



# Development of Recreational Marine Vessel Emissions Inventory Model (RMV2022)

Air Quality Planning & Science Division  
California Air Resources Board

March 30, 2021

# Multiple Goals



**2023:**  
South  
Coast &  
SJV Ozone

**2030:** GHG  
40 percent  
below 1990

**2037:**  
South  
Coast &  
SJV Ozone

**2050:** GHG  
80 percent  
below 1990



**2024/25:**  
South Coast & SJV PM2.5

**AB 617 Communities**

**2031:**  
South  
Coast &  
SJV Ozone

**2045:**  
Carbon  
Neutrality

# Executive Order N-79-20

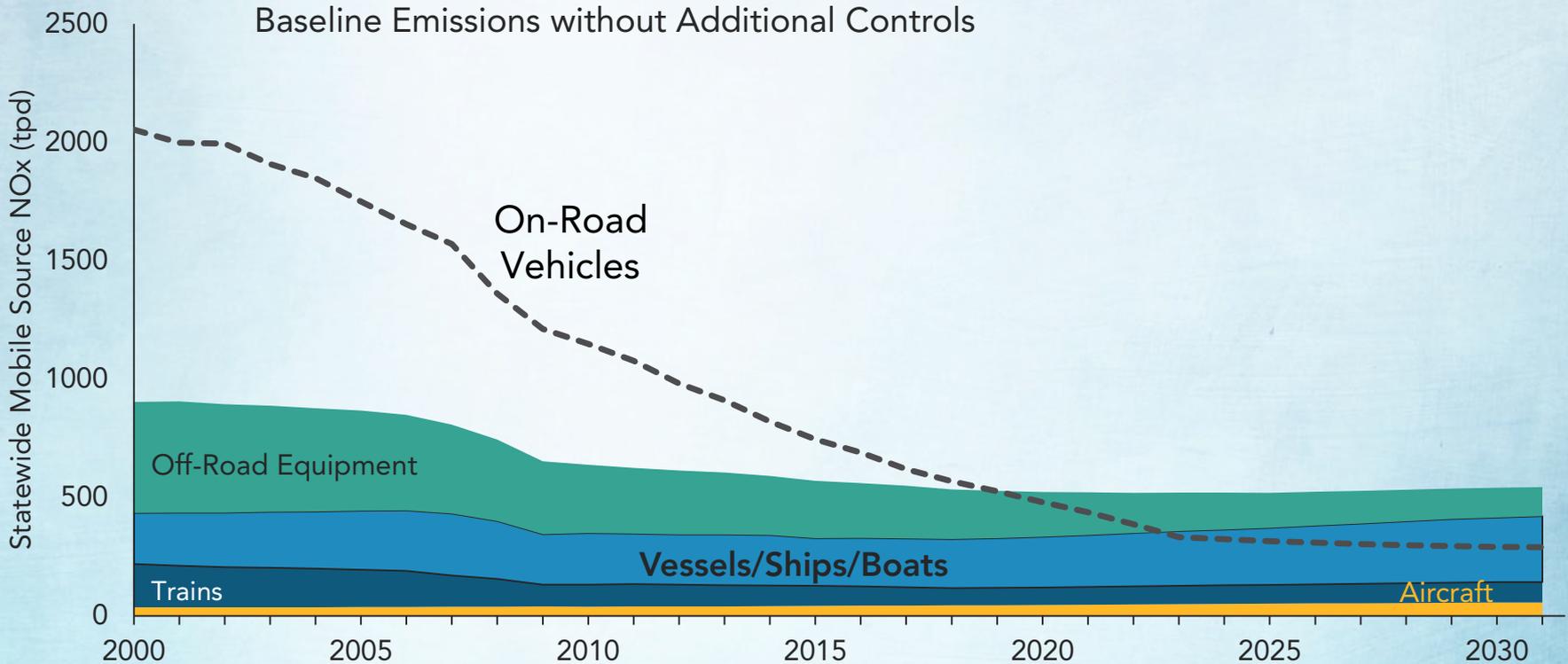
 **100% ZEV sales** by 2035

Full transition to  
**ZEV short-haul/drayage trucks**   
by 2035

Full transition to **ZEV buses & heavy-duty long-haul trucks**    
by 2045\*

Full transition to  
**ZE off-road equipment**   
by 2035\*

# Growing Off-Road Contribution



# Recreational Marine Vessels



Inboard



Outboard



Sterndrive



Jet



PWC



Auxiliary & Sails

# Emission Inventory Update

- PC2014 is outdated
- Availability of new data
  - 8 more years of DMV Registration
  - Engine Certification Database (SIME)
  - Engine Production Line Testing (PLT)
  - New Forecasting
  - 2021 Cal. State Fullerton Survey
- New inventory is needed to support future recreational marine vessel regulation

