Spring 2021

What Are the Thirty Most Populous Cities in California Doing to Regulate Unmanned Aircraft Systems?

Heather Heinbaugh
San Jose State University

What Are the Thirty Most Populous Cities in California Doing to Regulate Unmanned Aircraft Systems?

by
Heather Heinbaugh

A Thesis-Quality Research Paper
Submitted in Partial Fulfillment of the
Requirements for the
Master's Degree
in

PUBLIC ADMINISTRATION

Professor Frances Edwards, Ph.D.
Adviser

The Graduate School
San José State University
May 2021

TABLE OF CONTENTS

INTRODUCTION 1

Problem Statement 3

BACKGROUND 4

History of UAS 4

UAS Operation 5

Law Enforcement 5
Emergency Services 6
Infrastructure Maintenance 7
Agriculture 8
Real Estate 9
Delivery 9

Federal Regulations 10

Category 1: Part 107 Remote Pilots 10
Category 2: 333 Exemption 11
Category 3: Model Aircraft Operators 11
Category 4: Public Operators 13

Drone Registration 14

Education Effort 14

Enforcement 15

State Legislation 16

Preemption 18

Drone Misuses 20

Safety 21
Privacy 22
Perception of Drones 24

LITERATURE REVIEW 25

Perception of Drone Operation 25

Privacy and Victimization 26

Drones and Regulations 27

Assembly Bill 856 28

Drones as a Nuisance 29

METHODOLOGY 31

Design 31

Data 32

FINDINGS 34

Demographic Data for Each City 34

Population Size 34
Registered Drones 35
Drones Per Capita 35
City Ordinances **36**
Elements 36
Ordinances 37
Population and Drones per Capita 40
Public Parks or Public Land 40
Filming Permit Requirements 41
Definition of a Drone 42
Enforcement Clause 42
Interference with Emergency Operations 42
Time of Day 43
Operating over Unprotected Persons 43
Referencing FAA Regulations 43
Distribution of Goods 44
Privacy 44
Usage over Moving Vehicles 44
Fireworks, Public Venues, and Sporting Events 44
ANALYSIS **46**
CONCLUSION **50**
REFERENCES **52**

LIST OF TABLES AND FIGURES

Tables

Table 1: Policy Implementation Evaluation 31
Table 2: City with Ordinance Chapter Number and Year 38
Table 3: Cities' Ordinances Categorized by Element 39

Figures

Figure 1: States with Legislation Regulating Drones in 2019 17
Figure 2: Population of Each City 34
Figure 3: Total Number of Registered Drones in Each City 35
Figure 4: Number of Registered Drones Per Capita 36

INTRODUCTION

Unmanned aircraft systems (UAS) are known under many names—unmanned aerial vehicles (UAVs), remotely piloted vehicles, and drones—which are often used as synonyms. Definitions vary widely among legislative bodies, however, the state of Tennessee's legislation provides a comprehensive definition, describing a UAS or drone as:

> "a high-powered, aerial vehicle that: (A) Does not carry a human operator and is operated without the possibility of direct human interaction from within or on the aircraft; (B) Uses aerodynamic forces to provide vehicle lift; (C) Can fly autonomously or be piloted remotely; (D) Can be expendable or recoverable" (911 Security, 2019, 4).

Though defined by many terms, the public's familiarity with drones goes back to the beginning of World War I, when drones were used for military purposes. In a military context, drones can have wingspans well over 100 feet and weigh over 16 tons (Daly, 2020). However, the drones making headlines today are generally small model quadcopters (helicopters with four propellers) with cameras attached. High-rated consumer drones can cost over $1,000 and weigh about ten pounds, with flight times ranging from 20-45 minutes. But drones can weigh less than a pound, cost less than $100, and be flown in a living room. This paper will focus on the category of drones known as small UASs, which are drones that weigh less than 55 pounds. With technological advancements, a variety of drones will become increasingly available to consumers, regardless of cost or space constraints (911 Security, 2019).

Drones are more prevalent today due to the explosion of the drone industry, which is exemplified through registration numbers, public perception, and awareness. Drones are operated for an almost limitless number of reasons, from recreation to business applications, which include farmers checking crop yields, real estate companies creating profiles for houses on the

market, delivery companies bringing goods to people's homes, emergency personnel assessing risks, and insurance companies conducting roof inspections. This technology allows users to navigate and reduce hazardous situations and fosters ingenuity among entrepreneurs. With the list of uses for drones continually growing, their popularity is growing rapidly. According to the Federal Aviation Administration (FAA), there were over 1.6 million registered drone owners as of July 2020, with the number of registered drones in the United States exceeding the number of registered manned aircraft by more than 5,000 (FAA, 2020b). The FAA Aerospace Forecast projects that sales of small drones will increase from 2.5 million in 2016 to over 7 million by 2036 (FAA, 2020a). The Association for Unmanned Vehicle Systems International (AUVSI) projects that, by 2025, more than 100,000 jobs will be created, with an economic impact of $13.6 billion in the first three years after drones are integrated into the National Airspace System (AUVSI, 2013). This prediction is plausible, as the global drones market accounted for $4.4 billion in 2019 and is expected to reach $7.7 billion by 2027 (Research and Markets, 2021). California is expected to be one of the top ten states to see the most economic gains from UAS production (Research and Markets, 2021). While predictions vary regarding how quickly the drone industry will grow, its upward trajectory is undeniable.

With new opportunity comes new challenges. Growth in the drone industry and improved drone functionality create unique challenges for local and city governments. Drones raise safety, privacy, nuisance, and trespassing concerns, which are all compounded by a lack of accountability, the limited scope of existing regulations/laws. A comprehensive list of national and state drone regulations was compiled in 2015 (INSCT, 2015). However, minimal research has been done to catalog local drone regulations. In 2016, the National League of Cities—a nonprofit association of over 19,000 cities—expressed the need for a comprehensive list of local

legislation about drones, as "there has been relatively little movement at the city level compared with action by the states, despite the fact that cities are most directly impacted by drone usage" (NLC, 2016, 20). The purpose of this study is to provide information to address these concerns.

Problem Statement

This report presented and analyzed a list of local legislation to address the question, "*what regulations do the thirty most populous cities in California have in place to manage the usage of drones?*" It can serve as a guidance document for local agency administrators seeking to develop regulations for drone operations.

BACKGROUND

History of UAS

Unmanned Aircraft Systems (UAS), or drones, have been around for centuries. They originated as a technology for military purposes. The earliest records of drone use were from 1849 when the Austrians attacked Venice using unmanned balloons loaded with explosives. While unmanned balloons may seem outdated in comparison to today's drones, it was a huge technological advancement in the development and deployment of drones, unmatched for decades (Martinez, 2020). In 1915, the British military used aerial photography to their advantage during the Battle of Neuve Chapelle. The aerial photos allowed the British army to capture over 1,500 sky view maps of the German trench fortifications in the region (Martinez, 2020). During World War I, in 1916, the United States began to deploy their own version of drones, pilotless aircraft. Following this advancement, the U.S Army then built the Kettering Bug—a forerunner of present-day cruise missiles (Daly, 2020).

In 1930, the US military began the use of radio-controlled aircraft that resulted from technology experiments by the U.S Navy, leading to the creation of the Curtiss N2C-2 drone. During World War II, Reginald Denny created the first remote controlled aircraft—Radioplane OQ-2—which then became the first mass-produced UAV in the United States (Daly, 2020). The reliability and acceptance of drones were enhanced in the 1980s during the Israeli Air Force victory over the Syrian Air Force. The 1980s were a time of drone innovation, as the advantages of drones in the military became increasingly recognized (Daly, 2020). The U.S launched the Pioneer UAV Program, fulfilling the need for inexpensive drone fleet operations (Jenkins & Vasigh, 2013). The RQ2—a medium sized reconnaissance drone—was developed by a joint partnership between the U.S and Israeli military organizations. The Predator drone has paved the

way for military drones, and as of 2016, more than ten countries have used weaponized drones (Martinez, 2020).

In 2006, there was an increase in the use of non-militarized drones, largely by hobbyists. Commercial applications of drones began in 2013 when Amazon began testing drone delivery, putting drones in the media spotlight. The popularity of drones skyrocketed, generating $6 billion dollars in sales in 2017, $2.4 million attributed solely to recreational drone sales (AUVSI, 2013).

Despite this success, many enterprises were reluctant to develop their own drone programs, as the FAA's regulations for commercial use and their implications remained uncertain. With unclear legislation about drone management, manufacturers deemed investment risks too high, thus, prices remained high, and demand waned. Realizing that there was a need for a transparent regulatory framework for drone management, the FAA modified its legislation in 2016 and created Part 107 (FAA, 2020). Part 107 clearly defined requirements for commercial drone operations in the US, effectively making skies open for drone usage. Drone usage has since become more popular and increasingly varied.

UAS Operation

Law Enforcement

Local government entities typically use drones predominately for law enforcement purposes, firefighting, disaster relief, or for search and rescue missions. In May 2018, the Center for the Study of the Drone at Bard College estimated that at least 910 state and local police, sheriff, fire, and emergency services agencies in the U.S have acquired drones—58 being California agencies (Holland, 2017b). This number is growing increasingly fast, as there are twice as many agencies that own drones as there are agencies that own manned aircraft in the US. In addition, law

enforcement agencies make up two-thirds (599) of the public safety agencies with drones (Holland, 2017b).

In 2013, Seattle made plans to use drones for their police departments—one of the first cities to receive approval from the FAA to do so—but had to abandon operations due to there not being enough safeguards in place to address privacy concerns for citizens, with opposition from privacy protection advocacy groups, like the American Civil Liberties Union (Associated Press, 2012). However, other cities began to use drones for aiding police work, enabling them to identify and follow suspects in ways that ground units could not replicate and reducing risk factors, resources spent, and overall stress levels on SWAT teams. In 2019, police in Daytona Beach, Florida used a drone to help catch a roof-climbing burglary suspect (Jarvis, 2019).

Emergency Services

In addition to monitoring suspects and facilitating law enforcement, drones are being used in other emergency service operations, like fighting fires and for search and rescue operations. Drones can reach and access areas that may be hard or impossible for humans to reach. Massachusetts Institute of Technology (MIT) and Olin College have both worked on developing a drone that can actually fight fires, rather than just providing monitoring capabilities (UAS Vision, 2015). A Latvian company, Aerones, has developed a firefighter drone prototype that can climb 984 feet in six minutes and spray a "special chemical mix" (Van der Schlat, 2018).

Drones are also being used to reduce response times for emergency medical services. Drones can operate as a rapid delivery system to provide delivery of medication or equipment. These capabilities have allowed drones to be supplemental emergency medical services for people who inhabit rural or otherwise hard-to-access areas. In July 2020, Matternet, a medical device company, collaborated with Wake Forest Baptist Health in North Carolina and the United

Parcel Service (UPS) Flight Forward Inc. to create a hub-and-spoke routing model for rapid delivery of time- and temperature-sensitive medications and supplies, including Personal Protective Equipment (PPE) for medical professionals treating Coronavirus Disease 2019 (COVID-19) patients (Russo, 2020). They now have two operational routes which will increase reliability for emergency services and transporting critical medications (Russo, 2020).

Delft University is developing a type of drone with "wireless communications technology that would allow emergency personnel to instruct people near a heart attack victim how to use the drone's defibrillator paddles" (NLC 2016, 11). This drone technology development would be capable of flying over 60 miles per hour, lowering the average ambulance response time from ten minutes to one minute, and increasing average emergency survival chances from eight percent to eighty percent (NLC, 2016).

