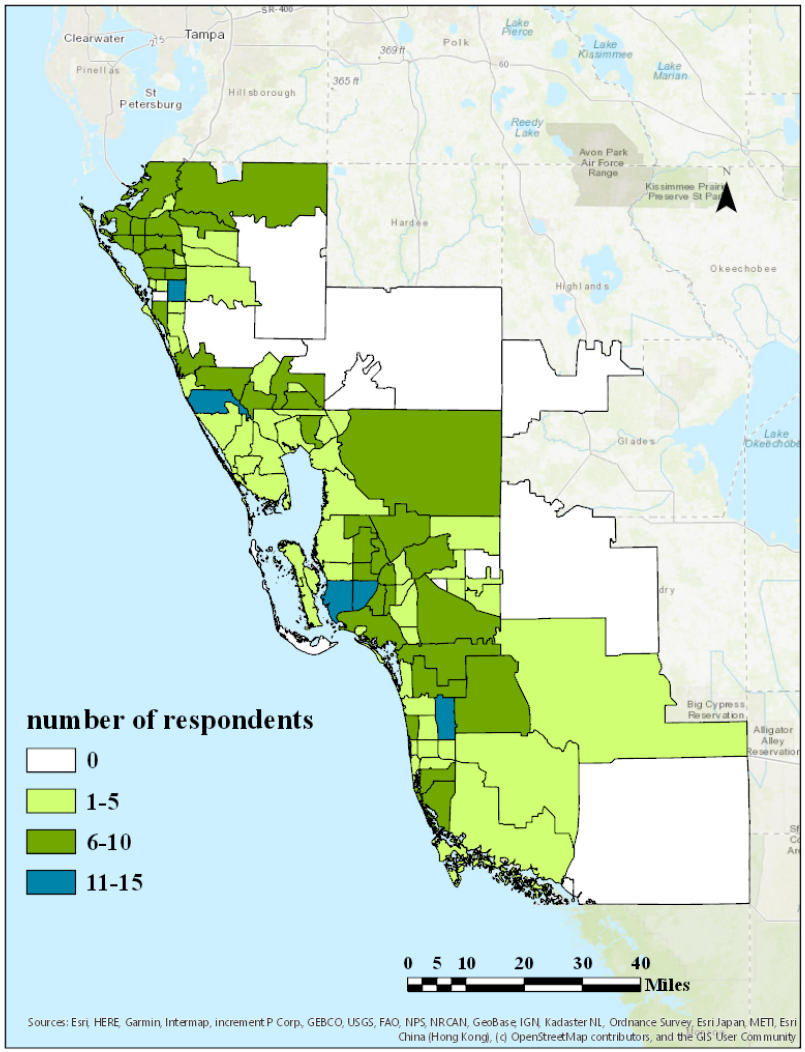
# Forecast accuracy



# Choice experiment

| Forecast features | Option A | Option B | |
|---|---|---|---|
| spatial coverage | 6 miles | 12 miles | **No new forecasting system, existing sources only** |
| accuracy, **first** 12 hours | 100% | 75% | |
| accuracy, **second** 12 hours | 50% | 50% | |
| cost to your household per year $ | $ 25 | $ 15 | $ 0 |

# Spatial location



# Outdoor activities impacted by RT

- Survey-elicited sixteen activities are impacted by red tide, such as cancel or shorten outdoor activities, cancel visits, had to see doctor and moved further from the shore, etc.

# Outdoor activities impacted by RT

- Survey-elicited sixteen activities are impacted by red tide, such as cancel or shorten outdoor activities, cancel visits, had to see doctor and moved further from the shore, etc.
- Five choices: never, sometimes, often, almost daily and cannot recall or not applicable.

# Outdoor activities impacted by RT

- Survey-elicited sixteen activities are impacted by red tide, such as cancel or shorten outdoor activities, cancel visits, had to see doctor and moved further from the shore, etc.
- Five choices: never, sometimes, often, almost daily and cannot recall or not applicable.
- Recode frequency of effects into binary indicator: 0=never, 1=otherwise.

