

2020 UC Davis

Aviation Noise & Emissions Symposium

# Evolution of Aviation Noise

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# Evolution of Aviation Noise

- What is noise?
- Community annoyance with noise is not a modern issue
- Early aircraft noise issues
- Evolution of federal regulations addressing aircraft noise
- Technological improvements to reduce aircraft noise
- Recent trends in aircraft noise concerns

## What is noise?

- Noise is unwanted sound
  - What is music to my ears, may be noise to you
- While noise is subjective on an individual basis, social surveys indicate a relationship between noise level and community annoyance
- Federal regulations set acceptable levels of aircraft noise for environmental assessment, land use planning, and noise mitigation purposes

## Community Annoyance

- In 6000 BCE, the Sybarites banned blacksmiths and cabinets makers from working in residential areas due to the noise
  - First recorded zoning ordinance
- Julius Caesar banned chariots from the streets of Rome after dark to reduce nighttime noise
  - Oldest recorded noise ordinance

## Community Annoyance

- In some medieval European cities, horse-drawn carriages were banned at night and straw was laid on the streets during the day to reduce noise levels
- Concerns regarding community noise levels and sleep disturbance have continued to modern times

## Early Aircraft Noise Issues

- Barnstormers used the sound of their aircraft engines to attract a public eager to experience the wonders of flight
- Early commercial flights, first US mail and then passenger carriers, were few and far between
- The public perspective shifted in the early 1960s as commercial air carriers transitioned from propeller-driven aircraft to jets

1935

DC-3



Photo Credit: Flightglobal.com

1918

DH-4



Photo Credit: Skyways Journal Magazine

## Early Aircraft Noise Issues

- Boeing 707s and Douglas DC-8s became the workhorses of commercial aviation
- Airport neighbors noticed and objected to this change in aircraft noise exposure and demanded action
- Aircraft noise was becoming recognized as a legitimate problem on both a local and national level



## 1958

DC-8



Photo Credit: [Airliners.net](http://Airliners.net)

## 1957

B-707



Photo Credit: [Air-Review.com](http://Air-Review.com)

## Federal Aircraft Noise Regulations – 1950s

- Federal Aviation Act of 1958
  - Congress gave the Federal Aviation Administration (FAA) the authority to regulate the use of the navigable airspace
  - Congress recognized that the public has a basic right to air transit, which was declared “*a right of national sovereignty*”

## Federal Aircraft Noise Regulations – 1960s

- Amendment of the Federal Aviation Act of 1968
  - Recognized aircraft noise as a problem and authorized FAA to establish standards of measuring noise as well as regulations to control and abate aircraft noise
  - Required the regulations be “consistent with the highest degree of safety” and be “economically reasonable, technologically practicable, and appropriate for the particular type of aircraft.”
  - Aimed at controlling noise at the source (i.e., aircraft) not airport proprietors

1963

B727-200



Photo Credit: RuthAS

1967

B737-200



Photo Credit: Boeing

## Federal Aircraft Noise Regulations – 1960s

- FAA Promulgates Federal Aviation Regulation (FAR) Part 36 in 1969
  - Established uniform measurement system for aircraft noise certification
  - Established maximum allowable aircraft noise limits for *newly manufactured aircraft*
  - Permitted heavier aircraft to have higher noise levels

## Federal Aircraft Noise Regulations – 1970s

- Noise Control Act of 1972
  - Prohibits FAA from issuing type certificates for aircraft not meeting the Part 36 noise limits
  - Added the Environmental Protection Agency (EPA) to the regulatory process, but did not require FAA to adopt EPA's regulations

## Federal Aircraft Noise Regulations – 1970s

- FAA Amends FAR Part 36 in 1976
  - Required *currently operating aircraft* to comply with Part 36 noise limits
  - Allowed for phased compliance with the requirements by January 1, 1985, which was extended to January 1, 1988
  - The 1988 amendment also added the requirement for foreign carriers to comply with the regulations
- Established the noise-related “Stages”

## Federal Aircraft Noise Regulations – 1970s

- FAA's Aviation Noise Abatement Policy of 1976
  - Identified the various roles and responsibilities for aircraft noise abatement
    - FAA, airport proprietors, airlines, state and local governments, and prospective residents
- This policy remains in effect today