# Timeline

March 2021  
1<sup>st</sup> Workshop

Finalizing Survey

September 2021

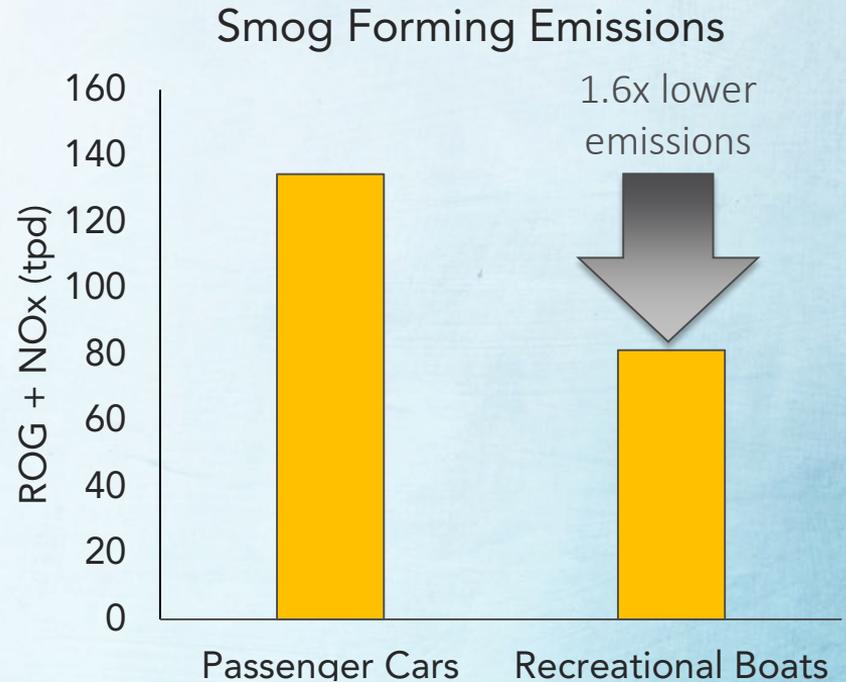
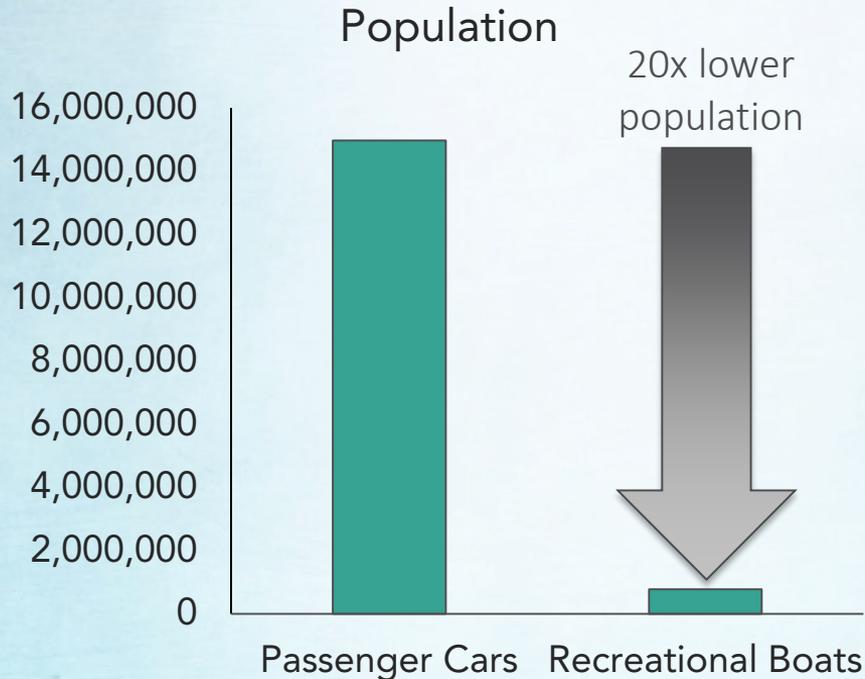
March 2022  
2<sup>nd</sup> Workshop

April 2022  
Final Inventory  
Release

2026/2027  
Potential Regulatory  
Action

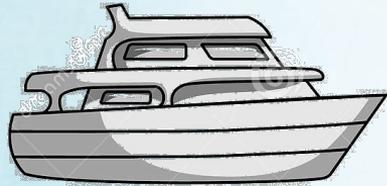
# Emissions from Recreational Marine Vessels

- Significant source of NO<sub>x</sub> and ROG emissions in 2019

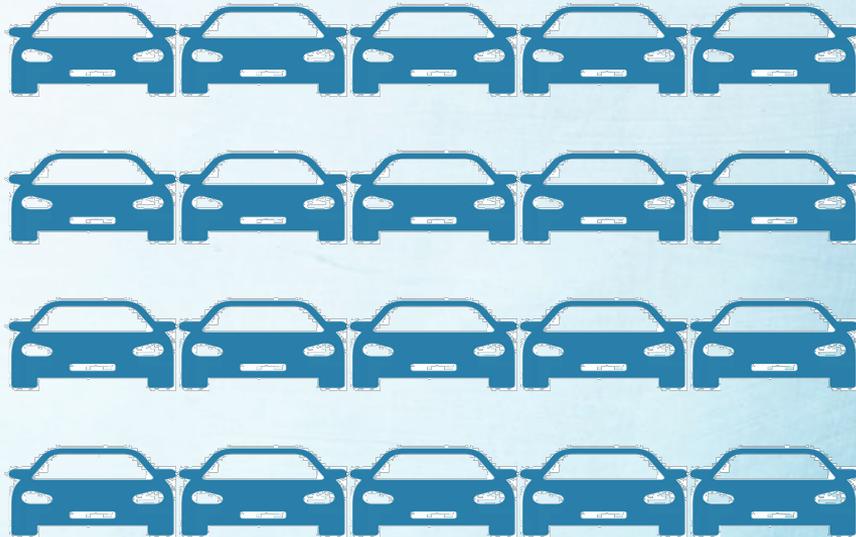


# Importance of Reducing Emissions from Recreational Marine Vessels

- By 2031, smog forming emissions from an average recreational boat in California is equivalent to 20 passenger cars