# Outdoor activities impacted by RT

- Survey-elicited sixteen activities are impacted by red tide, such as cancel or shorten outdoor activities, cancel visits, had to see doctor and moved further from the shore, etc.
- Five choices: never, sometimes, often, almost daily and cannot recall or not applicable.
- Recode frequency of effects into binary indicator: 0=never, 1=otherwise.
- Combine all 16 activities to measure overall impact from RT air contamination.

# Outdoor activities impacted by RT

| effect | variable | % NO | % YES | effect | variable | % NO | % YES |
|---|---|---|---|---|---|---|---|
| outdoor activities: | | | | other effects: | | | |
| cancel / postpone | outcancel2 | 38.26 | 61.74 | guests cancelled visits | visitcancel2 | 66.67 | 33.33 |
| shorten | outshort2 | 37.85 | 62.15 | unable to open windows (home or car) | windows2 | 48.1 | 51.9 |
| re-locate | outreloc2 | 48.7 | 51.3 | unable to let pets out | pets2 | 75.13 | 24.87 |
| | | | | toxins enered home / car via A/C system | accar2 | 69.44 | 30.56 |
| around house outside activities | | | | | | | |
| cancel / postpone | yardcancel2 | 57.17 | 42.83 | additional actions in response to RT: | | | |
| shorten | yardshort2 | 53.73 | 46.27 | moved away from coast | moved2 | 78.15 | 21.85 |
| | | | | sold boat / water sport equipment | soldboat2 | 91.11 | 8.89 |
| health effects: | | | | put house / condo on market | sellhouse2 | 92.93 | 7.07 |
| irritation (but no doctor) | irritation2 | 38.99 | 61.01 | changed job / retired early | changejob2 | 92.1 | 7.9 |
| severe irriation, see doctor | doctor2 | 87.66 | 12.34 | | | | |
| bothered / sickened by dead fish smell | fishsmell2 | 48.52 | 51.48 | | | | |
| any activities were impacted | RTimpact2 | 17.6 | 82.4 | | | | |

# Scientific Information: BCRS

- Respiratory irritation (RI) from Mote Marine Laboratory's Beach Conditions Reporting System (BCRS)

# Scientific Information: BCRS

- Respiratory irritation (RI) from Mote Marine Laboratory's Beach Conditions Reporting System (BCRS)
- RI reported by citizen scientists (usually lifeguards) in terms of frequency of observed coughing by beach visitors: none, slight, moderate and intense.