MD-80

1979

Photo Credit: Boeing

## Federal Aircraft Noise Regulations – 1970s

- Aviation Safety and Noise Abatement Act of 1979
  - Required FAA to establish a method of quantifying and assessing the impact of aircraft noise at airports
  - Provided for federal funding of voluntary airport noise and land use studies
- Resulted in FAR Part 150 Airport Noise and Land Use Compatibility Planning in 1984
  - Approved Noise Compatibility Programs measures are eligible for federal funding (e.g., sound insulation, land acquisition, ground run-up enclosures, noise monitoring systems)

1981

B757-200



Photo Credit: Boeing

B737-300



Photo Credit: Boeing

## Federal Aircraft Noise Regulations – 1990s

- Airport Noise and Capacity Act of 1990
  - Established the phase-out of Stage 2 aircraft greater than 75,000 pounds by January 1, 2000
  - Grandfathered existing airport-specific noise limits
- Resulted in 14 CFR Part 161- Notice and Approval of Airport Noise and Access Restrictions
  - Study of last resort
  - Many have tried, but only one restriction was approved since 1991

## Technological Improvements

- Aircraft have become significantly quieter since the 707s and DC-8s of the early 1960s
- More stringent noise requirements through FAR Part 36 and the International Civil Aviation Organization's (ICAO) Committee on Aviation Environmental Protection (CAEP) have helped to drive aircraft noise research
- The airlines' desire to reduce fuel consumption and air emissions have provided further incentives to reduce aircraft noise