Infrastructure Maintenance

The infrastructure segment holds the highest market share in the commercial drone market. This is attributed to the growing use of drones for inspections of power lines, power plants, storm damage, bridges, dams, oil platforms, and others. Drones can also be used to support work conducted by state departments of transportation (DOTs), including bridge inspections, road assessments, road sign monitoring and assessing, and many others. A May 2019 survey from the American Association of State Highway and Transportation Officials (AASHTO) found "through the rapid deployment of new Unmanned Aerial Systems (UAS) or drone technologies, more than 7 out of 10 state departments of transportation have hired hundreds of staff, including highly-skilled personnel and pilots to manage drone operations" (AASHTO, 2019, 2). In addition, 36 out of 50 state DOTs have funded centers or programs for UAS operations (AASHTO, 2019).

Three state DOTs—Kansas, North Dakota, and North Carolina—are in the Federal Aviation Administration Integration Pilot Program (AASHTO, 2019). This program allows them to fly beyond the line of sight, at night, and above people. These three states are using the program to test applications like monitoring plant growth, irrigation, emergency response, and commercial package delivery. AASHTO notes that in three years, 36 states have adopted the use of drones to conduct DOT related inspections. A cost comparison of inspections conducted with manual labor versus drones reported a decrease in costs from $4,600 to $1,200 per inspection (AASHTO, 2019). Many states have used this cost saving as sound justification for drone inspections; using drones saves tax dollars and reduces on-the-job hazards and project times by limiting closures of roads and bridges for inspections (AASHTO, 2019).

Agriculture

In 2014, Jerry Anderson, regional manager for the Iowa Farm Bureau Federation, told the *Des Moines Register* that drones represent a "huge potential" for precision farming and general agricultural use. "You can overlay these with the mapping characteristics you can get from soil types and harvest maps, and you can literally farm by the foot and take action as you need to during the growing season and as conditions warrant" (O'Leary, 2014, 1). Using drones to spray and treat crops can potentially save time and money, and result in more precise applications of pesticides and other chemicals, reducing runoff in local waterways (O'Leary, 2014). The use of commercial drones in the U.S. is still in its nascent stage, but countries such as Canada and Japan have been using drones in agriculture for years (Levin, 2020). States will likely see an increase in the use of agricultural drones over the next few years as more companies obtain clearance from the FAA to operate commercially (Levin, 2020).

Real Estate

Drone-based aerial imaging has become an important tool for a variety of industries, particularly real estate. An analysis done by the trade group Association for Unmanned Vehicle Systems International (AUVSI) of the first 1,000 commercial drone exemptions granted by the FAA found that 350 exemptions mentioned using drones for real estate purposes (NLC, 2016).

Delivery

The transport and delivery segment are estimated to be the fastest-growing segment of the commercial drone market. This growth can be attributed to the race among Amazon, UPS, and Google in using drones for delivery of goods to customers. In April of 2019, the FAA certified Alphabet's Wing Aviation, which began as a Google X project, to operate as an airline (Chappel, 2019). This certification allowed Wing Aviation to begin commercial delivery services such as the pilot program being run in Christiansburg, Virginia (Chappell, 2019). Wing made its first deliveries in Christiansburg from Walgreen stores in the fall of 2019, and foresees the program growing, even as it launches a full drone delivery service in Canberra, Australia.

Virginia has been one of the leading states in enacting legislation to prevent "regulation of drones by localities," as stated in HB 412, which went into effect in 2017 (Chappell, 2019, 2). In addition, as the first state to have drone deliveries occur, Virginia also appropriated $1 million in funding to support drone companies and the development of drone industries (Herman, 2020). The state also established the Unmanned Aerial Systems Commercial Center for Excellence and a business accelerator to share information among unmanned aerial systems (UAS) stakeholders and address key safety and policy concerns while keeping the airspace open, secure, and integrated with Federal Aviation Administration (FAA) control of the national airspace (Herman, 2020).

Amazon Prime entered this race for drone delivery systems in 2013 and is still working on a delivery system designed to deliver packages in thirty minutes or less. UPS and FedEx have created competing drone delivery pilot programs as well (McFarland, 2019). UPS was granted a certificate for limited drone delivery services and since then has completed 1,100 medical supply deliveries in Raleigh, North Carolina. UPS intends to expand its program to an additional twenty hospitals in the next two years (McFarland, 2019). More companies are seeking to become players in this sector as the FAA has an additional six applications pending for companies requesting special drone delivery certificates (McFarland, 2019).

Federal Regulations

Drones operate in the U.S National Airspace (NAS), therefore, the FAA has the primary authority to regulate drones and their operation in the national airspace. Though the definition of what constitutes national airspace has evolved over time, its regulation still remains with the FAA. The federal law divides drone operators into four categories. These categories distinguish among remote pilots holding a Part 107 certificate (civil drone operations), public drone operators, model aircraft operators, and those holding 333 exemptions**,** which are individuals who have been granted special permission to operate drones for non-recreational purposes (NLC, 2015).

Category 1: Part 107 Remote Pilots

This category refers to individuals 16 years and older who have passed the FAA knowledge test and a TSA background check. These individuals are issued a Part 107 certificate and may operate a drone under 55 pounds for any purpose (whether commercial or recreational) as long as the operator conforms to Part 107 regulations. The FAA issued these regulations on June 21,

2016, providing a fact sheet with the main requirements and operation limitations that individuals must abide by:

> "The average consumer over the age of 16 who purchases a drone and attempts to comply with Part 107 will be presented with two options:
>
> 1. To take and Pass the Part 107 test and fly for any purpose (whether it be commercial or recreational, at nearly any location) or
> 2. Elect to not take the test but be limited to recreational and model aircraft rules, which require the operator to strictly comply with a set of community-based guidelines, not to fly near airports/heliports without coordination, fly purely for recreational purposes, and satisfy other restrictive criteria." (FAA-a, 2020)

Category 2: 333 Exemption

Operators or holders are individuals who were granted permission to operate drones for non-recreational purposes. These exemptions allow for performance "of commercial operations prior to the finalization of the Small Drone Rule, which will be the primary method for authorizing small drone operations once it is complete" (FAA, 2020f, 1). Drone operators with a Section 333 exemption also must register their aircraft with the FAA and be piloted by someone with an FAA airman certificate (FAA, 2020c). Existing 333 exemptions will continue in force until their renewal date.

Category 3: Model Aircraft Operators

This category is made up of individuals who satisfy all of the exemption criteria listed in Section 336 of Public Law 112-95 (Pub. L. No. 112-94 §§ 331–336). When the FAA released the Part 107 regulation, the agency codified all of the requirements of Section 336 and added it under Part 110 of the Federal Aviation Administration Regulations (14 C.F.R. § 107). The FAA also

clarified that people can only qualify as model aircraft operators if they meet all of the specific requirements enumerated by Congress. If not, they are expected to operate under the more permissive rules in Part 107 and must obtain a Part 107 certificate. Section 336 of Public Law 112-95 requires satisfaction of all of the following criteria, according to Part 101 of the FAA regulations (14 C.F.R. Part 101 § 336).

1. The aircraft is flown strictly for hobby or recreational use.
2. The aircraft is operated in accordance with a community-based set of safety guidelines.
3. The aircraft is limited to not more than 55 pounds unless otherwise certified through a design, construction, inspection, flight test, and operation safety program. administered by a community-based organization, like the Drone User Group Network or the Academy of Model Aeronautics.
4. The aircraft is operated in a manner that does not interfere with and gives way to manned aircraft.
5. When flown within 5 miles of an airport, the operator of the aircraft provides the airport operator air traffic control tower with prior notice of operation.
6. The aircraft must fly below 400 feet and stay in the operator's line of sight.
7. The aircraft cannot be flown near people or stadiums or be operated in a careless or reckless manner.

Failing to meet any of these requirements can expose a drone operator to FAA penalties and punishments: "If an individual fails to meet any of these requirements, he or she is deemed to be a Part 107 operator, and if they have failed to take the test and otherwise satisfy Part 107's operational requirements, the operator can be subject to an $1,100 civil penalty per regulation

violated per flight" (NLC, 2015, 4). This is important for cities, because many operators may choose to become Part 107 operators instead (given a strict interpretation of Part 101), as these rules are more permissive for recreational flights. Part 101 requires that operators follow safety rules and guidelines in accordance with a nationwide community-based organization. The largest such organization, the Academy of Model Aeronautics (AMA), prohibits "flying directly over unprotected people, vessels, vehicles or structures" (AMA, 2018, 1). Thus, drone operators seeking less stringent rules may be more inclined to become a Part 107 operator and be required to pass a test (with a 90% pass rate) (AMA, 2018).

Category 4: Public Operators

This category refers to public agencies and those operating drones for governmental purposes. Public operators must obtain a Certificate of Waiver or Authorization (COA) from the FAA defining how and where the drone can be used. Public agencies that wish to operate under the rules of Part 107 may obtain a Part 107 certificate (14 C.F.R. § 107). A COA allows an operator to fly a UAS for a specific or intended purpose that violates normal FAA rules, such as needing to fly at night, outside of class G airspace, or operating a drone outside of the direct line of sight (NLC, 2016). A COA is usually valid for a specific length of time, often up to two years. Processing a COA generally takes about sixty days, while waivers for Part 107 can take up to ninety days, depending on the complexity of the request (14 C.F.R. § 107). Public agencies may apply for either type of permit. To grant more flexibility for public agencies using drones, the FAA has stated, "Under this rule, a public aircraft operation can continue to operate under a COA or can voluntarily operate as a civil aircraft in compliance with Part 107" (81 F.R. 42063).

Drone Registration

The FAA released small drone registration rules effective December 21, 2015. Under this rule, aircraft weighing more than 0.55 pounds and less than 55 pounds (the weight including payloads such as onboard cameras) must be registered. Hobbyists and other users whose drones meet these requirements are able to register using the FAA web-based register system, costing $5 per drone and valid for three years. All drones purchased before the effective date of the regulation had to be registered by February 2016 (FAA, 2020c). Once registration was complete, the individual received a registration certificate that he or she must have in his or her possession whenever flying.

Federal law (14 CFR § 48) requires drone operators who are required to register to show their certificate of registration to any federal, state, or local law enforcement officer if asked. Failure to register a drone that requires registration may result in regulatory and criminal penalties. The FAA may assess civil penalties up to $27,500 (FAA, 2020c). Criminal penalties include fines up to $250,000 and/or imprisonment for up to three years. In addition, qualifying drone operators are required to label their drone with their registration number before flight.

Education Effort

To provide measures to prevent operators from practicing unsafe flying habits, the FAA partnered with the Association for Unmanned Vehicle Systems International (AUVSI) and the Academy of Model Aeronautic (AMA) to educate current and future drone operators about drone safety, regulations, and where operating a drone is allowed. The FAA began the "Know Before You Fly" safety campaign through an app that provides prospective users with information and guidance needed to fly safely and responsibly (FAA, 2020e). Currently, six states support the campaign: Alaska, California, Louisiana, Rhode Island, South Dakota, and Utah, as well as over

50 companies. Support is defined as any "form of sharing links to Know Before You Fly content, including co-branded safety fliers in retail boxes, or providing access to airspace information, including signage in stores" (FAA, 2020e, 1). Key features of the B4UFLY app include:

- A clear "status" indicator that informs the operator whether it is safe to fly or not (for example, it shows that flying in the Special Flight Rules Area around Washington, D.C. is prohibited);
- Informative, interactive maps with filtering options;
- Information about controlled airspace, special use airspace, critical infrastructure, airports, national parks, military training routes and temporary flight restrictions;
- The ability to check whether it is safe to fly in different locations by searching for a location or moving the location pin; and
- Links to other FAA drone resources and regulatory information.