# Scientific Information: BCRS

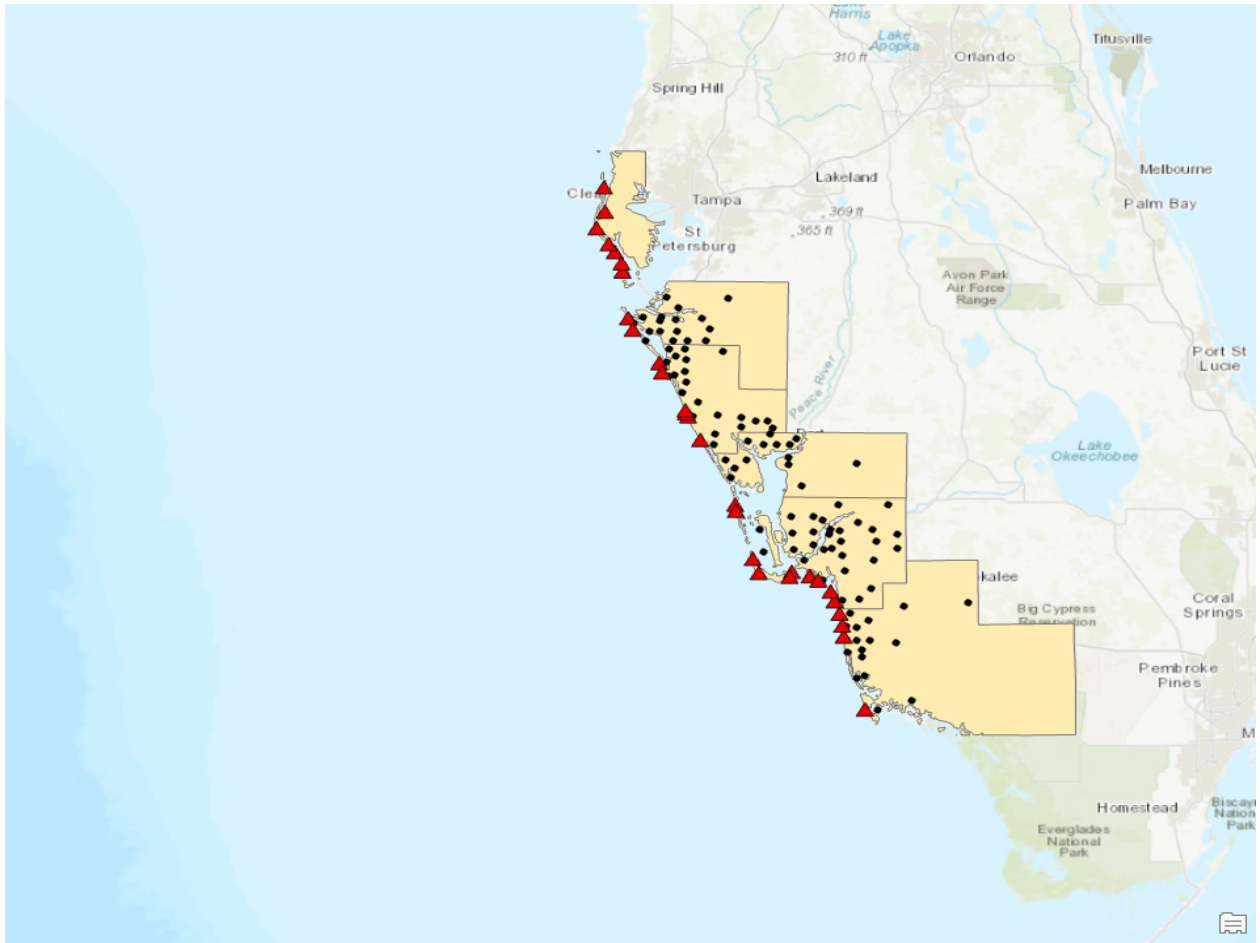
- Respiratory irritation (RI) from Mote Marine Laboratory's Beach Conditions Reporting System (BCRS)
- RI reported by citizen scientists (usually lifeguards) in terms of frequency of observed coughing by beach visitors: none, slight, moderate and intense.
- Categorized none and slight as low RI; moderate and intense as high RI.

# Scientific Information: BCRS

- Respiratory irritation (RI) from Mote Marine Laboratory's Beach Conditions Reporting System (BCRS)
- RI reported by citizen scientists (usually lifeguards) in terms of frequency of observed coughing by beach visitors: none, slight, moderate and intense.
- Categorized none and slight as low RI; moderate and intense as high RI.
- Calculate the number of days in two-year period (2018-2019) when RI was reported as high.

# Scientific Information: BCRS

- Identify the three-nearest beaches for respondents and calculate the average days.