B727-22

B787-9

Photo Credit: Museum of Flight



## GE-9X Turbofan Engine for the 777X

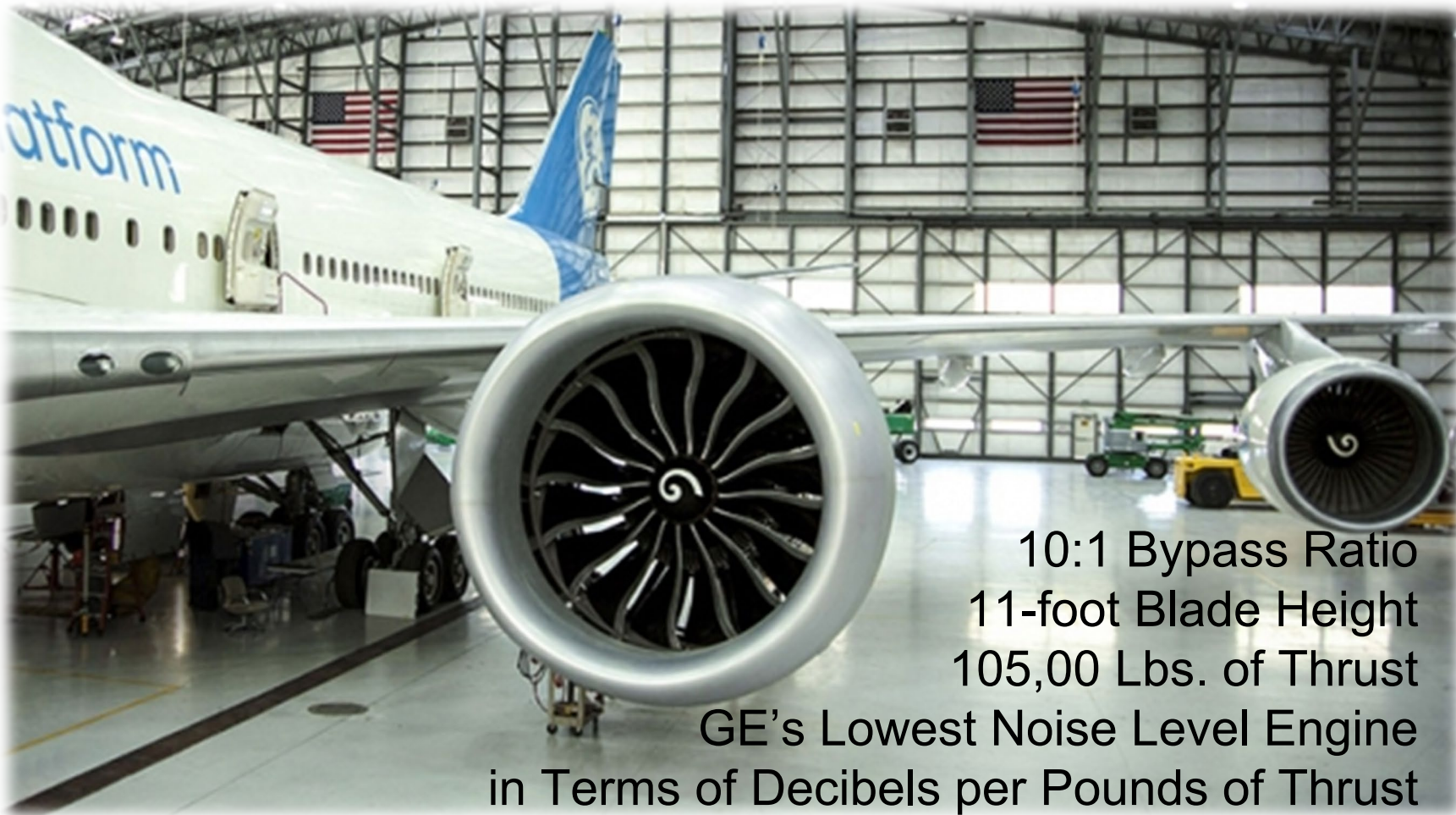


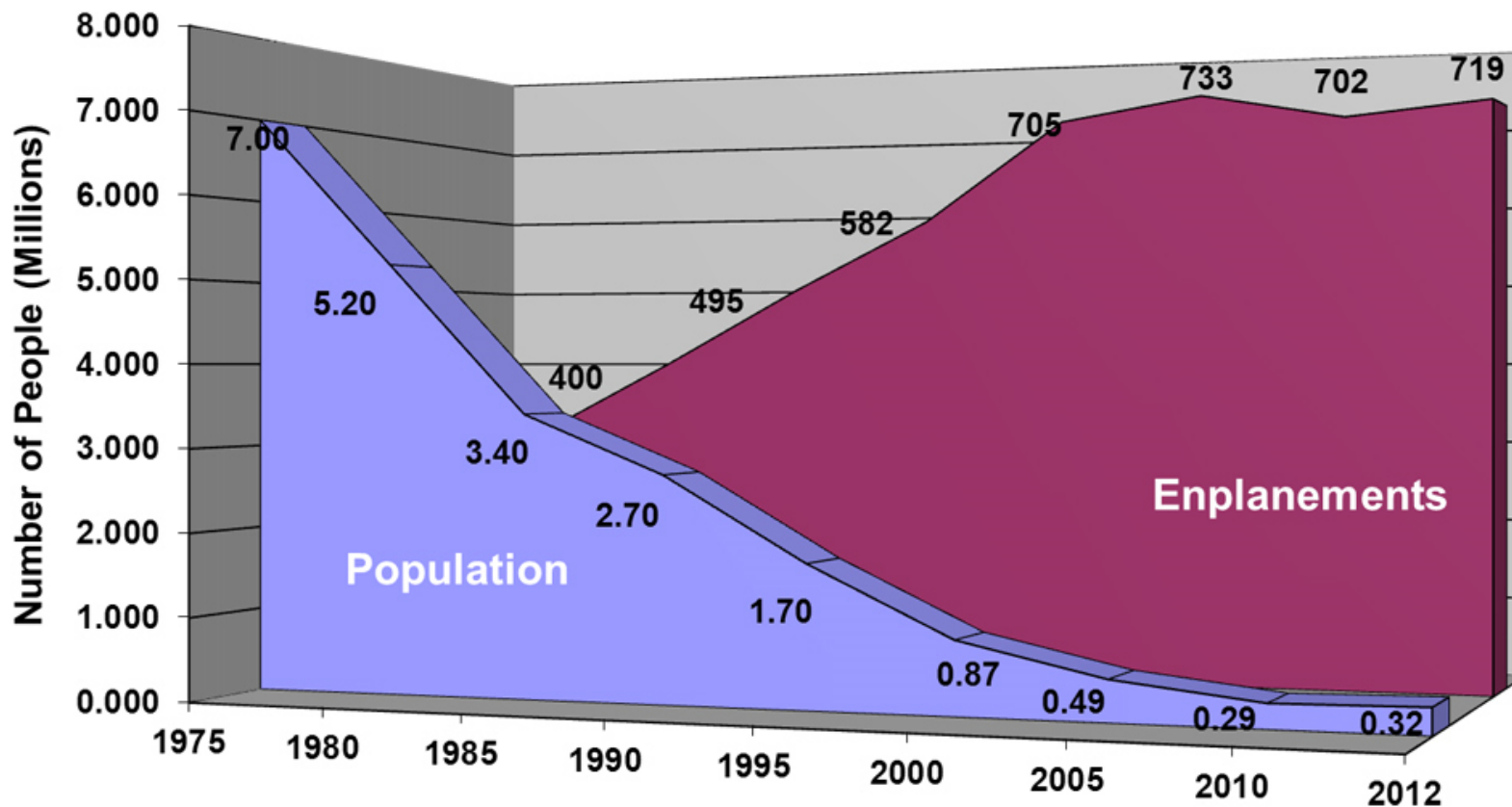
Photo Credit: General Electric

## Technological Improvements

- At many airports, the average aircraft size is increasing as airlines “upgauge” their fleets
  - More passengers are carried with fewer operations
- As a result, aircraft operations have increased modestly as passenger volume has gone up dramatically
- These technological improvements and airline practices have resulted in millions of people being removed from noise impact areas near airports



## The Historical Record: Order of Magnitude Noise Exposure Reduction Despite Traffic Growth



Source: FAA

## Technological Improvements

- On the aircraft
  - Low-bypass engines replaced by high bypass engines
  - Improved wing designs and winglets; improved climb performance
  - Vortex generators reduce tonal noise from wing vents



Photo Credit: Lufthansa



Photo Credit: Aviation Partners



# 2017

## 737 MAX



Photo Credit: Boeing

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## Airline Fleet Changes

- For improved fuel efficiency, airlines are replacing four-engine long-haul aircraft (e.g., A-380s and B-747s) with twin-engine widebody aircraft (e.g., B-787s and B-777s)
- These aircraft look very similar to their much smaller twin-engine narrowbody counterparts such as the A-320 and B-737
- As a result, these widebody twin-engine aircraft often appear to be lower at the same altitude



## Comparison of a Boeing 787-900 to a Boeing 737-900 at an altitude of 2,500' Above Ground Level



Source: Environmental Science Associates

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Last year, Airbus announced the cessation of the production of the A-380 aircraft because. . .

A-380



Photo Credit: Airbus



. . .it cannot compete with the fuel efficient, twin-engine widebody aircraft such as the 777 and 787.