In addition, the FAA is implementing a public outreach campaign called the No Drone Zone in Washington, D.C. Under the No Drone Zone, drones are prohibited from being operated within a 15-mile radius of the Ronald Reagan Washington National Airport without special authorization from the FAA (FAA, 2019). Elements of this campaign include a free digital toolkit with outreach materials to federal, state, and other partners to educate unmanned aircraft operators flying in certain areas. It also includes campaign specific signage for social media, websites, and printing flyers.

Enforcement

The FAA provides guidance for state and local police who "are often in the best position to immediately investigate unauthorized drone operations, and as appropriate, to stop them" (FAA, 2018, 1). This is because laws traditionally related to state and local police power—including

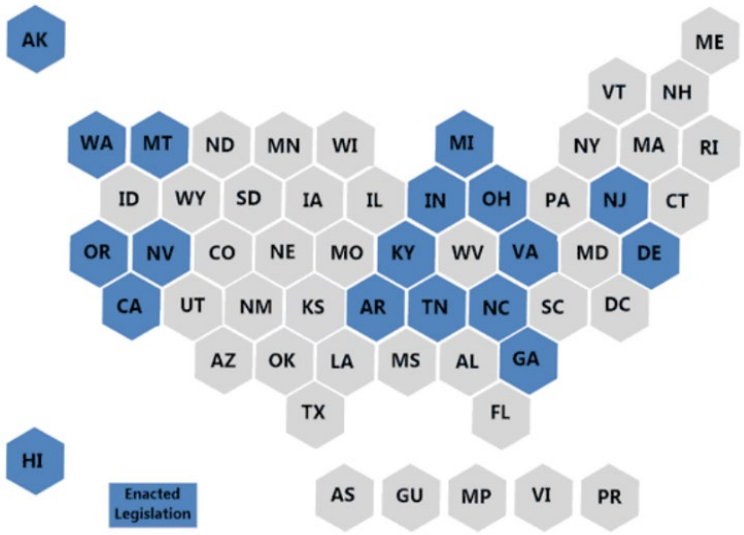
land use, zoning, privacy, and law enforcement operations—generally are not subject to federal regulation (FAA, 2018). Most reported drone infractions violate either land use, privacy, zoning, or law enforcement operation interference; therefore, the FAA places the responsibility to enforce most drone regulations on local authorities. The agency's suggestions for investigating unauthorized operations include (FAA, 2018):

- Identifying potential witness and conducting initial interviews
- Contacting the suspected operators of the drone or model aircraft
- Viewing and recording the location of the event
- Collecting evidence
- Identifying if the drone operation was in a sensitive location, event, or activity
- Notifying one of the FAA's Regional Operation Centers about the operation as soon as possible

State Legislation

Although regulation of the airspace falls under the jurisdiction of the federal government and is regulated by the FAA, many states have enacted legislation to regulate drone operations. By 2019, at least 18 states—Alaska, Arkansas, California, Delaware, Georgia, Hawaii, Indiana, Kentucky, Michigan, Montana, Nevada, New Jersey, North Carolina, Ohio, Oregon, Tennessee, Virginia, and Washington—had enacted 22 bills addressing unmanned aircraft systems (UAS). To compare, just four years earlier, the list only included 15 states (NCSL, 2019).

Figure 1*:* States with Legislation Regulating Drones in 2019



Source: (National Conference of State Legislatures, 2019)

Issues covered by these laws include:

- The establishment of drone programs or appropriation of funding for such programs (seven states: Alaska, Nevada, New Jersey, North Carolina, Ohio, Oregon and Washington),
- The prohibition of flying drones over property, including correctional and other facilities for utilities, defense, telecommunications and railroads (six states: Arkansas, Delaware, Georgia, Kentucky, Virginia and Tennessee),
- Drone-related privacy protections (three states: California, Indiana, and Tennessee),
- Specification of instances in which evidence obtained from drones may be used in criminal proceedings and of which drones may be used by law enforcement (three states: Hawaii, Montana, and Virginia)

- The prohibition of drones delivering medical marijuana (one state: New Jersey)

Preemption

Preemption is an important factor in state and local government's creation of regulations for drones. If a state or local law directly conflicts with federal law or regulations, the state or local law is likely to be invalidated. The FAA is the designated federal authority acting over navigable airspace in the U.S; therefore, any local law or regulation that conflicts with FAA regulations or attempts to regulate an area under the purview of the FAA may be rejected due to preemption. However, in December 2015, the FAA provided a fact sheet for guidance to local authorities. This fact sheet included a few recommendations in an attempt to define the scope of the FAA purview in regards to drone regulations, stating that "the FAA is not persuaded that including a preemption provision in the final rulemaking is warranted at this time" and that "the FAA will address preemption issues on a case-by case basis rather than doing so in a rule of general applicability" (Federal Aviation Administration, 2015, 3). Instead, the FAA provided common scenarios when local authorities should consult the FAA to prevent preemption:

- Operational drone restrictions on flight altitude, flight paths; operational bans; any regulation of the navigable airspace […]
- Operational drone restrictions on flight altitude, flight paths; operational bans; any regulation of the navigable airspace. For example – a city ordinance banning anyone from operating drones with state drone legislative action in the city limits, within the airspace of the city, or within certain distances of landmarks.
- Mandating equipment or training for drones related to aviation safety, such as geo-fencing, would likely be preempted. Courts have found that state regulation pertaining to

mandatory training and equipment requirements related to aviation safety is not consistent with the federal regulatory framework.

- Laws traditionally related to state and local police power – including land use, zoning, privacy, trespassing, and law enforcement operations – generally are not subject to federal regulation (Federal Aviation Administration, 2015, 3).

The FAA issued further requirements and prohibitions as well (Federal Aviation Administration, 2015, 3):

- Requirement for police to obtain a warrant prior to using drones for surveillance.
- Prohibition on using drones for voyeurism.
- Prohibitions on using drones for hunting or fishing, or to interfere with or harass someone who is hunting or fishing.
- Prohibitions on attaching firearms or similar weapons to drones.

Preemption from a federal perspective is not the only issue being considered. One of the first observed drone regulations was enacted in 2009 in Grand Forks, North Dakota. This ordinance limited where drones and helicopters could take off or land, prohibiting these actions at airports and other locations. In 2012, Oregon banned local government regulation of drones (Holland, 2017a). Similarly, Maryland and Virginia prohibit local authorities from regulating drone operations. In addition, seven state legislatures—Virginia, Arizona, Delaware, Rhode Island, Michigan, Oregon, and Maryland—have banned local government regulation of drones. An additional four states—Tennessee, California, Nevada, and Minnesota—have declared state sovereignty of the airspace (Holland, 2017a).

The incongruities in regulations and the jurisdictional power of local authorities versus the FAA may be the reason that many local government authorities have been reluctant to take

action (NLC, 2016). For example, when Cobb County, Georgia attempted to ban drone operations near stadiums and other venues in the county, the FAA sent a letter to the county's attorney stating that any operational restrictions of drones by a local ordinance would be "inconsistent with federal statutory and regulatory framework" and subject to legal challenge (Axelrod, 2017, 2). In other words, according to the FAA, Cobb County was violating federal law by creating a law outside its legal jurisdiction.

Understanding jurisdictional scope is important when regulating and enforcing drone infractions. If done incorrectly, cities and local governments can open themselves up for preemption lawsuits, either from enthusiastic drone hobbyists or the FAA. As cities begin to learn from each other and the implications surrounding regulating this fast-growing technology, the FAA warns against making local legislation too specific because of the possibility of fractionalizing airspace control. This segmented control is a possible outcome if numerous municipalities issue different restrictions on drones. Such a "patchwork quilt" of regulations could complicate the FAA's control of airspace safety, but it could also make lawful drone operations difficult for pilots who might be operating in areas with overlapping drone regulations (NLC, 2016).

Drone Misuses

When designing legislation to help regulate drone usage in cities, it is important to know the common instances in which drones are not properly used. Understanding the circumstances of these infractions can help legislators predict challenges that may arise as drones increase in popularity and technology advances.

Safety

The concern for safety is a main topic in drone regulations. Though the FAA emphasizes drone safety in many of its campaigns, the lack of regional governance of drone operations has not been without incident. In 2019, emergency services were interrupted during the Maria Fire in Santa Paula, California due to unauthorized drones flying over the scene (Childs, 2019). The fire personnel had to ground their firefighting helicopters for over 45 minutes due to the risk of collision when drones are flown in unauthorized zones (NIFC, 2019). Since October of 2019, drones have intruded on wildfire scenes at least nineteen times and halted operations for nine emergency responses (NIFC, 2019). Firefighting helicopters usually fly about 200 feet above the ground, in the same air space that drones typically operate in. According to the NIFC website, "While helicopters engaged in firefighting operations are slower than the aerial supervision and retardant-dropping aircraft, the air movement dynamic created by the rotor system of a helicopter creates a unique collision hazard" (NIFC, 2019). In other words, the drone can be sucked into the rotors of a helicopter, jeopardizing the life of the pilot and anyone nearby. Instances like these show that more legislation is needed to regulate appropriate fly zone areas.

In another instance, a drone struck a hot air balloon carrying a certified pilot and two passengers at the Teton County Fairgrounds in Idaho in August of 2018 (Tellman, 2018). The drone's rotors were destroyed when they made contact with the balloon's envelope (Tellman, 2018). No one was injured and the pilot was able to land the passengers safely. Upon investigation, it was discovered that the drone was being operated by an inexperienced hobbyist drone operator. In addition, the individual was operating the drone within five miles of the Driggs-Reed Memorial Airport without notifying air traffic control, which is against FAA

regulations (Tellman, 2018). The variability in these cases shows the need for hobby related regulations.

Very few regulations specific to hobby or recreational drone operation have been in place. For the most part, states have deferred to the FAA in enacting legislation; most regulations deal with commercial and governmental use. Many cities have either been hesitant due to a lack of information, direction, or capacity to enforce regulations. Local government is challenged with having to create legislation, with limited direction, that addresses safety and privacy concerns of citizens, while simultaneously ensuring that these enacted policies are not too strict to deter drone operation entirely. North Carolina is one of the only states that has focused regulations primarily on hobby usage, the 2014 legislation stated that a drone "could not be launched or recovered from any state or private property without consent of the owner" (NCSL, 2019, 2). The enforcement of regulations on hobby drones have predominantly been pursued on a case-by-case basis (NCSL, 2019).

Privacy

In one survey, 63 percent of respondents agreed that allowing private and commercial drones into the American airspace could cause harm (Hitlin, 2017). Some worry that drones will be used for voyeuristic purposes, spying by looking through windows or other normally assumed protected spaces, like backyards. These concerns are not new: in 1946 a Supreme Court case involving airplane take-offs and landings over a farm addressed similar fears, ruling that people should retain control "over their immediate reach of the enveloping atmosphere" above their properties (*United States v. Causby et us.*, 1946).

However, privacy invasion is still occurring and evolving with rapidly changing technology and slowly implemented regional enforcement. For example, one Utah man was

convicted of voyeurism by electronic equipment for using his recreational drone to peer into other people's bedrooms and bathrooms (Harkins, 2017). The prevalence of drone victimization—like privacy invasion—is a unique form of infringement on Fourth Amendment rights. In an analysis of newspaper content from 1960 to 2019, only 25 unique cases of recreational drone victimization were identified within the U.S. (Graham et al., 2021). However, in the United Kingdom, this number is significantly higher, with complaints to police ranging from "mid-air near misses to irate neighbors squabbling about flights over gardens to criminals flying drugs into prisons" and numbers surging from 283 in 2014 to over 3,000 in 2016 (Corfield, 2017, 1).