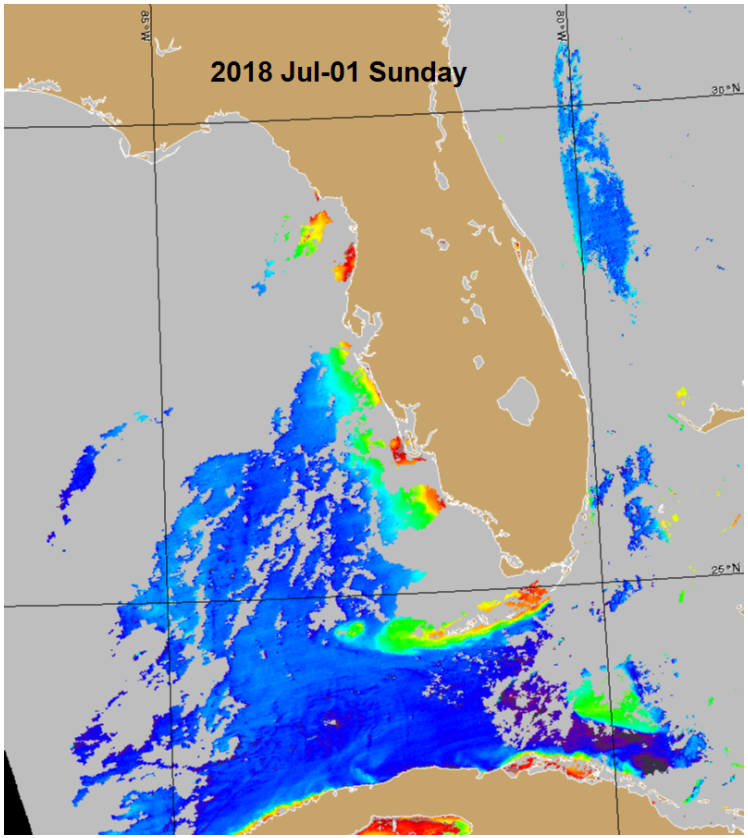


# Scientific Information: NOAA

- Chlorophyll-a (Chl-a) are strongly suspected to contain *K. brevis* which is the organism responsible for the RT.

# Scientific Information: NOAA

- Chlorophyll-a (Chl-a) are strongly suspected to contain *K. brevis* which is the organism responsible for the RT.
- Chl-a concentration from NOAA satellite images

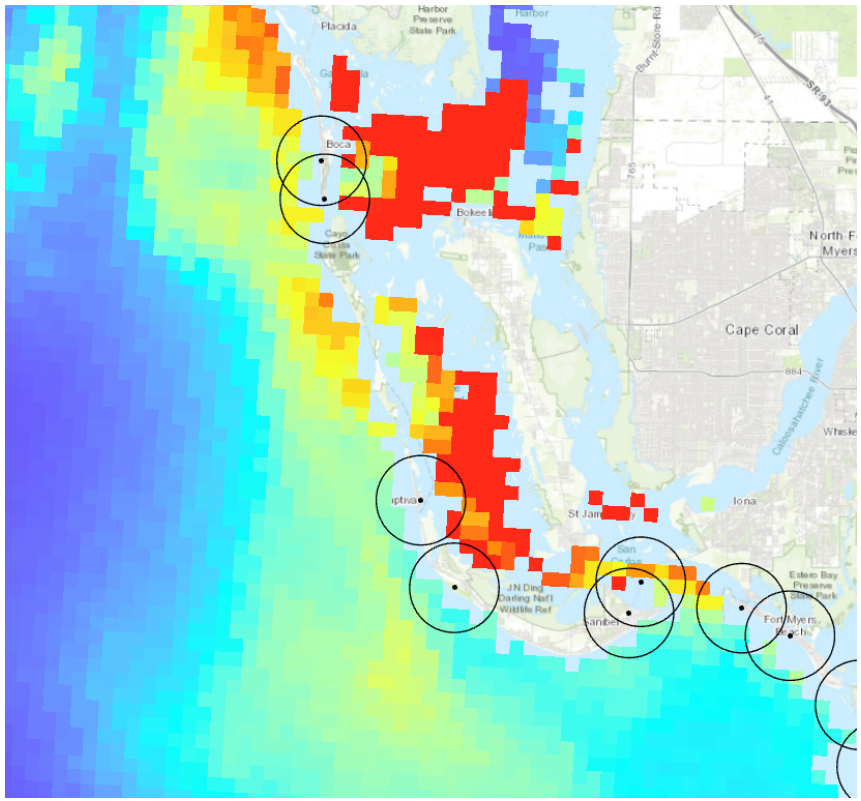


# Scientific Information: NOAA

- Make 2-mile buffers for beaches to get the daily average Chl-a

# Scientific Information: NOAA

- Make 2-mile buffers for beaches to get the daily average Chl-a
- The resolution of Chl-a concentration is approximately 1000*1000 meters.



# Scientific Information: NOAA

- Calculate the average chlorophyll for two-year period in beaches.

# Scientific Information: NOAA

- Calculate the average chlorophyll for two-year period in beaches.
- Identify the three nearest beaches and calculate the average chlorophyll of these beaches.

# Differences between BCRS and NOAA

- BCRS–what is in the air; NOAA–what is in the water

# Differences between BCRS and NOAA

- BCRS–what is in the air; NOAA–what is in the water
- BCRS–key to beach goers and land activities; NOAA–key to offshore fishing

# Differences between BCRS and NOAA

- BCRS–what is in the air; NOAA–what is in the water
- BCRS–key to beach goers and land activities; NOAA–key to offshore fishing
- Factors such as wind and wave translate what is in the water to what is in the air.