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# Major Updates

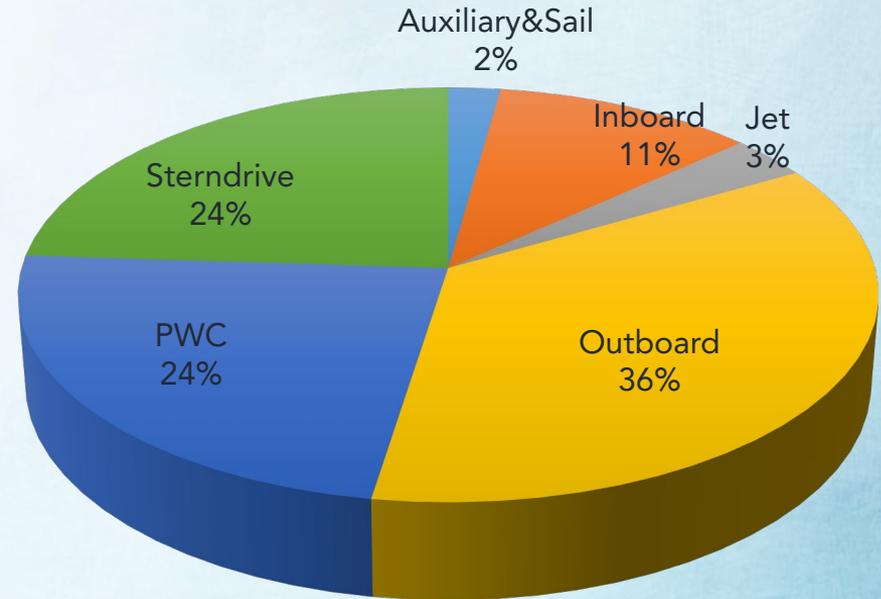
- Population
- Forecasting
- Emission Factors
- Boating Activity
- Spatial Allocation
- Model Structure



# Population & Forecasting

# 2020 DMV Vessel Registration

- Population ~785,000
- ~15% Inactive population on average.
- Outboard and PWC are increasing in market share
- Sterndrives are phasing out





# RMV Sales: Highlights

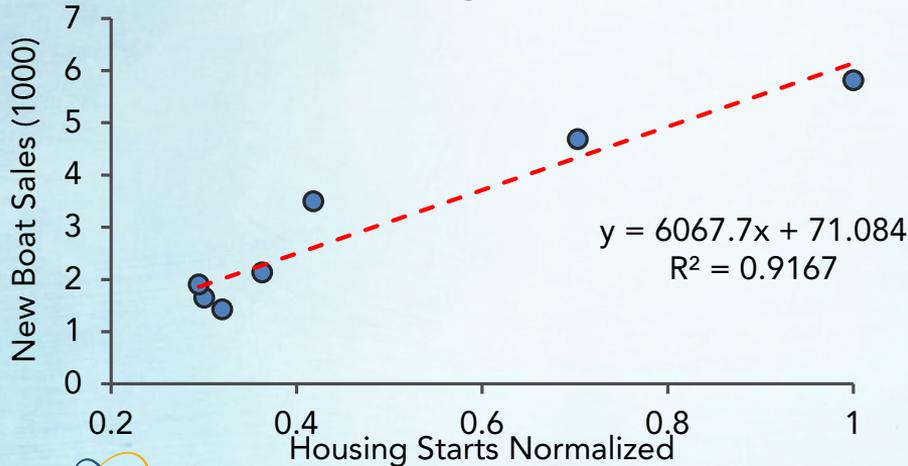
- Despite increase in sales, the overall population of RMV has been steadily decreasing over the last 10 years
- Demographic changes (age group who owns boat)
- California higher housing prices, less disposable income for leisure
- California population growth projection shows slow down trend
- According to industry report, boat sales skyrocketed last year during the pandemic, and the trend shows no signs of slowing in 2021



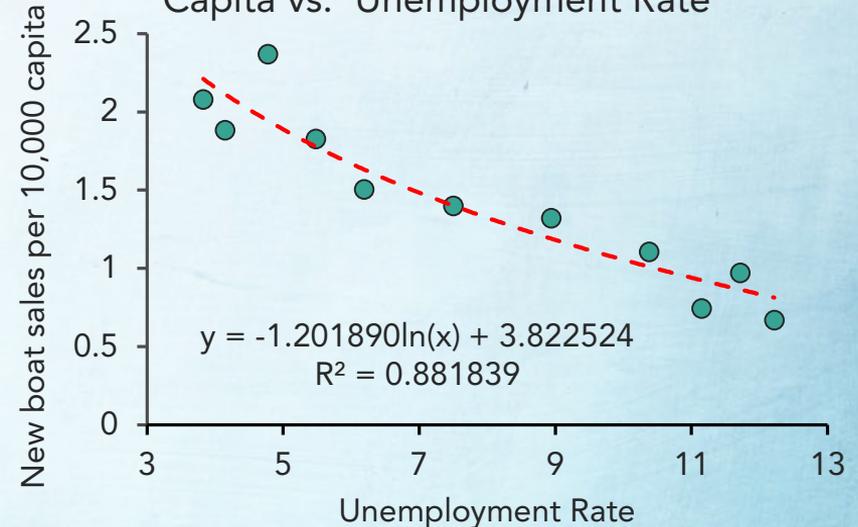
# New Vessel Sales vs. Economic Indicators