Reported cases for privacy invasion by drones included following children home from school, hovering over people and making threats, crashing through windows into homes, and spying on people sunbathing in their own backyard (Family in Cleveland, 2018). These are just a few recent examples of the nefarious ways drone operators are abusing the use of this technology. Another privacy threat is the potential recording and sharing of materials and use by violent offenders to monitor a target's movements. Questions have been raised about whether registered sex offenders should have permission to own drones, as 29 states currently have legislation on residence restrictions for sex offenders, meant to limit their contact with vulnerable populations, like children (Graham et al., 2021). Operating drones could provide sex offenders with new avenues to jeopardize the safety of potential victims. Michigan is the only state known to restrict drone usage by registered sex offenders (Mich. Comp. Laws §§ 259.301 *et seq.,* 2016).

Perception of Drones

Privacy issues are involved in what options and rights people have to protect themselves against these victimizations. A qualitative study was conducted to assess public perception of drones and solicit feedback from participants about their own personal concerns. One participant listed her concern as, “One concern would be stalking… if parents see stalking of their child, they will be very angry and use every means to find the controller of the drone and punish him” (Stansbury et al., 2009, 3). Instances like this have occurred by individuals who felt violated by inappropriate hobby drone operations. People in California, Kentucky, and New Jersey have been arrested for shooting down drones flying over their backyards (Schneier, 2015). One man in Kentucky was charged with criminal mischief and even served jail time for his actions (Ison et al., 2018). People have rights to their own sense of privacy in their homes regardless of who is operating the drone. Shooting down a drone is currently still illegal and people who feel threatened are told to call the police to handle it (Schneier, 2015). In an effort to create a low-tech drone effort, Dutch police have taken to using trained eagles to “snatch them out of the sky” (Holligan, 2016). Similarly, net guns can dispense a webbing around the drone to disable its ability to operate. To continue in attempting to protect people’s rights to privacy, 33 states have attempted to use legal controls to limit the use of drones, Arkansas added the use of drones into their anti-voyeurism laws to ensure aerial protection where reasonable expectations of privacy exist (Graham et al., 2021).

LITERATURE REVIEW

Perception of Drone Operation

Local legislation may be predominantly responsible for addressing and creating operation restrictions for drones in relation to land use, zoning, privacy, trespassing, noise, wildlife concerns, and law enforcement (NLC, 2016). This range of control would thus provide local agencies the ability to designate where and when drones may take off and land, and outline ordinances or fines when operators violate established restrictions (Holland, 2017a). One survey sought to establish trends among local agency practices and issues associated with drones among local jurisdictions in Idaho. Three areas of interest were addressed: drone use by local agencies, local agency perceptions about the threats of drone use, and local agency beliefs about the need for local regulation of drone use (McNeal, 2014). One key finding was the influential level privacy and safety concerns have in regards to the way people perceive drones; they were identified as the largest areas of concern with drone operation in participants' communities, with 22% of respondents indicating significant concern and 58% indicating at least some concern with the threat to privacy (McNeal, 2014).

Research has been growing on how users view privacy and security issues regarding drone operation. A 2017 survey of 200 users in Germany showed that non-drone operators feared privacy violations, whereas active drone pilots saw more of a risk in possible collisions (Lidynia & et al., 2017). These results demonstrate that the need for regulations and drone perception varies among users; drone operators perceive legislation for regulations differently than bystanders.

Survey respondents also felt that the restrictions imposed on drone operation should match what the drone is being used for, e.g., emergency drones should be allowed to fly freely.

However, in another survey conducted in Australia, participants had a neutral attitude towards drones and did not consider drones to be particularly unsafe, risky, or threatening, or, for that matter, beneficial. The researchers hypothesized that this neutrality could be attributed to a lack of awareness and education among participants (Farber, 2016).

Perceptions of drones stem from who is operating the drone and what the drone is being used for. A study conducted by Embry-Riddle Aeronautical University (2019) showed that privacy concerns were a function of who was flying the drone (Rice, 2019). Participants indicated less concern about hobbyists, construction, and real estate companies, and far more concern about drones owned by the government, military or law enforcement; unmarked drones generated the greatest amount of privacy concerns. Despite the difference in operators, participants generally indicated that they were not proponents of drones flying over their homes or land (Rice, 2019). Another study conducted by Embry-Riddle Aeronautical University concluded that gender and political affiliations influence privacy concerns when it comes to drone operations, as women and participants with more conservative viewpoints favored stricter privacy rules (Rice, 2019).

Privacy and Victimization

The issues of privacy and victimizations from advancements in technology cannot go unnoticed. Just like privacy concerns arose with cyberstalking, new forms of victimization will arise with new technology. A study conducted by Graham et al. (2021) analyzed the misuse of recreational drones. Of the 560 respondents, 30.8% of the sample had experienced some form of drone misconduct. Females and those with higher antisocial propensities were more likely to be victims of the more invasive drone behaviors, such as a drone peeking through a window of a home (Graham et al., 2021). In addition, the majority of respondents viewed deviant drones as an issue

requiring a police response, but were more doubtful of the ability of law enforcement officials to apprehend the drone operator. A majority of respondents also believed that if someone or an entity was to misuse a drone, he or she should be punished accordingly (Graham et al., 2021). Public support has also been expressed for developing requirements to obtain consent from anyone whose image was intentionally or unintentionally captured by a drone.

Drones and Regulations

Emerging technology brings emerging issues. In order to ensure that legislation stays relevant, assessing the needs for public support is important. One 2019 study assessed the level of public support for various drone policies and how they aligned with federal, state, and local regulatory authority. Participants were most in favor of regulations that limited the operation of drones in some way, and less in favor of more severe policies that banned their usage either temporarily, (e.g., just at night) or completely (Zwickle et al., 2019). One of the main factors influencing these preferences was the perceived trustworthiness of the operator, with participants "more supportive of regulation when they found the operator less trustworthy" (Zwickle et al., 2019, 2).

Legal scholars posit that drones used for surveillance have the potential to violate the Fourth Amendment, which protects citizens from unreasonable searches and seizures. Therefore, regulations to restrict drone usage should be in place to protect these Constitutional rights (Altawy, 2017). The FAA has also received criticism for issuing ambiguous guidance and not taking more initiative to monitor drone use. When developing legislation to monitor the operation of drones, legislators should take into account how drones are being used and operated, and other concerns of citizens (Altawy, 2017).

This research coincided with trends seen in reported news articles and media outlets, where the most widely supported legislation related to regulating flying or operating drones over private property. In another study, 73% of respondents were drawn to the idea of using drones for hobby purposes, but an equal number (73.1%) said they were somewhat concerned or very concerned about drones in the US airspace, with particular concerns about privacy and safety (Ondrovic, 2017). Despite 11.7 % of respondents admitted to wanting to observe their own neighbors if they had a drone, nearly half of the respondents (47.5%) agree or strongly agreed that private citizens should be banned from owning drones (Ondrovic, 2017).

Survey results like these indicate the need for legislation regarding drone usage. One legal scholar has proposed a framework for regulating drone use in California (Gonzalez, 2017). His recommendation is for California to use the privacy-related objectives in its penal code together with law enforcement, rather than relying solely on law enforcement to police unlawful privacy violations. California has traditionally provided its citizens with numerous privacy protections through its civil and criminal frameworks. However, California's current invasion of privacy statute does not yet address meaningful applications to drone technology. It was recently amended, but only for the purpose of protecting celebrities from paparazzi, not for ensuring the same levels of privacy for the general public.

Assembly Bill 856

An additional drone-related amendment signed into law on October 6, 2015 was Assembly Bill 856. A.B. 856 was introduced for the sole purpose of expanding the scope of physical invasion of privacy to include a person who "knowingly enter(s) into the airspace above the land of another person without permission" (Cal. Legis. Assemb., 2015). A.B 856, according to the bill's author, aimed to prohibit actual trespassing into properties—when drones fly over fences,

or locked gates, or film through windows. The proposal integrates a hybrid approach that uses different departments to create a comprehensive drone management system. A.B 856 plugs this loophole by clarifying that individuals are liable for invasion of privacy when they enter someone else's property, including entering the airspace immediately above the property (Cal. Legis. Assemb., 2015).

Drones as a Nuisance

Drone presence acceptance encompasses aspects beyond trespassing and enforcement. Drones' noise annoyance has become a relevant aspect of drone regulations, as well. As the total number of drones operating rises—whether it be for hobby use or large-scale delivery—the total ambient noise levels of normal life will likely increase (Garth, 2019). This can cause concern and annoyance to residents and people nearby. A study measured noise tolerances, comparing tolerance of drone noise versus other normal outdoor noise exposure, and concluded that participants found the sound of drones to be more annoying than normal traffic noises (Garth, 2019). Drones increase overall noise pollution by an average of 5.6 decibels when compared to noise generated from normal delivery vehicles (Garth, 2019, 1). In addition, drones used for commercial reasons fly much closer to the public, potentially creating risks in the urban environment (Garth, 2018). This factor should be considered when designing drone regulations with the forecasted increase in industries relying on drones to conduct business operations. Though most consumers agree that drones are more environmentally friendly forms of transportation, the rise in ambient noise may decrease support (Garth, 2019). Most of the research that has been conducted in the drone field has focused on the roles that drones play in people's personal views and beliefs. This research is a vital component that local government

officials should use to guide regulation development. The regulation framework should reflect the needs and threats that match the climate of opinion in specific jurisdictional areas.

METHODOLOGY

Design

The research was an evaluation of the drone policies and procedures in relation to the thirty most populous cities in California. A policy implementation evaluation was conducted to determine whether this policy is achieving its goals (Sylvia & Sylvia, 2012). To answer the research question, "*What regulations do the thirty most populous cities in California have in place to manage the usage of drones?*", this research examined drone regulations and policies in California. This research is excluded from an Institutional Review Board (IRB) review because there are no human subjects.

The intent of this research was to provide local officials with a reference framework to assist in the future evaluation, development, implementation, and evolution of drone regulations within their jurisdictions.

Table 1: Policy Implementation Evaluation

Policy Implementation Evaluation			
Problem Identification	**Solution Development**	**Implementation**	**Evaluation**
(1) Lack of consistency between drone regulations among local government agencies in California. (2) With an expansion in drone adoption and usage, the likelihood of a safety infraction, privacy infraction, or becoming a nuisance increases.	An established framework that local governments can use to create ordinances to regulate drone usage.	Local government enacting and enforcing developed drone ordinances.	Determine whether a drone ordinance exists, and if so, what descriptive and enforcement elements do the ordinances include?

Data

This research investigated the variations among drone regulations and ordinances for the most populous thirty cities in California through a policy implementation analysis. The largest thirty cities were identified based on population numbers from the 2020 census. The number of registered drones within each of the thirty cities was also determined. The data were retrieved from the FAA database of registered drone users, which is available to the public and updated every quarter (FAA, 2020b). This data was then used to calculate the number of registered drones per 1,000 people for each city.

No document or guide currently exists for cities to use when creating drone regulations in California; therefore, a framework to compare ordinance variations was developed first. Subject matter research was conducted from various sources, including existing drone ordinances, reported infractions associated with drones, media and news coverage articles, city council staff reports and agendas, and law enforcement websites' information. This research, which included a further analysis of existing drone regulating ordinances, then determined the fourteen elements that should be included in drone regulation development for a comprehensive approach that does not entirely restrict the usage of drones.