# Impact Model

- A simple binary logit model for all effects presented to investigate the relationship between scientific information and survey-elicited experience impacted by RT air contamination.

# Impact Model

- A simple binary logit model for all effects presented to investigate the relationship between scientific information and survey-elicited experience impacted by RT air contamination.
- In each regression, we also add the demographic variables including gender, age, household size, number of family members under seven, number of family members ages seven to 18, family members with respiratory conditions, years lived at current address, years lived at current county, income and education.

# Impact Model: marginal effects

| | RTimpact2 | outcancel2 | outshort2 | outreloc2 | yardcancel2 | yardshort2 | visitcancel2 | windows2 | pets2 |
|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| chlora_mean | 0.0284*** | 0.0099 | 0.0307*** | 0.0108 | 0.0532*** | 0.0590*** | 0.0190*** | 0.0680*** | 0.0528*** |
| | (0.0046) | (0.0074) | (0.0074) | (0.0078) | (0.0078) | (0.0078) | (0.0073) | (0.0078) | (0.0072) |
| resp1_days | 0.0028*** | 0.0029*** | 0.0046*** | 0.0014** | 0.0052*** | 0.0054*** | 0.0031*** | 0.0080*** | 0.0050*** |
| | (0.0004) | (0.0006) | (0.0006) | (0.0006) | (0.0006) | (0.0006) | (0.0006) | (0.0006) | (0.0006) |
| Observations | 5940 | 5460 | 5520 | 5484 | 5628 | 5568 | 5376 | 5628 | 4632 |

| | accar2 | irritation2 | doctor2 | fishsmell2 | moved2 | soldboat2 | sellhouse2 | changejob2 |
|---|---|---|---|---|---|---|---|---|
| | (10) | (11) | (12) | (13) | (14) | (15) | (16) | (17) |
| chlora_mean | 0.0614*** | -0.0027 | 0.0230*** | 0.0307*** | -0.0120* | -0.0043 | -0.0124*** | -0.0022 |
| | (0.0075) | (0.0072) | (0.0042) | (0.0078) | (0.0065) | (0.0037) | (0.0029) | (0.0033) |
| resp1_days | 0.0066*** | 0.0023*** | 0.0014*** | 0.0056*** | -0.0023*** | -0.0008*** | -0.0009*** | -0.0005** |
| | (0.0006) | (0.0006) | (0.0003) | (0.0006) | (0.0005) | (0.0003) | (0.0002) | (0.0003) |
| Observations | 5292 | 5676 | 5592 | 5604 | 4992 | 4404 | 4872 | 4812 |

# Choice Model

| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| sq | -0.8017*** | -0.4012*** | 0.2994 | -0.8282*** | 4.3274*** |
| | (0.1041) | (0.1289) | (0.6392) | (0.1443) | (1.5578) |
| cov12 | 0.1097 | 0.1097 | 0.1117 | 0.1101 | 0.1103 |
| | (0.0940) | (0.0945) | (0.0941) | (0.0940) | (0.0942) |
| acc175 | 0.2628** | 0.2655** | 0.2579** | 0.2619** | 0.2622** |
| | (0.1294) | (0.1297) | (0.1294) | (0.1295) | (0.1296) |
| acc1100 | 0.9346*** | 0.9364*** | 0.9305*** | 0.9339*** | 0.9348*** |
| | (0.1429) | (0.1432) | (0.1428) | (0.1429) | (0.1431) |
| acc275 | 0.2219** | 0.2187** | 0.2224** | 0.2220** | 0.2223** |
| | (0.0954) | (0.0955) | (0.0954) | (0.0954) | (0.0955) |
| acc2100 | -0.0069 | -0.0067 | -0.0018 | -0.0061 | -0.0052 |
| | (0.1286) | (0.1289) | (0.1286) | (0.1287) | (0.1288) |
| bid | -0.0464*** | -0.0464*** | -0.0465*** | -0.0465*** | -0.0465*** |
| | (0.0049) | (0.0049) | (0.0049) | (0.0049) | (0.0049) |
| sq_RTimpact | | -0.0789*** | | | |
| | | (0.0160) | | | |
| sq_chlora | | | -0.0545* | | -0.2234*** |
| | | | (0.0313) | | (0.0673) |
| sq_resp1 | | | | 0.0006 | -0.0150*** |
| | | | | (0.0024) | (0.0053) |
| Observations | 4416 | 4416 | 4416 | 4416 | 4416 |
| Pseudo R-squared | 0.0668 | 0.0747 | 0.0678 | 0.0668 | 0.0702 |