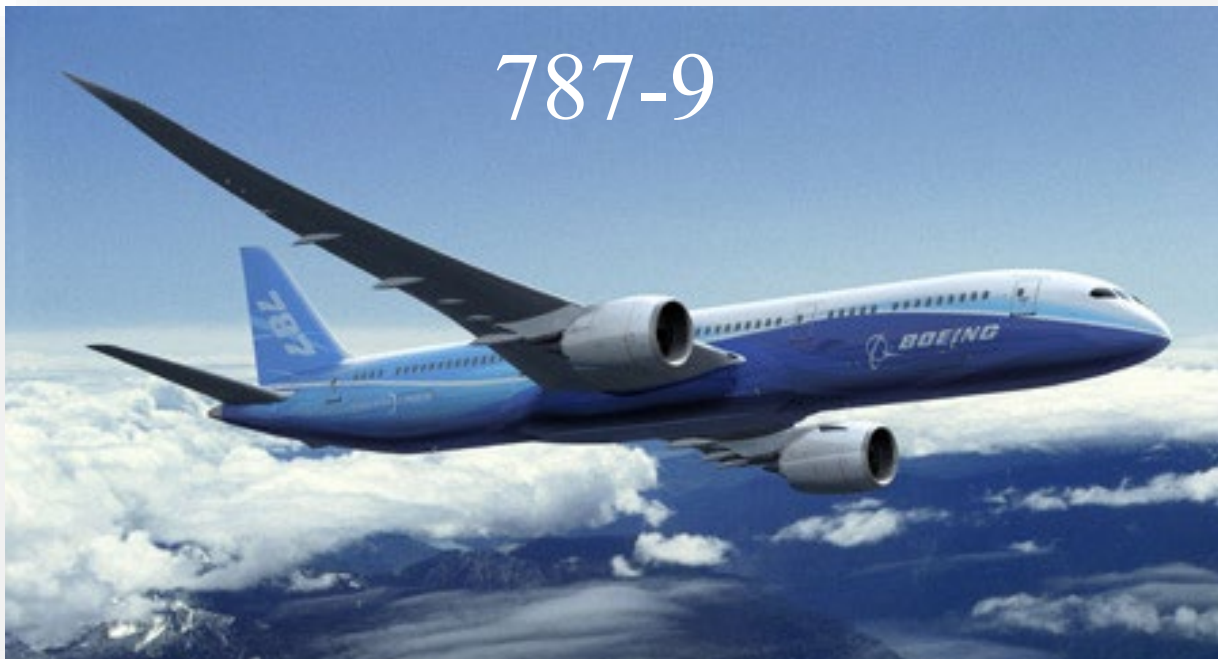


Photo Credit: Boeing

While some future aircraft may become even quieter, others may require changes in current noise standards



Image Credit: Zunum



Image Credit: Airbus



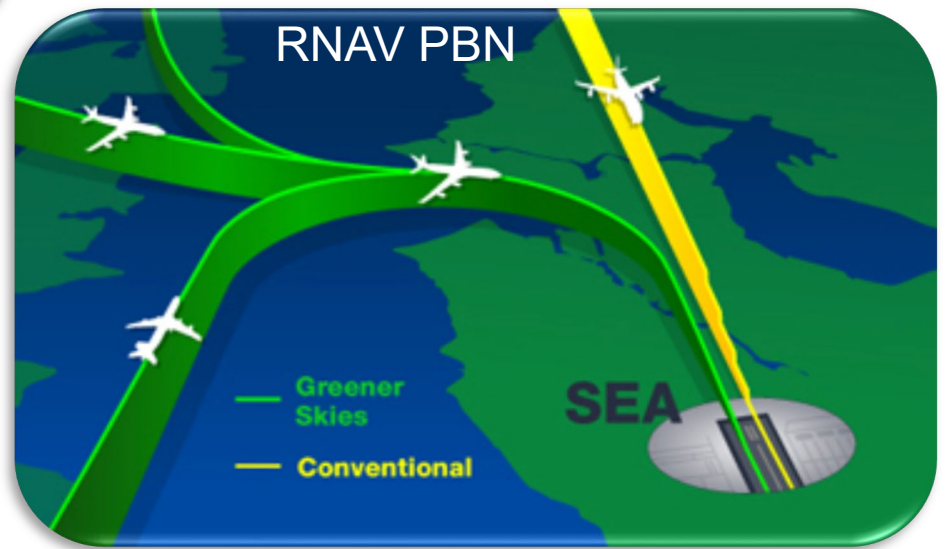
Image Credit: Aerion

## Technological Improvements

- In flight
  - Continuous Descent Approaches (CDAs) or Optimized Profile Descents (OPDs)
    - Uses flight-idle throttle settings and keeps the aircraft “clean” until several miles from touchdown
  - Performance Based Navigation (PBN), Required Navigation Performance (RNP), and Area Navigation (RNAV) departures and approaches
    - Incorporates OPDs into standard arrival procedures and, when possible, concentrates aircraft over compatible land uses