After the fourteen elements were identified, each city's municipal code database and website were analyzed. There were high levels of variability in how each city defined a drone in the scope of drone regulation policies. Thus, when each municipal code and website were analyzed, various search terms were used: *drone, unmanned aircraft system, remote-operated vehicle, motor-driven vehicle, motor-driven model aircraft, and model airplane*. The cities with applicable ordinances were then categorized by each element. If a drone ordinance was identified, an "x" was marked under each element in accordance with the ordinance. In addition,

the chapter, date of the ordinance implementation, and URL for each ordinance was included in the data.

FINDINGS

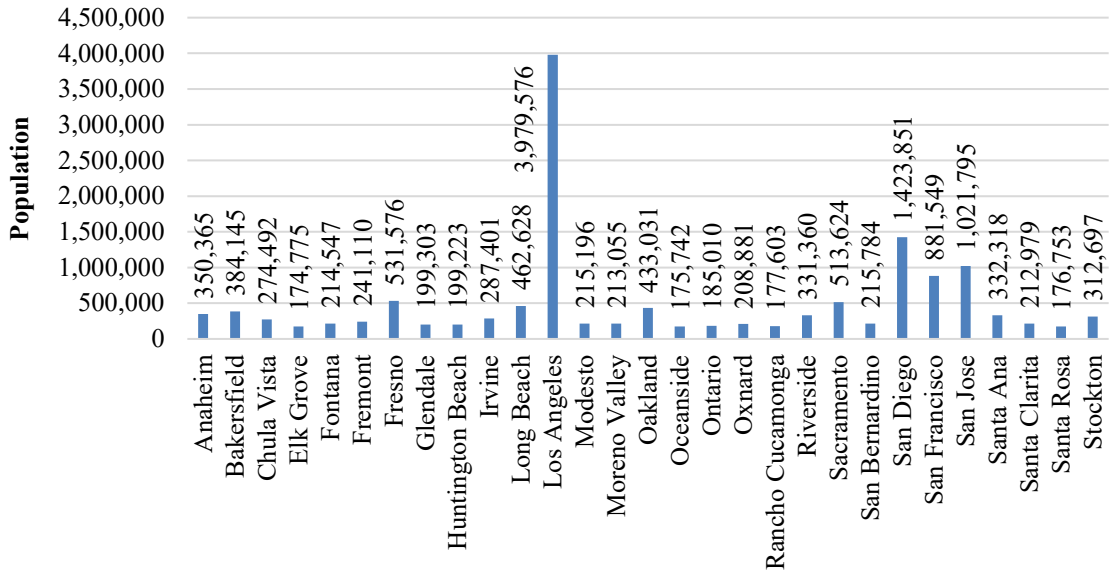
This section presents the research results, including data for each city, population size, number of registered drones with the FAA, and the number of drones per capita. This data is relevant when creating local regulations as larger populations will likely have more drone adoption and therefore, more incidents associated with drone usage. This section also included an evaluation of each city's ordinances (as of December 15, 2020) based on which elements were identified in the ordinances.

Demographic Data for Each City

Population Size

Figure 2 shows the population of each of the thirty cities in 2020. Elk Grove had the smallest population, with 174,775 people, while Los Angeles had the largest population, with 1,423,851.

Figure 2*:* Population of Each City

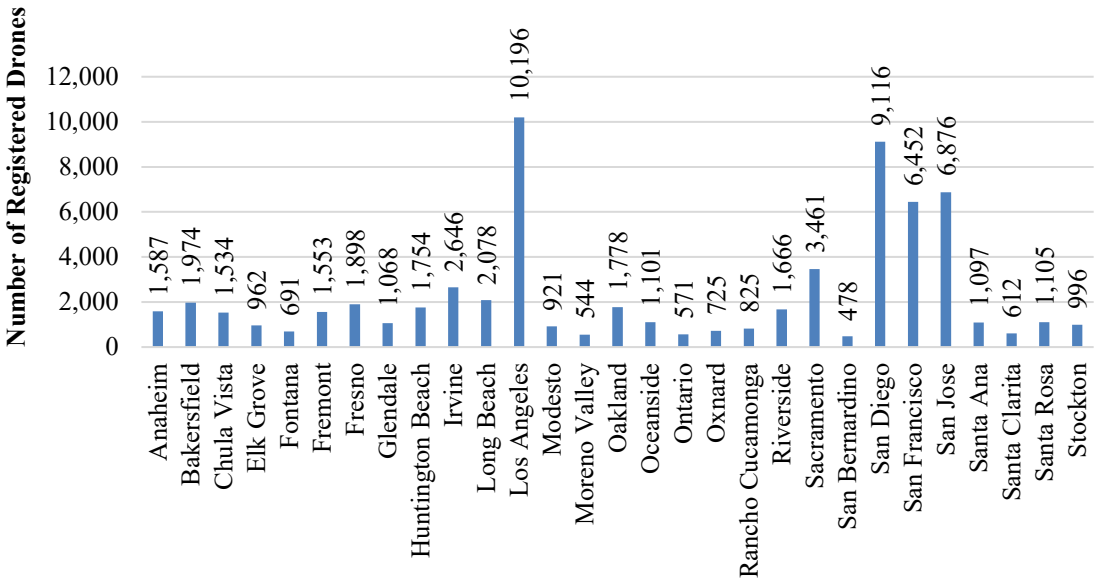


Source: (US Census Bureau, 2020)

Registered Drones

Figure 3 shows the number of drones registered in 2019 with the FAA. The FAA releases the number of hobby and commercial drones registered by zip code on a quarterly basis (2020b). San Bernardino had the fewest registered drones, at 478, and Los Angles had the most, at 10,196.

Figure 3: Total Number of Registered Drones in Each City

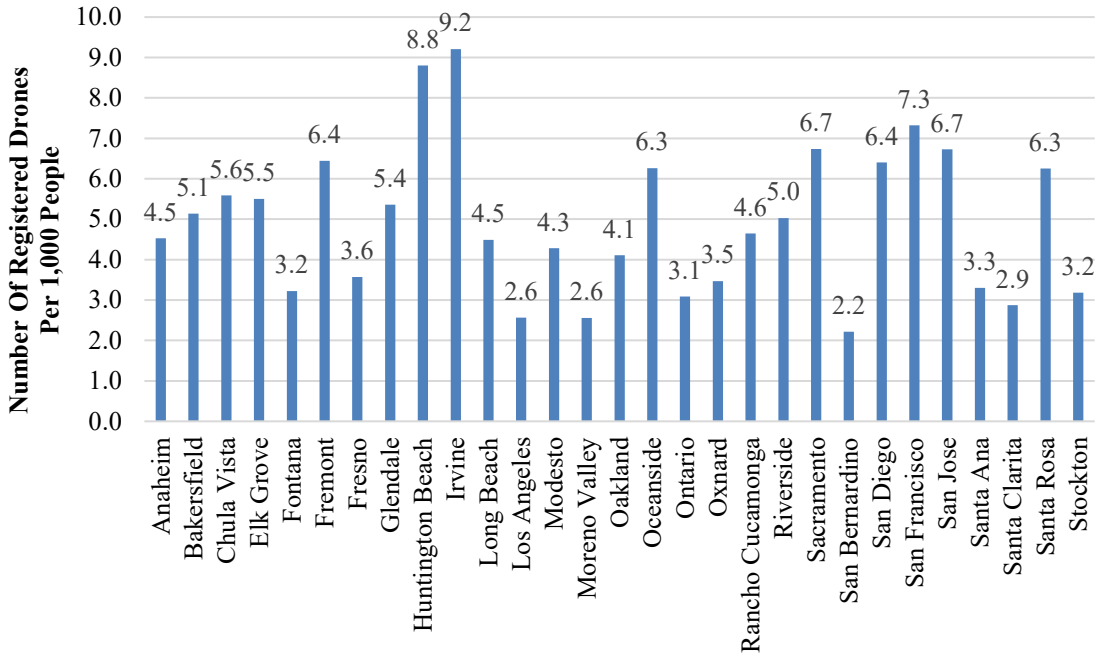


Source: (FAA, 2020b)

Drones Per Capita

Figure 4 shows the number of drones per 1,000 people in each of the cities. San Bernardino had the fewest registered drones per capita, 2.2 registered drones for every 1,000 people, and Irvine had the most, 9.9 registered drones for every 1,000 people.

Figure 4: Number of Registered Drones Per Capita (1,000 People)



Source: (Federal Aviation Administration, 2019; US Census Bureau, 2020)

City Ordinances

Elements

The following list includes the fourteen general elements developed and used to categorize the city ordinances.

- Does a city ordinance exist in relation to the regulation of drone operations?
- Does the ordinance include a definition of the term “drone”?
- Does the ordinance regulate the distribution of goods or services?
- Does the ordinance include language about privacy or invasion of privacy?
- Does the ordinance include regulating drones in public parks or on public land/property?
- Does the ordinance regulate using drones for filming or recording purposes?

- Does the ordinance reference or refer to any city permit required to operate a drone in the city's jurisdiction?
- Does the ordinance regulate the usage of drones flying over other vehicles?
- Does the ordinance regulate the usage of drones flying over other people?
- Does the ordinance include an enforcement clause that can be used by if an infraction was to occur?
- Does the ordinance regulate the use of drones to prevent interference with emergency service operations?
- Does the ordinance regulate the use of drones during a fireworks show?
- Does the ordinance regulate the use of drones near or around sports arenas or private or public entertainment venues (such as theme parks)?
- Does the ordinance regulate the use of drones during sporting events?
- Does the ordinance include restrictions regarding hours of operations?
- Does the ordinance refer back to the Federal Aviation Authority?

Ordinances

Table 2 lists each city and denotes whether it had an ordinance or not, and if so, the corresponding ordinance chapter number. The associated web address (URL) was listed as well.

Table 2: City with Ordinance Chapter Number and Year

City	Existing City Ordinance	City Ordinance Chapter	Year Implemented	URL
Anaheim	X	6.43.010	2018	Anaheim URL
Bakersfield	X	12.56.050	2009	Bakersfield URL
Chula Vista	X	2.66.180	2014	Chula Vista URL
Fontana	X	15.960	2019	Fontana URL
Glendale	X	9.28.050	2019	Glendale URL
Irvine	X	3.4.113	1974	Irvine URL
Los Angeles	X	56.31	2015	Los Angeles URL
Ontario	X	10.1.21	1981	Ontario URL
Oxnard	X	7.301	2020	Oxnard URL
Rancho Cucamonga	X	12.04.010	2019	Rancho Cucamonga URL
Riverside	X	9.08.090	2017	Riverside URL
San Diego	X	5.52.5401	2017	San Diego URL
San Francisco	X	1626	2019	San Francisco URL
Santa Clarita	X	14.06.210	2018	Santa Clarita URL
Stockton	X	12.56.010	2007	Stockton URL
Elk Grove	n/a			
Fremont	n/a			
Fresno	n/a			
Huntington Beach	n/a			
Long Beach	n/a			
Modesto	n/a			
Moreno Valley	n/a			
Oakland	n/a			
Oceanside	n/a			
Sacramento	n/a			
San Bernardino	n/a			
San Jose	n/a			
Santa Ana	n/a			
Santa Rosa	n/a			

*n/a refers to all cities that did not have an existing city ordinance.