- New vessels sale is highly correlated with housing starts and unemployment rates

PC 2014: Outboard New Sales vs. Housing Start

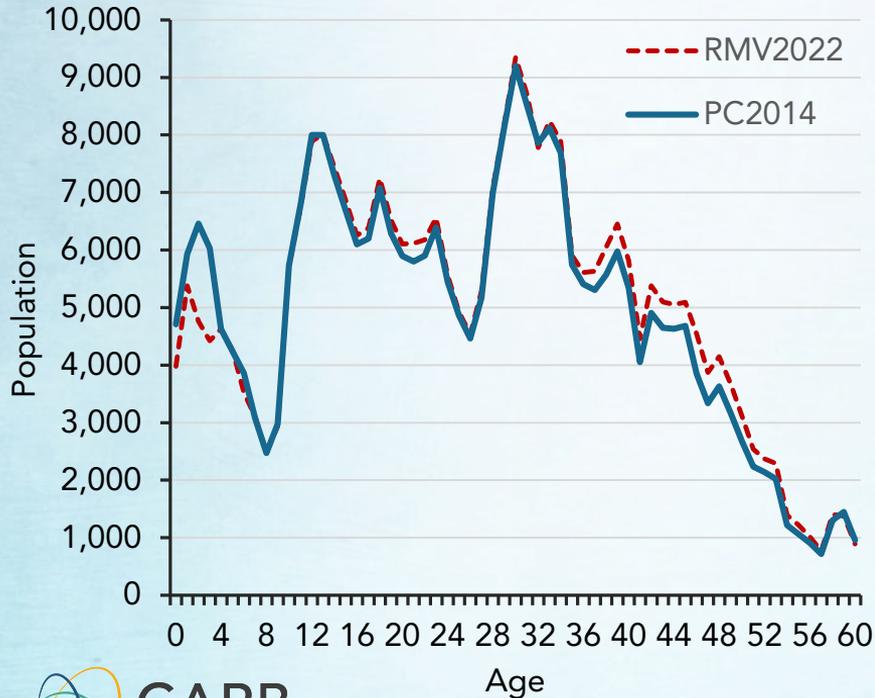


RMV2022: Outboard New Sales per Capita vs. Unemployment Rate

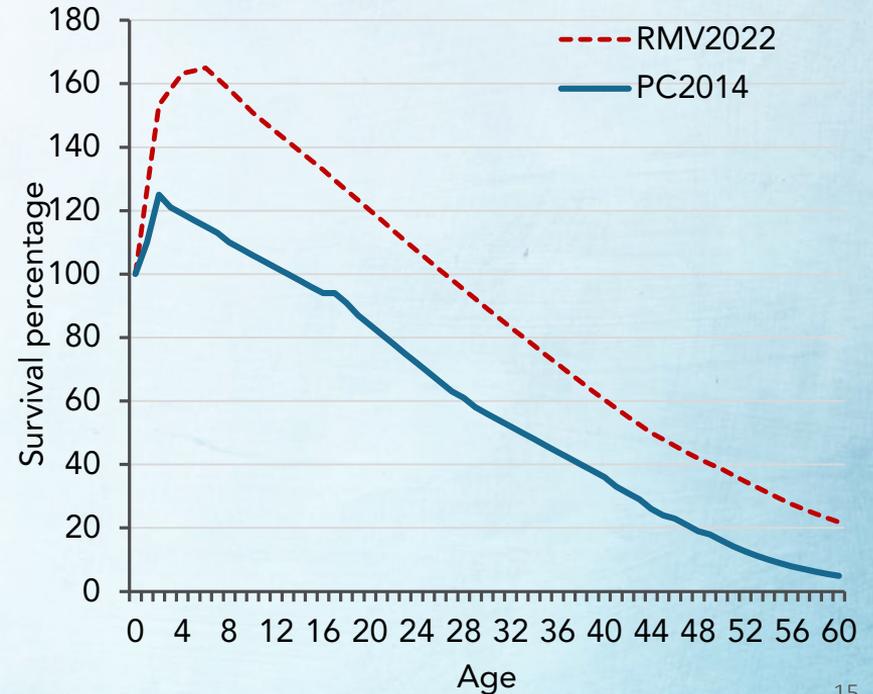


# Age Distribution & Survival Rates

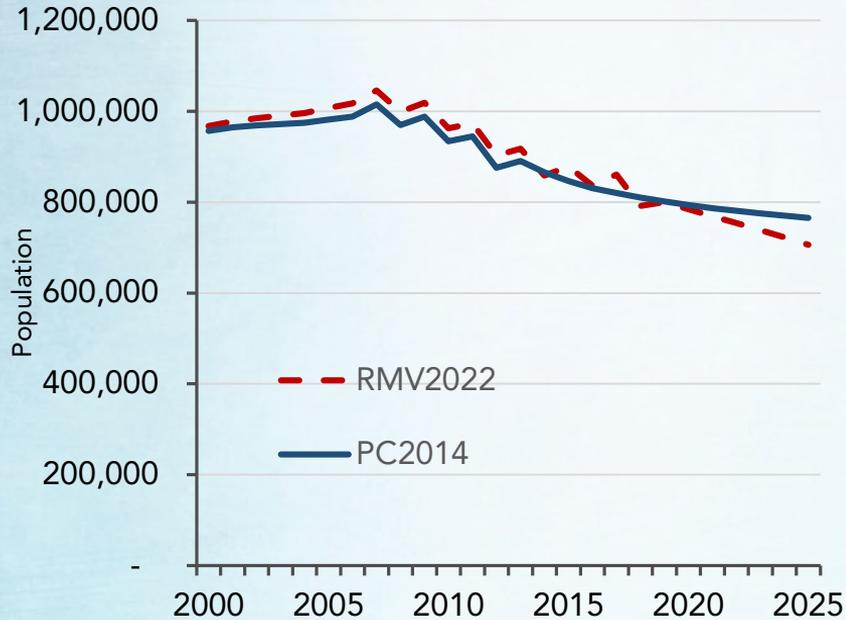
Outboard CY 2018: Age Distribution



Outboard Survival Curve



# Population Update: PC2014 vs. RMV2022



- 16 Years of DMV Registration ( CY2006-2021)