# WTP estimates

| forecast scenario | | | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 |
|---|---|---|---|---|---|---|---|
| coverage | accurancy 1st 12 hrs | accurancy 2nd 12 hrs | mean | mean | mean | mean | mean |
| 6 | 50 | 50 | 17.26167 | 17.58826 | 17.40197 | 17.2687 | 17.66083 |
| 6 | 50 | 75 | 22.03904 | 22.30427 | 22.18213 | 22.04638 | 22.44036 |
| 6 | 50 | 100 | 17.11263 | 17.44483 | 17.36225 | 17.1375 | 17.54968 |
| 6 | 75 | 50 | 22.91978 | 23.31279 | 22.94345 | 22.90662 | 23.29946 |
| 6 | 75 | 75 | 27.69714 | 28.0288 | 27.72361 | 27.6843 | 28.07899 |
| 6 | 75 | 100 | 22.77074 | 23.16936 | 22.90373 | 22.77541 | 23.18831 |
| 6 | 100 | 50 | 37.38477 | 37.77708 | 37.39891 | 37.37033 | 37.7606 |
| 6 | 100 | 75 | 42.16214 | 42.49308 | 42.17907 | 42.14801 | 42.54013 |
| 6 | 100 | 100 | 37.23574 | 37.63365 | 37.35919 | 37.23912 | 37.64945 |
| 12 | 50 | 50 | 19.62437 | 19.95287 | 19.80194 | 19.63794 | 20.03353 |
| 12 | 50 | 75 | 24.40174 | 24.66888 | 24.5821 | 24.41562 | 24.81306 |
| 12 | 50 | 100 | 19.47534 | 19.80944 | 19.76222 | 19.50673 | 19.92238 |
| 12 | 75 | 50 | 25.28248 | 25.6774 | 25.34342 | 25.27586 | 25.67216 |
| 12 | 75 | 75 | 30.05985 | 30.39341 | 30.12358 | 30.05353 | 30.45169 |
| 12 | 75 | 100 | 25.13345 | 25.53397 | 25.3037 | 25.14465 | 25.56101 |
| 12 | 100 | 50 | 39.74747 | 40.14169 | 39.79888 | 39.73957 | 40.1333 |
| 12 | 100 | 75 | 44.52484 | 44.8577 | 44.57904 | 44.51725 | 44.91283 |
| 12 | 100 | 100 | 39.59844 | 39.99826 | 39.75916 | 39.60836 | 40.02216 |

# Conclusion

- The probability of activities affected by RT air contamination increases when the Chl-a concentration increases or the number of high RI days increases.

# Conclusion

- The probability of activities affected by RT air contamination increases when the Chl-a concentration increases or the number of high RI days increases.
- Respondents are less likely to choose the current status when outdoor activities are more influenced by RT air contamination.

# Conclusion

- The probability of activities affected by RT air contamination increases when the Chl-a concentration increases or the number of high RI days increases.
- Respondents are less likely to choose the current status when outdoor activities are more influenced by RT air contamination.
- Respondents are more favorable of the new HABs forecast system when the Chl-a concentration increases or the number of high RI days increases.

# Conclusion

- Using self-reported impacts in the choice model seems not to pose endogeneity problems in this application - attribute coefficients remain stable, and WTP estimates are almost the same between model with self-reported impacts and model with scientific information.

# Conclusion

- Using self-reported impacts in the choice model seems not to pose endogeneity problems in this application - attribute coefficients remain stable, and WTP estimates are almost the same between model with self-reported impacts and model with scientific information.
- The outside objective scientific information can be effectively combined with choice experimental data.

# Conclusion

- Using self-reported impacts in the choice model seems not to pose endogeneity problems in this application - attribute coefficients remain stable, and WTP estimates are almost the same between model with self-reported impacts and model with scientific information.
- The outside objective scientific information can be effectively combined with choice experimental data.
- We can predict both impacts of survey-elicited experience and WTP estimates directly from scientific data without asking related questions for respondents or even without having to do another survey.


Thank You