Source: (Anaheim, Municipal Code § 6.43; Bakersfield, Municipal Code § 12.56.050(A); Chula Vista, Municipal Code § 2.66.180; Fontana, Municipal Code § 15.960; Glendale, Municipal Code § 9.28.050; Irvine, Municipal Code § 3-4-113; Los Angeles, Municipal Code § 56.3; Ontario, § 10.1.21; Oxnard, Municipal Code § 7.301(G); Rancho Cucamonga, Municipal Code § 12.04.010(M); Riverside, Municipal Code § 9.09.090; San Diego, Municipal Code § 5.52.54; San Francisco, Municipal Code § 1626(b)(2); Santa Clarita, Municipal Code § 14.06.210(E); Stockton, Municipal Code § 12.56.010(L)).

Table 3 identified which cities did have an ordinance to regulate drones and what elements each ordinance included.

Table 3: Cities' Ordinances Categorized by Element

City	City ordinance	Parks/public land	Film permit requirements	Definition	Enforcement reference	Interference with emergency services	Time of day restrictions	Flying over unprotected persons	Reference FAA regulations	Distribution of goods	Privacy	Flying over vehicles	Flying during fireworks	Flying over public/private venue	Flying over sports arenas
Anaheim	X	X		X	X	X	X	X			X	X	X	X	X
Bakersfield	X	X													
Chula Vista	X	X													
Fontana	X		X	X											
Glendale	X	X	X				X								
Irvine	X	X													
Los Angeles	X		X	X	X	X	X	X	X						
Ontario	X	X													
Oxnard	X	X	X												
Rancho Cucamonga	X	X	X												
Riverside	X		X												
San Diego	X		X	X	X	X			X						
San Francisco	X									X					
Santa Clarita	X	X													
Stockton	X	X													
Elk Grove	n/a														
Fremont	n/a														
Fresno	n/a														
Huntington Beach	n/a														
Long Beach	n/a														
Modesto	n/a														
Moreno Valley	n/a														
Oakland	n/a														
Oceanside	n/a														
Sacramento	n/a														
San Bernardino	n/a														
San Jose	n/a														
Santa Ana	n/a														
Santa Rosa	n/a														

*n/a refers to all cities that did not have an existing city ordinance.

Source: (Anaheim, Municipal Code § 6.43; Bakersfield, Municipal Code § 12.56.050(A); Chula Vista, Municipal Code § 2.66.180; Fontana, Municipal Code § 15.960; Glendale, Municipal Code § 9.28.050; Irvine, Municipal Code § 3-4-113; Los Angeles, Municipal Code § 56.3; Ontario, § 10.1.21; Oxnard, Municipal Code § 7.301(G); Rancho Cucamonga, Municipal Code § 12.04.010(M); Riverside, Municipal Code § 9.09.090; San Diego, Municipal Code § 5.52.54; San Francisco, Municipal Code § 1626(b)(2); Santa Clarita, Municipal Code § 14.06.210(E); Stockton, Municipal Code § 12.56.010(L)).

Population and Drones per Capita

Only 50% of the thirty cities analyzed had a drone ordinance in place despite all cities having at least some registered drones. Out of the 30 cities, three cities, Anaheim, Los Angeles, and San Diego, had ordinances with five or more elements. Anaheim had the most elements, despite having fewer drones per capita (4.5) than San Diego (6.4) (Federal Aviation Administration, 2019). San Francisco, the fourth-largest city in California, with the third highest number of drones per capita, had only one element in their drone policy, regulating the usage of drones for the distribution of commercial goods, specifically cannabis delivery (Federal Aviation Administration, 2019). Irvine, with the largest drone per capita value, had only one element for its ordinance. Huntington Beach, with the second highest number of drones per capita (8.8), did not have any drone ordinance (Federal Aviation Administration, 2019).

Public Parks or Public Land

The most common element of drone regulations pertained to the usage of drones in public parks or on public land. Seven cities had ordinances prohibiting the operation of drones in public parks and spaces. As shown in Table 3, of the seven cities, Glendale, Irvine, Los Angeles, Ontario, Oxnard, Rancho Cucamonga, Riverside, Santa Clarita, and Stockton prohibit the operation of drones or unmanned aircrafts in community parks or spaces except in areas stated specifically for drone flying. Ontario stated in their park drone ordinance that only City Council can label areas designated specifically for drone operations (Ontario, Municipal Code § 10.1.21). However,

Bakersfield and Chula Vista prohibited the use of drones entirely in public parks or recreational spaces and did not include a clause like Ontario's for special designated areas (Bakersfield, Municipal Code § 12.56.050(A); Chula Vista, Municipal Code § 2.66.180). Irvine had a city ordinance from 1974 that uses the term "flying of motor driven airplane of any type" and specified that drones shall not be permitted in any public park except areas designated for use by the Community Services Department (Irvine, Municipal Code § 3-4-113). Additionally, though Modesto did not have a city ordinance in place, rules and regulations on the Community Services Department website prohibited drones from flying in the Soccer Complex and Mary Grogan Community Park (City of Modesto, 2020).

Filming Permit Requirements

Seven of the cities' ordinances required permits for the use of drones for filming purposes. These are specific permits, usually administered through the City Manager or the Fire/Police Department. The purpose of including this element in an ordinance is to ensure that drones being used for filming purposes are monitored to protect bystander privacy and safety. Los Angeles' ordinance prohibited flying drones over the Port of Los Angeles generally, but if an individual sought to operate a drone over the Port of Los Angeles for filming purposes, the city ordinance required the operator to obtain a film permit (Los Angeles, Municipal Code § 56.3). Fontana also required a permit to use drones for filming operations and included language referencing the FAA regulations about prohibited behavior when using a drone for filming reasons (Fontana, Municipal Code § 15.960). San Diego's ordinance listed specific language that prohibited all filming activities while using a drone without a film permit (San Diego, Municipal Code § 5.52.54).

Definition of a Drone

Of the fifteen cities with drone ordinances, only four cities included a definition and description section for a drone. Each of the four cities—Fontana, Los Angeles, San Diego, and Anaheim—defined a drone specifically as an Unmanned Aircraft System, which included any aircraft operated without the possibility of direct human intervention from within or on the aircraft (Fontana, Municipal Code § 15.960, Los Angeles, Municipal Code § 56.3; San Diego, Municipal Code § 5.52.54; Anaheim, Municipal Code § 6.43). For each of these cities, the definition of a drone was provided at the beginning of the ordinance before stating the elements and scope of the ordinance.

Enforcement Clause

An enforcement clause, which defines the authority of the enforcer of the ordinance or the course of action if an ordinance violation was to occur, was included only in the Los Angeles, San Diego, and Anaheim ordinances (Los Angeles, Municipal Code § 56.3; San Diego, Municipal Code § 5.52.54; Anaheim, Municipal Code § 6.4). Defining the enforcing body reduces ambiguity around how to enforce, process, and prosecute an individual who violates the privacy rights of another with a drone. Specifically, the City of San Diego authorized the Chief of Police to administer the provisions listed in the drone regulations; the other two did not provide a title (San Diego, Municipal Code § 5.52.54). In addition, these ordinances decreed that violations could be prosecuted as misdemeanors and that violators were subjected to fines or jail time.

Interference with Emergency Operations

Drones have had significant media coverage in recent years for interfering with emergency service operations, delaying services like fighting fires or emergency relief aid, by flying irresponsibly or in a manner that is unsafe for emergency services personnel to be able to fulfill

their duties. Some cities have had firefighting services delayed due to a drone, like San Bernardino and Santa Rosa, but they did not have drone ordinances or language prohibiting or regulating the use of drones during emergency operations. However, others, including Anaheim, Los Angeles, and San Diego, specified that no drone should be flown in any manner that interferes with the operation of law enforcement or firefighting efforts (Los Angeles, Municipal Code § 56.3; San Diego; Municipal Code § 5.52.54; Anaheim, Municipal Code § 6.4).

Time of Day

Time of day restrictions were specified in both Los Angeles and San Diego. Drones were not authorized to be operated after sundown or before sunrise, prohibiting all drone operation during non-daylight hours. The ordinances used similar language and the term "daylight hours" (Los Angeles, Municipal Code § 56.3; San Diego; Municipal Code § 5.52.540).

Operating over Unprotected Persons

Anaheim and Los Angeles were the only two cities that prohibited operating drones over an unprotected person. Specifically, Anaheim deemed it unlawful to operate a UAS less than 100 feet away measured horizontally from any individual (Anaheim, Municipal Code § 6.4). Neither ordinance provided information as to what distinguished a protected from an unprotected person (Los Angeles, Municipal Code § 56.3; Anaheim, Municipal Code § 6.4).

Referencing FAA Regulations

Referencing FAA regulations is necessary since the FAA is the regulating authority over national airspace, but a reference was present only in Los Angeles' and San Diego's ordinances. Each of those two cities included a separate section that stated that all ordinances were in compliance with the FAA authority and terms and conditions listed in the FAA regulations (Los Angeles, Municipal Code § 56.3; San Diego, Municipal Code § 5.52.540).

Distribution of Goods

San Francisco was the only city with an ordinance that prohibited the distribution of goods by drones. This ordinance was passed in 2019 and specifically controlled the operation of distributing marijuana as a commercial product (San Francisco, Municipal Code § 1626(b)(2)). This ordinance also included the term "drone," but did not provide any further definition or refer to additional commercial goods. This ordinance was listed under the Cannabis Delivery section in San Francisco's municipal codes (San Francisco, Municipal Code § 1626(b)(2)).

Privacy

Only one city, Anaheim, specifically prohibited the use of drones to invade an individual's privacy. The ordinance required permission from private property owners before an individual can hover in place over private property, and deemed it unlawful to specifically take photos or videos without express permission (Anaheim, Municipal Code § 6.4). No other city included specific language that prohibited the usage of drones regarding the violation of privacy rights of others.

Usage over Moving Vehicles

Anaheim was the only city that prohibited operating a drone over a moving vehicle. This ordinance also prohibited the use of drones over vehicle traffic or across a street with more than two lanes (Anaheim, Municipal Code § 6.4). No other city with existing ordinances prohibited the use of drones over moving vehicles or traffic.

Fireworks, Public Venues, and Sporting Events

Regulations for operating a drone during a fireworks production, over a public or private venue where groups of people would congregate, or over a sporting events venue were only identified in Anaheim's ordinance. Anaheim's ordinance also included a population threshold, prohibiting

the operation of drones within 1,000 feet of any venue where more than 1,000 people are estimated to attend (Anaheim, Municipal Code § 6.4). However, proximity to an airport can influence need for these ordinances, as the FAA bans operating drones within five miles of an airport, and some cities like Los Angeles and Oakland, have sports stadiums within a five-mile radius of a professional sports facility. Therefore, a drone operating during a sporting event at those locations would be in violation of federal law, which preempts local law.

ANALYSIS

The Federal Aviation Administration has established specific areas where local regulation may be most appropriate without the FAA having to assert preemption. Some of these areas include land use, property rights, privacy rights, and nuisance management, providing cities a unique opportunity to administer specific ordinances that can address existing and potential issues in relation to drones. However, the creation, adoption, implementation, and enforcement of ordinances have been slow. Due to the high variability of interpretation, cities are reluctant to pave the way for drone ordinance creation to ensure that drones are operated safely. Cities need direction, a more comprehensive guide to create drone-regulating ordinances. It is important that cities be proactive in this realm and create ordinances and regulations that promote accountability but still foster innovation. Cities need to implement policies that protect communities, people, research and innovation, while avoiding issues of preemptions and the complete banning of drones all together. In addition, drone ordinances need to be created and implemented in a manner that matches the individual needs of the city. However, the basic template developed through this research can serve as a guide.