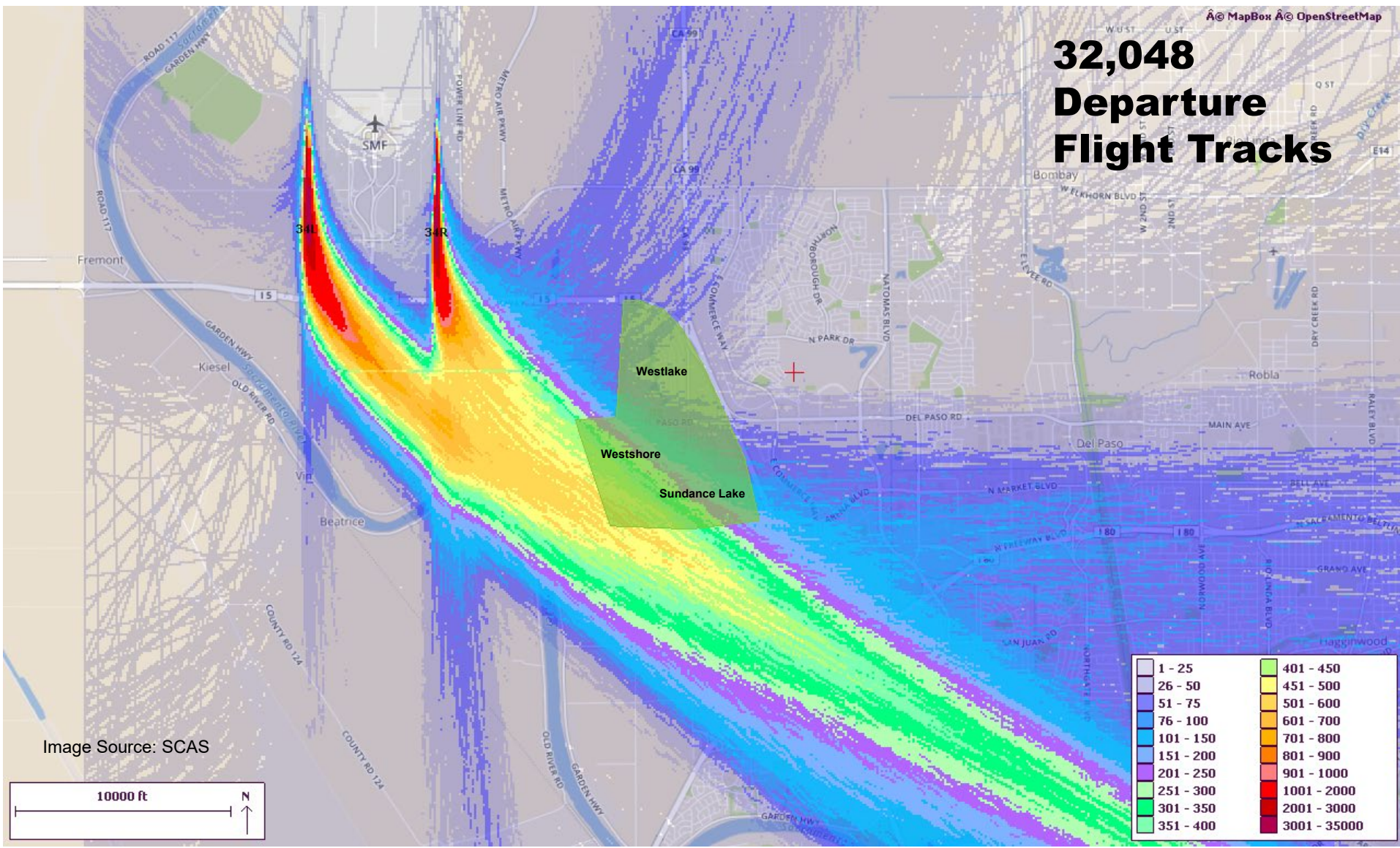
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Source: FAA