- Improved Fleet Survival Rate
- New Sales Correlation Development
- U.S. Coast Guard 2018 Registration Adjustment

# Emission Factors

# Emission Factors Update

- **Evaporative**

- CARB In-house testing data

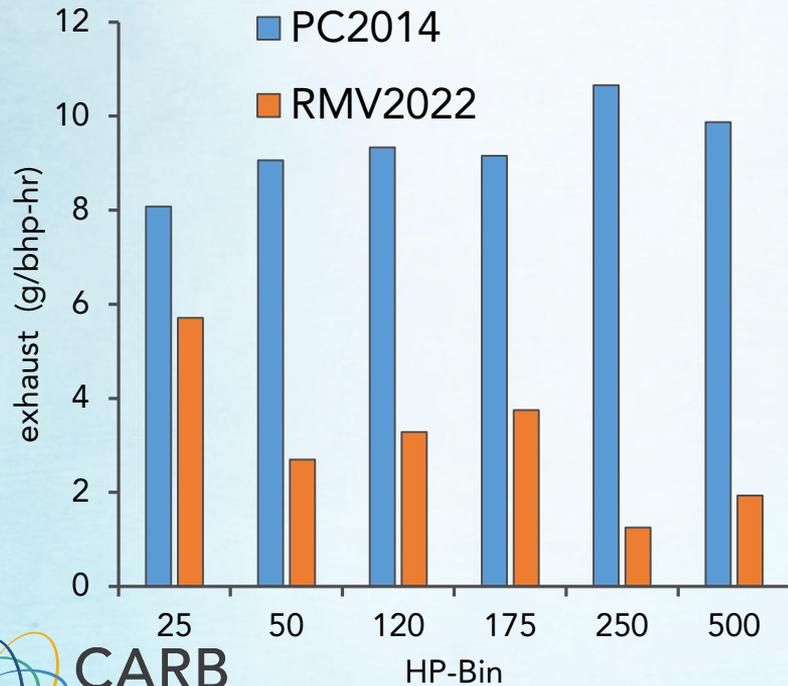


- **Exhaust**

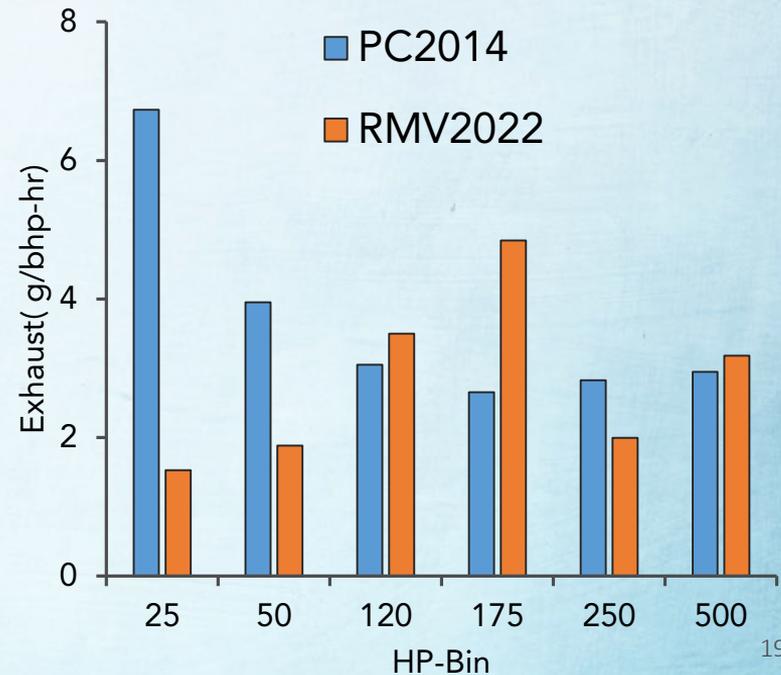
- Population weighted
- PC2014: Spark Ignition Marine Engine (SIME) Database
- RMV2022: Engine Production Line Testing (PLT) Database