This research showed that having registered drones in a given city did not necessarily mean that (1) a drone ordinance existed, or (2) any existing ordinances had the parameters necessary to be effective. The City of San Francisco has reported over 135 drone violations by hobby drone users in Golden Gate Park (Li, 2019). Park rangers are using an antiquated city ordinance from 1981 that includes the language “landing or launching a flying apparatus” to define a drone and to keep people from operating drones in the park. However, using this launching and landing language to regulate drone operations is limiting because it does not include provisions for in-flight usage. For example, an individual could launch a drone from

outside of the park, fly the drone into the park, and then walk back across the street to land the drone, without ever violating an ordinance, but still potentially causing safety or privacy harm to bystanders nearby. In addition, cities using older ordinances to issue violations, that were before widespread adoption of drones, like Irvine or San Francisco, to issue violations need to ask the question, is the language from an ordinance created before hobby drones were ever used on a large scale applicable to today's needs? Because, in another context, the city of San Francisco does have an actual drone ordinance, that uses the term drone (not flying apparatus)—but only to regulate the delivery of cannabis goods. Lack of clarity in applicable ordinances, lack of applicability, and outdated terminology has created a bitter relationship between park staff, residents, and city policies.

Drones are multi-use forms of technology with the potential to expand in all markets, with almost an endless list of uses. Therefore, it is important that cities recognize drones for their expansion in capabilities to provide services by not overregulating, but still ensuring privacy and protections for residents. People are concerned about their privacy being violated by a drone flying over their backyard or looking through their window without their consent. Associated trepidations with the wide use of drones also include the confusion on what rights do people have to protect themselves if a situation like this arose. This is where ordinances and regulations about drone operations are relevant. Cities can use Table 2, the elements chart, as a checklist to structure drone ordinances that address these fears. Drone ordinances can include language that clearly defines dedicated drone fly zone areas and privacy standards limiting the scope of where drones can be used.

In addition to public safety fears, drones often interfere with services like crime scene investigations or active wildland firefighting operations, interrupting planes from delivering

protectant retardant or flying over homes during small house fires. News teams are protected by First Amendment rights to operate drones for gathering facts and photos. However, ordinances can include violation clauses that makes flying drones during these events unlawful and susceptible to appropriate punishment. Adding language prohibiting drone usage to interfere with emergency services could be helpful to cities that are high-hazard areas and prone to fires.

Public debate about drone operations, like privacy issues, or where and how a drone can be launched, will only increase as drones are used more frequently by both hobby and commercial users. Cities need to provide a clear and concise definition of a drone, like the Anaheim or Los Angeles ordinances, to delineate what a drone is and who is allowed to operate them. Providing definitions of protected persons versus unprotected, which are terms found in the drone ordinances, should also be included. This work could avoid issues like San Francisco's, which has issued over 100 drone-related violations in regards to ordinance infractions in recent years (Li, 2019).

Cities have an established right to regulate the use of land in any rational way, pursuant to established policing powers. Therefore, regulations that encourage protecting the safety of the public's health or the general welfare of the public would be a legitimate use of the local government's police power. Cities should regulate drones through various regulatory authorities as listed by the FAA and include an enforcement clause that law enforcement agencies can use to deter reckless drone operation. Clearly defining drone usage with an enforcement scope assists both law enforcement agencies and residents. It helps law enforcement agencies stay with the purview of authority and brings awareness to drone operators regarding the severity of charges that could be faced if the ordinance was violated.

The high variability in the format, location, sections, and language that was used for each existing ordinance shows that cities are lacking both clear and concise methods to implement effective drone regulations. Almost all cities with existing drone ordinances prohibited the use of drones in public places. However, the sections where these regulations were identified, the headings, language, and terminology used lacked consistency, even though the regulatory intent was the same.

Not all ordinances need identical elements, as cities operate differently, and may or may not have fireworks shows or sporting arenas. Therefore, elements that are city-specific should be implemented on an as-needed basis. The definition of a drone, responsible enforcement agency, a punishment clause if a violation were to occur, and reference back to FAA regulations should be standard elements in all drone ordinances. Referencing back to the FAA is important for cities to integrate into ordinances to avoid issues of preemption, and to recognize that cities are operating under a specific jurisdictional power that does not supersede that of the FAA. Standardizing these elements for a drone ordinance would facilitate the development of a comprehensive drone regulation template that leaves little to no personal interpretation for drone enthusiasts, residents, public agencies, or law enforcement.

CONCLUSION

This research on the thirty most populous cities in California demonstrated that, though drone adoption and registration is growing, there is a gap in applicable ordinances, as many cities still lack regulations entirely. Further, it is important that cities work together and develop policies that align with each other rather than creating conflict or patchwork regulations that could potentially run counter to those of the FAA. Cities can adopt measures to create a universal framework for wide-scale drone ordinance implementation, including committees or pilot programs. The National League of Cities might create a model ordinance for national use that would incorporate the FAA's guidance for permitted local action.

Conducting further research within each city to assess residents' opinions of drones and propensity to use one would provide vital information to establish the need for ordinances and/or guide the degree of freedom permitted by such ordinances. Drones already serve a number of socially beneficial purposes, such as assisting farmers in water management for crops, and delivering packages in areas with congested traffic. Their operation can, however, constitute a nuisance, when people's privacy is invaded or emergency services flights are interfered with.

Further research should be conducted to analyze the most common drone infractions reported to the FAA and local law enforcement agencies for each city. This data would inform policymakers which specific elements an ordinance needs in order to be effective. In addition, cities and legislatures should be working with the FAA to discuss policies about who should be allowed to own and operate drones. Such policies should keep in mind the public's main concerns about mass deployment of drones: privacy and safety. Designing regulations that place specific parameters on the operations of drones according to national city-level usage would be relevant for cities to administer, as well. Cities can continue their implementation strategies,

using the results from this report to create ordinances that maintain the safety and wellbeing of the public, while still encouraging drone operation and usage for socially beneficial purposes.

REFERENCES

911 Security. (2019, June). *U.S. Drone Laws: Overview of Drone Rules and Regulations in USA by State* [White paper]. www.utsystem.edu/sites/default/files/offices/police/policies/USDroneLaws.pdf.

Academy of Model Aeronautics (AMA). (2018, January 1). *Academy of Model Aeronautics National Model Aircraft Safety Code*. www.modelaircraft.org/content/official-ama-national-model-aircraft-safety-code.

Altawy, R., & Youssef, A. (2017). Security, Privacy, and Safety Aspects of Civilian Drones. *ACM Transactions on Cyber-Physical Systems*, *1*(2), 1–25. https://doi.org/10.1145/3001836.

American Association of State Highway and Transportation Officials (AASHTO). (2019, May). *2019 AASHTO UAS/Drone Survey of all 50 State DOTs*. www.transportation.org/wp-content/uploads/2019/05/MissionControl_Drones3.pdf.

Anaheim, California, Municipal Code § 6.43.010 (2018). www.codelibrary.amlegal.com/codes/anaheim/latest/anaheim_ca/0-0-0-57517

Associated Press. Seattle police drafting policy for using drones. (2012, October 25). *HeraldNet*. www.heraldnet.com/news/seattle-police-drafting-policy-for-using-drones.

Association for Unmanned Vehicle Systems International (AUVSI). (2013, March). *The Economic Impact of Unmanned Aircraft Systems Integrations in the United States*. www.auvsi.org/our-impact/economic-report.

Association for Unmanned Vehicle Systems International (AUVSI). (2016, March). *The Economic Impact of Unmanned Aircraft Systems Integration in the United States* [White paper]. www.auvsi.org/our-impact/economic-report.

Association of California Cities – Orange County. (n.d.). *The ultimate checklist for creating a model drone ordinance.* www.ama10.wildapricot.org/resources/The%20Ultimate%20Checklist%20for%20Drone%20Ordinance.pdf.

Axelrod, J. (2017, September 6). The Drone Dilemma. *American City and County*. www.americancityandcounty.com/2017/09/06/the-drone-dilemma.

Bakersfield, California, Municipal Code §12.56.050 (2009). https://bakersfield.municipal.codes/Code/12.56.050

Cal. Legis. Assemb. S-856. Reg. Sess. 2015–16 (2015). www.leginfo.ca.gov/pub/15-16/bill/asm/ab_0851-0900/ab_856_cfa_20150713_143110_sen_comm.html.

Cauchard, J., E. J., Zhai, K., & Landay, J. (2015, September). Drone & Me: An Exploration into Natural Human-Drone Interaction. In K. Mase, M. Langheinrich, D. Gatica-Perez, H. Gellersen, T. Choudhury, T., & K. Yatani (Eds.), *Proceedings of the 2015 ACM International Joint Conference on Pervasive and Ubiquitous Computing* (pp. 361–365). Association for Computing Machinery. https://doi.org/10.1145/2750858.2805823.

Cavoukian, A. (2012). *Privacy and Drones: Unmanned Aerial Vehicles.* Office of the Information and Privacy Commissioner/Ontario. www.ipc.on.ca/wp-content/uploads/resources/pbd-drones.pdf.

Chappell, B. (2019, April 23). FAA certifies Google's wing drone delivery company to operate as an airline. NPR. www.npr.org/2019/04/23/716360818/faa-certifies-googles-wing-drone-delivery-company-to-operate-as-an-airline.

Childs, J. (2019, November 2). Unauthorized drones interrupt efforts to fight California wildfire. *The Weather Channel*. weather.com/news/news/2019-11-02-drones-grounded-firefighting-aircraft-maria-fire.

Chula Vista, California, Municipal Code § 2.66.180 (2014). https://chulavista.municipal.codes/CVMC/2.66.180

City of Modesto. (2020). Mary E. Grogan Community Park. www.modestogov.com/facilities/facility/details/maryegrogancommunitypark-159.

Corfield, G. (2017, April 3). Drone complaints to cops are up twelvefold in three years. *The Register*. www.theregister.com/2017/04/03/uk_drone_police_complaints_up.

Daly, D. (2020). A Not-So-Short History of Unmanned Aerial Vehicles (UAV). Consortiq. https://consortiq.com/short-history-unmanned-aerial-vehicles-uavs.

FAA Modernization and Reform Act of 2012, 49 § U.S.C 40101 *et seq.* (2012).

Family in Cleveland in living nightmare with hacker who continually harasses them through electronics. (2018, December 28). *KXXV Central Texas News Now.* https://leoaffairs.com/family-in-cleveland-in-living-nightmare-with-hacker-who-continually-harasses-them-through-electronics.

Farber, H. (2016). Eyes in the Sky and Privacy Concerns on the Ground. *Human Rights, 41*(4), 23-25. Retrieved April 5, 2021, from http://www.jstor.org/stable/26423459.

Federal Aviation Administration. (2015, December 17). *State and Local Regulation of Unmanned Aircraft Systems (UAS)* [Fact sheet]. U.S. Department of Transportation. www.faa.gov/uas/resources/policy_library/media/UAS_Fact_Sheet_Final.pdf.

Federal Aviation Administration. (2018, November 18). *Understanding Your Authority: Handling Sightings and Reports*. www.faa.gov/uas/public_safety_gov/sightings_reports.

Federal Aviation Administration. (2019, August 29). *No Drone Zone.* www.faa.gov/uas/resources/community_engagement/no_drone_zone.

Federal Aviation Administration. (2020a). *FAA Aerospace Forecasts*. U.S. Department of Transportation. www.faa.gov/data_research/aviation/aerospace_forecasts.

Federal Aviation Administration. (2020b). *Geographic listing of hobbyist/non-hobbyist sUAS registry enrollments and registrants (CY 2019 Q1-Q4)*. [Data set]. http://www.faa.gov/foia/electronic_reading_room/ - geo_list.