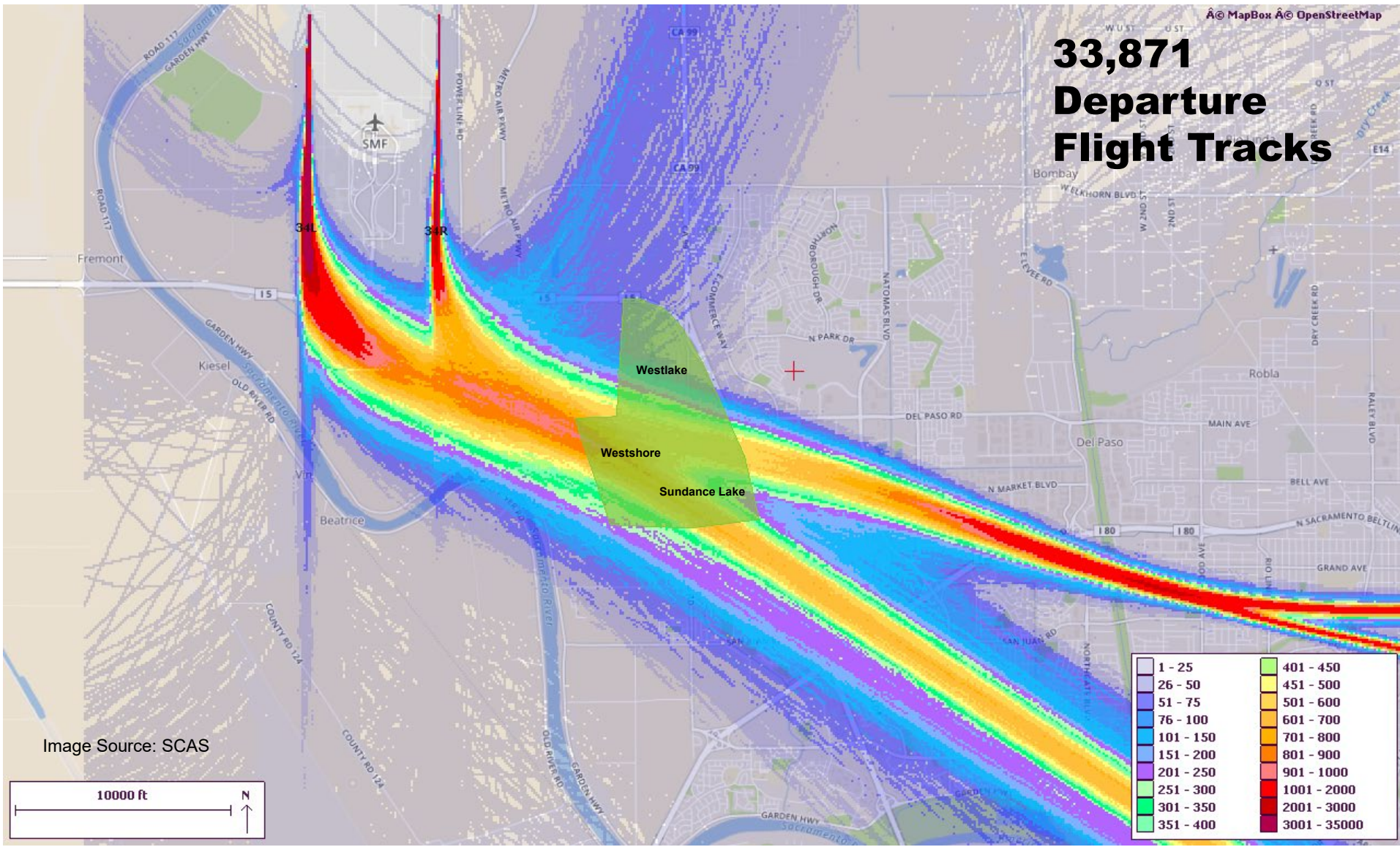


# 2014 SMF South Flow Departures





## 2017 SMF South Flow Departures



# Recent Trends in Aircraft Noise Concerns

- Concerns
  - Aircraft altitudes
  - Frequency of overflights
  - Increased nighttime flights
  - Concentrated flight tracks over noise sensitive land uses
  - New noise sensitive areas exposed to aircraft overflights and noise
  - Impact of aircraft noise on human health

# Recent Trends in Aircraft Noise Concerns

- Reaction
  - Increased community activism
  - Requests for the establishment of lower national aircraft noise standards (i.e., 55 DNL)
  - Formation of a congressional caucus on aircraft noise
  - Independent aircraft noise complaint websites and automated noise complaint filing apps
  - Threats of litigation



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*Questions?*