# Exhaust Emission Factors Comparison Outboard MY2018

Outboard G4\_Fl: HC zero-hour  
Emission



Outboard G4\_Fl: NOx zero-hour  
Emission



# Boating Activity

# Boating Activity

PC2014

Vessel Type	Annual Activity (hrs)
Outboard	62
Inboard	60
Sterndrive	47
Auxiliary & Sail	76
Jet	42
PWC	42

RMV2022



# Spatial Allocations



## Storage allocation

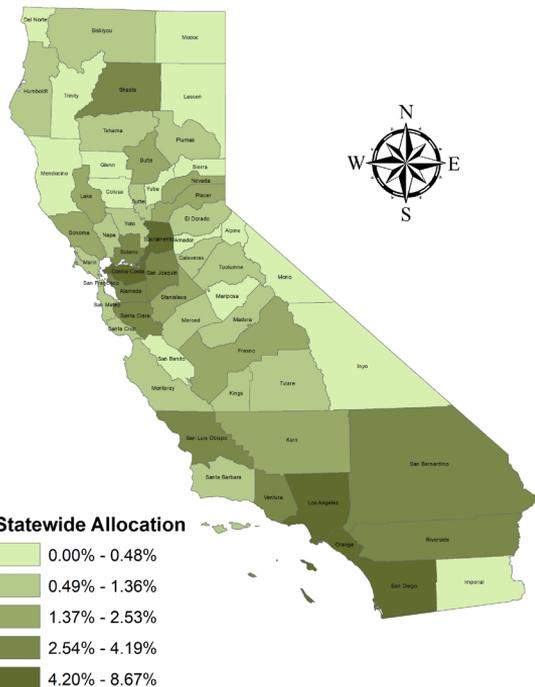
- Residential areas & marina slips
- Active & inactive population
- Evaporative
  - Diurnal
  - Resting loss

## Operational allocation

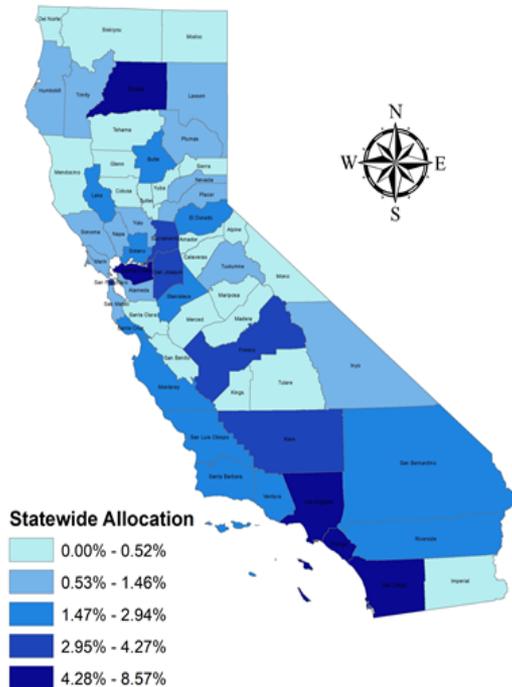
- Lakes & coastal areas
- Active population
- Exhaust
- Evaporative
  - Hot soak
  - Running loss

# Spatial Allocations

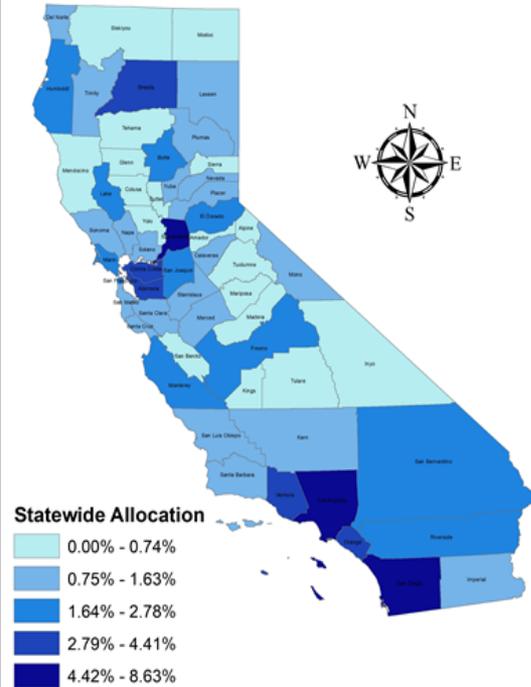
PC2014 Boat Storage Location



PC2014 Boat Launch Location



RMV2022 Boat Launch Location



# 2021 California Recreation Marine Vessel On-line Survey

## Online Survey Steps:

1. Turn on your smart phone's camera and let it scan the QR Code below.



2. Enter your survey code.
3. Complete the survey.
4. When you have completed the survey, provide your contact information so we can follow up with you about your survey experience.