Federal Aviation Administration. (2020c, December 2). *Register your drone*. www.faa.gov/uas/getting_started/register_drone.

Federal Aviation Administration. (2020d, December 2). *Special authority for certain unmanned aircraft systems*. www.faa.gov/uas/advanced_operations/certification/section_44807.

Federal Aviation Administration. (2020e, December 8). *B4UFLY Mobile App*. www.faa.gov/uas/recreational_fliers/where_can_i_fly/b4ufly.

Federal Aviation Administration. (2021, March 16). *Integration Pilot Program Lead Participants*. www.faa.gov/uas/programs_partnerships/completed/integration_pilot_program/lead_participants.

Fontana, California, Municipal Code § 15.960 (2019). https://library.municode.com/ca/fontana/codes/code_of_ordinances?nodeId=CO_CH15LIPEBURE_ARTXXFIPERE_S15-960SMUNAESYDR

Gettinger, D. (2017c, April). Public safety drones. *Center for the Study of the Drone at Bard College*. https://dronecenter.bard.edu/projects/public-safety-drones-project.

Glendale, California, Municipal Code § 9.28.050 (2019). http://www.qcode.us/ codes/glendale/.

Gonzalez, B. (2017). Drones and Privacy in the Golden State. *Santa Clara High Technology Law Journal, 33*(2), 288–323.

Graham, A., Kutzli, H., Kulig, T. C. & Cullen, F.T. (2021). Invasion of the Drones: A New Frontier for Victimization. *Deviant Behavior 42*(3), 386–403. https://doi.org/10.1080/01639625.2019.1678973.

Harkins, P. (2017, October 17). Utah man convicted of using drone to spy on people in their homes gets suspended jail sentence. *The Salt Lake Tribune*. www.sltrib.com/news/2017/10/31/utah-man-convicted-of-using-drone-to-spy-on-people-in-their-homes-gets-suspended-jail-sentence.

Herman, M. (2020, August 5). Virginia to launch unmanned aerial systems flight information exchange. *Center for Innovative Technology.* doav.virginia.gov/calendar-and-news/news/2020-june/virginia-to-launch-unmanned-aerial-systems-flight-information-exchange.

Hitlin, P. (2017, December 19). One in ten Americans would be angry or scared if they saw a drone. *Pew Research Center.* www.pewresearch.org/fact-tank/2017/12/19/8-of-americans-say-they-own-a-drone-while-more-than-half-have-seen-one-in-operation.

Holligan, A. (2016, September 12). Dutch police fight drones with eagles. *BBC News*. www.bbc.com/news/world-europe-37342695.

Institute for National Security and Counterterrorism (INSCT). (2015, May). *Local Regulation - Domesticating the Drone.* Syracuse University. https://uavs.insct.org/local-regulation.

Irvine, California, Municipal Code § 3.4.113 (1974). https://library.municode.com/ca/irvine/codes/code_of_ordinances?nodeId=TIT3COSE_DIV4PA_CH1INGE_S3-4-113AIRO

Ison, A.G., Loffi, J.L., Vance, S.M., & Wallace, R.J. (2018). Who Owns the Sky? *Journal of Unmanned Aerial Systems*, 4(1). www.uasjournal.org/volume-four/article/who-owns-sky.

Jarvis, M. (2019, February 25). Drone Lookout Helps Catch Murder Suspect. *Embry-Riddle Aeronautical University*. https://news.erau.edu/headlines/drone-lookout-helps-capture-murder-suspect.

Jessup, M. (2015, August 24). 2 arrested in plot to fly contraband into prison with drone. *WUSA-TV*. www.usatoday.com/story/news/nation/2015/08/24/2-arrested-plot-fly-contraband-into-prison-drone/32306943.

Li, R. (2019). Drones fly illegally and crash at the Golden Gate Bridge. *San Francisco Chronicle*. www.sfchronicle.com/business/article/Drones-fly-illegally-and-crash-at-the-Golden-Gate-15076473.php.

Lidynia, C., Philipsen, R., & Ziefle, M. (2017). Droning on About Drones—Acceptance of and Perceived Barriers to Drones in Civil Usage Contexts. In: P. Savage-Knepshield & J. Chen (Eds.), *Advances in Human Factors in Robots and Unmanned Systems.* Springer. https://doi.org/10.1007/978-3-319-41959-6_26.

Los Angeles, California, Municipal Code § 56.31 (2015). https://codelibrary.amlegal.com/codes/los_angeles/latest/lamc/0-0-0-289397.

Martinez, K. (2020). *The History of Drones*. Dronenthusiast. www.dronethusiast.com/history-of-drones.

Matternet. (2015, December 14). More than one third of Americans say they'd like to have a drone. *PR Newswire*. www.prnewswire.com/news-releases/more-than-one-third-of-americans-say-theyd-like-to-have-a-drone-300192356.html.

McFarland, M. (2019, October 1). UPS broke into drone deliveries shuttling medical samples. Now it's ready to take off. *CNN*. www.cnn.com/2019/10/01/tech/ups-drones-faa/index.html.

McNeal, G. (2014, November). *Drones and aerial surveillance: considerations for the legislatures.* Brookings Research. www.brookings.edu/wp-content/uploads/2016/07/Drones_Aerial_Surveillance_McNeal_FINAL.pdf.

Michel, H. (2017a, March). Local and State Drone Laws. *Center for the Study of the Drone at Bard College*. https://dronecenter.bard.edu/projects/other-projects/drones-at-home.

Michel, H. (2017b, March). Public safety and drones. *Center for the Study of the Drone at Bard College*. https://dronecenter.bard.edu/projects/public-safety-drones-project.

Michel, H. (2017c, March). Drone incidents. *Center for the Study of the Drone at Bard College*. https://dronecenter.bard.edu/drone-incidents.

National Conference of State Legislatures. (2016, June). *Taking off: State Unmanned Aircraft Systems (Drones) Policies*. www.ncsl.org/research/transportation/taking-off-state-unmanned-aircraft-systems-policies.aspx.

National Conference of State Legislatures. (2020, January). *Current Unmanned Aircraft State Law Landscape.* www.ncsl.org/research/transportation/current-unmanned-aircraft-state-law-landscape.aspx.

National Interagency Fire Center. (2019). *Drones and Wildfires*. www.nifc.gov/drones.

National League of Cities (NLC). (2016). *Cities and Drones*. www.nlc.org/wp-content/uploads/2016/12/NLC-Drone-Report.pdf.

O'Leary, J. (2014, October 27). Iowa city farmer uses drone to aid farming precision. *Des Moines Register*. www.desmoinesregister.com/story/money/agriculture/2014/10/27/iowa-city-farmer-uses-drone-aide-farming-precision/18031077.

Ondrovic, L. (2016, December 12). Saint Leo polls finds opinions split on drones. Saint Leo Polling Institute. https://polls.saintleo.edu/saint-leo-poll-finds-as-the-public-learns-more-about-drones-opinions-split-on-the-best-civilian-uses.

Ontario, California, Municipal Code § 10.1.21 (1981). https://codelibrary.amlegal.com/codes/ontarioca/latest/ontario_ca/0-0-0-54369.

Operation and Certification of Small Unmanned Aircraft Systems, 14 CFR Parts 21, 43, 61, 91, 101, 107, 119, 133, and 183 (2016). http://www.govinfo.gov/content/pkg/FR-2016-06-28/pdf/2016-15079.pdf.

Oxnard, California, Municipal Code § 7.301 (2020). https://codelibrary.amlegal.com/codes/oxnard/latest/oxnard_ca/0-0-0-52368.

Paine, G. (2019, May 3). Drones to deliver incessant buzzing noise, and packages. *The Conversation.* https://theconversation.com/drones-to-deliver-incessant-buzzing-noise-and-packages-116257.

Rancho Cucamonga, California, Municipal Code § 12.04.010 (2019). http://qcode.us/codes/ranchocucamonga/.

Research and Markets. (2021). *Target Drones - Global Market Trajectory & Analytics*. www.researchandmarkets.com/reports/4806291/target-drones-global-market-trajectory-and.

Rice, S. (2019, February 4). Eyes in the sky: the public has privacy concerns about drones. *Forbes*. www.forbes.com/sites/stephenrice1/2019/02/04/eyes-in-the-sky-the-public-has-privacy-concerns-about-drones/?sh=44199e806984.

Riverside, California, Municipal Code § 9.08.065 (2017). https://library.municode.com/ca/riverside/codes/code_of_ordinances?nodeId=PTIICOOR_TIT9PESAMO_CH9.08USPUPA_9.08.090GARE.

Russo, J. (2020, July 14). Matternet's M2 drone system enabling new US hospital delivery network at Wake Forest Baptist Health. *PR Newswire*. www.prnewswire.com/news-releases/matternets-m2-drone-system-enabling-new-us-hospital-delivery-network-at-wake-forest-baptist-health-301093121.html.

San Diego, California, Municipal Code § 5.52.5401 (2017). https://docs.sandiego.gov/municode/MuniCodeChapter05/Ch05Art02Division54.pdf.

San Francisco, California, Municipal Code § 6.1626 (2019). https://codelibrary.amlegal.com/codes/san_francisco/latest/sf_police/0-0-0-50458.

Santa Clarita, California, Municipal Code § 14.06.210 (2018). https://www.codepublishing.com/CA/SantaClarita/#!/SantaClarita14/SantaClarita1406.html#14.06.210

Schneier, B. (2015, September 9). It is ok to short down a drone over your backyard? *CNN*. www.cnn.com/2015/09/09/opinions/schneier-shoot-down-drones/index.html.

Stansbury, R., Vyas, M. & Wilson, T. (2009). A Survey of UAS Technologies for Command, Control, and Communication (C3). Journal of Intelligent and Robotic Systems. 54. 61–78. 10.1007/s10846-008-9261-2.

Stockton, California, Municipal Code § 12.56.010 (2007). https://qcode.us/codes/stockton/?view=desktop&topic=12-12_56

Sylvia, R.D., & Sylvia, K. M. (2012). Program planning and evaluation for the public manager (4th ed.). Long Grove, IL: Waveland Press.

Tellman, J. (2018, October 1). First ever recorded drone hot air balloon collision prompts safety conversation. *Teton Valley News*. www.idahostatejournal.com/news/local/first-ever-recorded-drone-hot-air-balloon-collision-prompts-safety-conversation/article_7f68ca57-1f63-588b-8a30-caafe5483be8.html.

UAS Vision. (2015, September 30). Firefighting drones and MIT and Olin College. *UAS Vision*. www.uasvision.com/2015/09/30/firefighting-drones-at-mit-and-olin-college.

United States Census Bureau. (2020, May 21). *sub_esq 2019_6.* [Data set]. www2.census.gov/programs-surveys/popest/datasets/2010-2019/cities/totals.

United States v. Causby et ux., 328 U.S. 256 (1946). www.loc.gov/item/usrep328256.

Unmanned Aircraft Systems Act of 2016, MCL 259.301 *et seq.* (2016). http://legislature.mi.gov/doc.aspx?mcl-Act-436-of-2016.

Van der Schlat, P. (2018, July 18). Firefighting drones aim to fly higher, help save lives. *Robotics Business Review.* www.roboticsbusinessreview.com/unmanned/firefighting-drones-aim-to-fly-higher-save-lives.

Zwickle, A., Farber, H.B., & Hamm, J.A. (2019). Comparing public concern and support for drone regulation to the current legal framework. *Behavioral Sciences & the Law*, *37*(1), 109–124. https://doi.org/10.1002/bsl.2357saint.