- Conducted by Social Science Research Center of Cal. State Fullerton with **Qualtrics**
- Beta-test: December 2020 ~ April 2021
- Pilot-test: June 2021
- Survey: Summer 2021
- Estimated sample size (n = 1,500 ~ 2,000)
- Staff report expected around early 2022

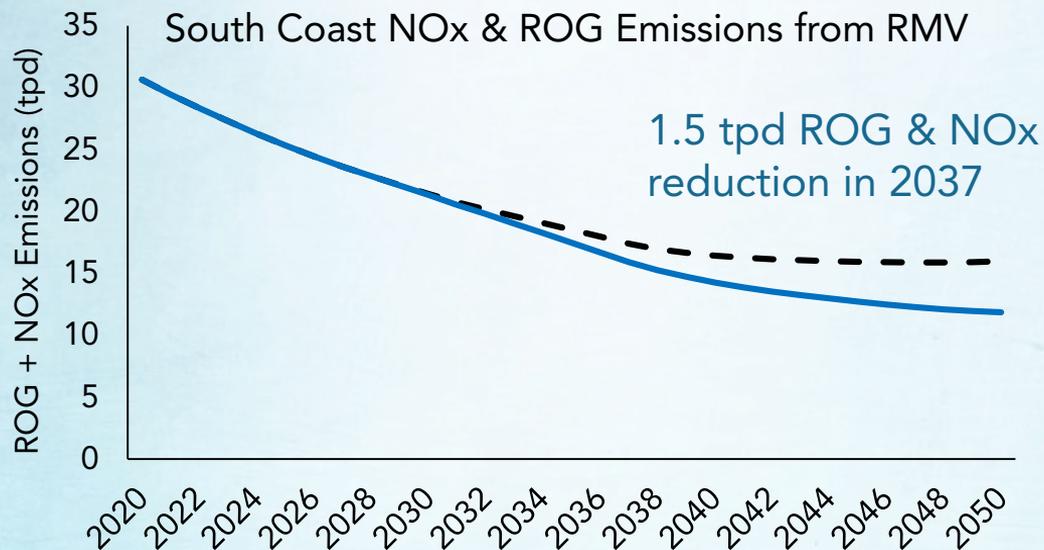
# Sample Questions for The Survey

- Is your vessel registered with DMV or U.S. Coast Guard?
- Is your vessel's engine original or re-build?
- How many engines are within your craft?
- What type of fuel do you use in your craft?
- Does the fuel tank always have fuels inside even when the vessel is in the storage?
- Which month(s) do you use your craft and the time duration of each usage?
- Where do you operate and store your craft?



# Upcoming State SIP Strategy

- **RMV MSS:** More stringent THC+NO<sub>x</sub> standards along with electrification of outboard engines (<19 kW) and personal watercraft
- Potential Board Date: 2026/2027



# Next Steps



- Incorporate feedback from stakeholders
- Release draft inventory (December 2021)
- Final inventory report (March 2022)

# Contacts

- Questions, comments, and feedback are encouraged and welcome
- To address comments and reflect any changes, please submit comments and any supporting data by **July 30, 2021**

Wenjing Wong  
Inventory Lead Staff  
Off-Road Gasoline Inventory Section  
[wenjing.wong@arb.ca.gov](mailto:wenjing.wong@arb.ca.gov)

David Chou  
Manager  
Off-Road Gasoline Inventory Section  
[david.chou@arb.ca.gov](mailto:david.chou@arb.ca.gov)

The background features a dark blue gradient with a starry space pattern. Overlaid on this are several technical diagrams, including circular gauges with numerical scales (e.g., 140, 150, 160, 170, 180, 190, 200, 210, 220, 230, 240, 250, 260) and various circular arrows indicating rotation or flow. The text is centered in a clean, white, sans-serif font.

# SOCIAL SCIENCE RESEARCH CENTER, CSUF AND CARB'S RECREATIONAL MARINE VESSEL (RMV) SURVEY

HISTORY, BACKGROUND, QUALIFICATIONS, AND  
SERVICES OF THE SSRC AND A METHODOLOGICAL  
EXPLANATION OF THE CARB'S RMV SURVEY

# INTRODUCTIONS

## Laura Gil-Trejo

- SSRC Director
- With SSRC since 2004, Director since 2008
- MA in Social Ecology from UCI; MPH from SDSU
- Oversight of SSRC Research Activities



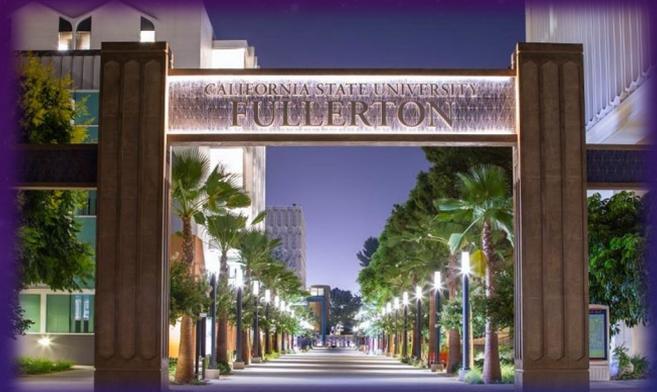
## Frederick Rose

- SSRC Research Operations Coordinator
- With SSRC since 2012
- MPH from CSUF
- Daily Operations of SSRC Research Activities



# ABOUT THE SSRC

- Established in 1987
  - To provide research services campus and community organizations
  - To give research support to faculty on campus
- Committed to providing high quality research services
  - Using the most updated and evidence-based methodologies and software
- Member of AAPOR's Transparency Initiative



# SERVICES PROVIDED

## Quantitative

- Telephone
- Paper-based
- Online
- Mail Push-to-Web
- In-Person

## Qualitative

- In Depth Interviews
- Focus Group Discussions
- Observations
- Program Evaluations

SSRC crafts research solutions to fit client needs using one or both types of approaches.

# STAFF AND QUALIFICATIONS

- Three managerial staff
  - All with a decade or more of social science research experience
- CATI-Lab Staff
  - Seven supervisory staff
  - Between 25 and 75 telephone interviewers
- Two to three interns
  - Program to promote student learning in research environment
- All upper management possess advanced degrees in their fields
  - Director – MPH and MA in Psychology
  - Research Operations Coordinator – MPH
  - Administrative Operations Manager – MPA
- Director has multiple publications to her credit
- Consistently positive reviews from past clients

- Researchers at CSUF
- Researchers at other universities
- Government entities and agencies
  - Federal
  - State
  - Local
- Community-based organizations
- Faith-based organizations
- Other non-profits



## TYPES OF CLIENTS

# CALIFORNIA AIR RESOURCES BOARD RECREATIONAL MARINE VESSEL SURVEY



## SSRC'S ROLE AND METHODOLOGICAL CONSIDERATIONS

# SSRC AND CARB'S PAST ENDEAVORS

- Large Spark Ignition (LSI) Equipment
  - Telephone survey
  - Inventory of forklifts, tow tractors, and sweeper/scrubbers
  - Conducted in 2015 – 2016
  - 1,200 businesses
- Small Off-Road Engine (SORE) Equipment
  - Three phase telephone survey
    - Households, businesses, and landscapers
  - Inventory of lawn and garden and other outdoor power equipment
  - Conducted in 2017 – 2019
  - 1,152 households, 1,350 businesses, and 628 landscapers



- Purpose
  - Develop an emissions inventory of pleasure craft within the State of California
- Previous activity were based on a survey that is almost a decade old
- Covers six boat types: outboard, sterndrive, inboard, auxiliary sailboat, jet boats, and personal watercraft
- Goal
  - Collect a minimum of 2,000 surveys

# ARB RECREATIONAL MARINE VESSEL SURVEY: STUDY BACKGROUND





# PUSH-TO-WEB METHOD: EXPLANATION OF APPROACH

- Method:
  - Uses address-based sampling (ABS) – addresses selected at random from around the state
  - Invitation postcard:
    - Explains the purpose of the study, who is conducting it, and information about the incentive for completing
    - Contains a QR code to access an online version of the survey
    - Contains a unique ID to authenticate participant information



# PUSH-TO-WEB METHOD: SUPPORT FOR APPROACH

- Pilot tested by UCLA Center for Health Policy Research
  - California Health Interview Survey (CHIS) in 2018.
  - Subsequently made the primary mode for the 2019-2020 CHIS cycle (followed up with phone calls where necessary).
- Being employed to account for decreasing response in traditional methods.
- Improved US postal addresses coupled with online survey cost savings make this a viable approach
- <http://healthpolicy.ucla.edu/chis/design/Pages/2019-2020-methods.aspx>



- Purpose:
  - To make sure survey items elicit the responses we are looking for and are interpreted the same way by different respondents
- Process: Cognitive Interviewing
  - To study how target audiences understand, mentally process, and respond to materials - emphasis on the breakdown of these processes.
    - When a questionnaire designer develops question to have a specific interpretation, yet finds that individuals presented with the question adopt an alternative understanding that, in retrospect, appears quite reasonable, that is a potential breakdown.
  - Well conducted cognitive interviews lead to this finding and thus modified questions to improve clarity, we achieve our goal of improving our question through cognitive techniques.

## BETA-TESTING (COGNITIVE INTERVIEWING)

# GENERAL FEATURES OF THE COGNITIVE INTERVIEWING PROCESS

- Cognitive focus (comprehension, recall, decisions and judgement)
- Timing
- Interviewers
- Verbal procedures (think aloud and verbal probing)
- Reliance on probing techniques
- Recruitment
- Emphasis on covert and overt problems
- Laboratory environments
- Modest sample sizes (5-15)
- Iterative testing
- Flexible application
- Information rather than validation
- Advisory in nature



# SURVEY TIMELINE

Beta  
Testing:  
Dec 2020  
through  
Apr 2021

Survey  
Pilot:  
June  
2021

Survey  
Fielding:  
Summer  
& Fall  
2021

Final  
Report to  
CARB:  
Early 2022

The background is a dark blue gradient with a subtle pattern of small white dots. On the left side, there are several overlapping circular elements. A prominent feature is a large circular scale with tick marks and numerical labels ranging from 140 to 260. Other circles include dashed lines, solid lines, and arrows, some pointing inwards and some outwards, creating a sense of motion or rotation. The overall aesthetic is technical and futuristic.

QUESTIONS?