Technical Appendix E
User-Level Analysis
APPENDIX E: THE USER PERSPECTIVE: THE VALUE CREATED BY AVIATION

Introduction

The Aviation Economic Impact Study is focused primarily on understanding how aviation affects Washington’s economy. To do that, three types of analysis are conducted to understand the different contributions aviation provides:

- **Airport-level Analysis.** In the airport-level analysis, the jobs, wages, and spending associated with each public use airport in the state are estimated.
- **Industry-level Analysis.** In the Study’s industry-level analysis, the broader relationship between the state’s airport system and business is examined.
- **User-Level Analysis.** The analysis which follows seeks to answer a different question: **What value do users derive from the state’s aviation system?** This user-level analysis, the third perspective of this study, is typically not included in state aviation economic impact studies, but the policy implications are significant.

Aviation supports a number of services and activities. Some of these—such as commercial service or cargo activities—have been touched upon elsewhere in this study, but some services—such as medical air transport and search and rescue—demand more attention because they generate significant value to their users.

Economic value is not measured in terms of jobs, wages, or spending (that is economic impacts), but rather, it is the intrinsic worth derived by each individual user of the system. This means it is incredibly difficult to measure user-level economic value because it requires knowing how much each user (out of millions of users) values the aviation service he or she uses. There are ways, however, to get an overall sense of the magnitude of economic value created, which is what this section seeks to do, using basic economic theory, existing data, and real world examples.

**Section Overview.** This section looks at aviation from a user-level perspective. It begins by introducing the concept of economic value and describes how value is created by the state’s aviation system and the related services it supports. Next, it presents the approach for assessing value and poses key analytic questions. Lastly, the approach is applied to 17 aviation-related services to demonstrate the immense value created by the aviation system for individual users.

How Aviation Users Derive Value and How to Estimate that Value

**Aviation Enables a Range of Key Activities**

The aviation industry and Washington State’s system of public use airports support a diverse range of activities and facilitate millions of transactions each year, including:

- Business travel through millions of commercial service and general aviation (GA) flights.
- Personal travel through millions of commercial service and GA flights.
- Movement of more than one million tons of cargo.
- Thousands of medical air transport flights and search and rescue operations.
This appendix highlights 17 different services supported by the state’s aviation system ranging from scientific research to skydiving. The breadth of services makes clear that the state’s aviation system makes possible a long list of things that would be virtually impossible in its absence. For these services, it becomes clear that the advantages of aviation in terms of time and access over other modes of transportation are extremely valuable to users.

**Estimating the Value Users Derive from Aviation-related Services**

Users derive value from aviation-supported activities. Exactly how much value is impossible to say, but it is possible to estimate the magnitude of value.

The concepts of value and cost are important to understanding how value can be estimated. The exhibit below illustrates how these concepts relate to one another. This simplified chart shows a demand curve for some product or outcome, the actual price paid (it assumes that all buyers pay a single market price), and the quantity purchased.

**Exhibit 1**

**Demand Curve and Consumer Surplus**

[Diagram of demand curve with areas labeled]

Source: BERK, 2011.

Within this chart, the “value” of the product is described by the Customer Demand Curve. This demand curve maps how much the product is worth to a series of customers (i.e. how much they would be willing to pay to acquire the good), it maps out how much they did pay (Area B), and it shows the difference between the two (Area A). In economic terms, Area A is described as the consumer surplus—the difference between the total value of the good to the purchasers and the cost they paid.

In economic terms, if one wants to know the value that is created by something, one would like to know two things:

- **How big is Area B?** – How many transactions occur? And at what cost?
- **How big is Area A?** – What is the value of the service? (i.e. how much would customers ultimately be willing to pay?)
In theory, at least, it is possible to observe transactions and calculate Area B. One simply needs to know how many transactions occurred and what price was paid for each transaction. Unfortunately, Area A is much harder to know. As was noted above, knowing the worth of a given set of services would require knowing what millions of users would ultimately be willing to pay for each transaction (a level of knowledge that no single person can possess).

**Example: Passengers on a Commercial Passenger Flight.** An example can better illustrate the abstract concepts described above. Take a commercial passenger flight: on the plane, each passenger has a different purpose for taking his or her trip.

**Exhibit 2**

**Example: How Passengers on a Plane Value Their Flight**

As shown above in Exhibit 2, the value created by that one flight for each user varies based on his or her trip purpose. For the businessman, this flight is incredibly valuable, perhaps worth double the amount he paid for the ticket, whereas for the college student, the value created may only be a few dollars more than she actually paid.

**The Magnitude of User Value is Immense**

Applying these basic concepts of user-derived value, cost, and the demand curve to other aviation-supported services, some key insights emerge:

- **For many aviation-related services, the value created for the user through a given transaction is small.** Perhaps you would have been willing to pay $10 to ship a package by air but you actually paid $8. In this case, the value created for the user is just $2.

- **For other transactions, however, the value created by aviation services can be extraordinarily high.** For example, when a top executive from Boeing, Microsoft, Amazon, or Starbucks needs to get to China overnight to ensure a billion-dollar deal gets done, the company in question would be willing to pay almost anything to make that trip happen. When an emergency medical flight allows a severely-burned child to get access to life-saving care, the value created by that flight, too, is
extraordinarily high. The same can be said of search-and-rescue operations, or of fighting wildfires through air operations.

In addition, in some cases an individual derives value just by having the option of using an aviation-supported service. For example, medical air transport services offer access to the state's top acute-care hospitals for virtually all communities across the state. Even though most people will never need to use the service, those who live in communities with no acute-care hospital can carry with them a sense of well-being from knowing that access to such services is available.

Adding together the value created for each user of Washington’s aviation system from all aviation-related services results in an immense number, totaling in the range of tens of billions of dollars per year. While it is impressive to note that the aviation system creates tens of billions of dollars of value each year, such a statement is abstract and may conceal the true impact of that value.

Perhaps more importantly, this user-level perspective captures the additional impact of what is missing in the job totals from the airport-level and industry-level perspectives. Airports, in addition to supporting wages and businesses, enable life-saving, resource-saving, and entertaining services. When considering the total benefit that an airport brings to a community, this user-level economic value is an essential piece of the dialogue.
Detailed Assessment: The User Value Created for 17 Aviation-supported Services

To understand how users benefit from aviation, this section examines the following 17 aviation-related services:

- **Moving people and goods.** Commercial passenger service; business and corporate travel; personal transportation; pilot training and certification; air cargo; and blood, tissue, and organ transportation.

- **Protecting people and resources.** Medical air transport, search and rescue, firefighting, national security, and emergency preparedness and response.

- **Supporting research.** Scientific research and aerial photography.

- **Supporting industry.** Aircraft manufacturing and agriculture.

- **Flying for recreation.** Aerial sightseeing and skydiving.

While not comprehensive, these services encompass a range of aviation activities and users. These services occur in a number of airports throughout the state. In fact, one airport likely will offer several of the services described. For each service description, the following three questions are asked and answered:

- In Washington, what is the scale of the activity or service?
- How much does the service cost the user?
- Beyond what is paid by users, what can be said about the total value created for the user?

What follows are stand-alone service descriptions that aim to describe and, where possible, quantify how users benefit from these services.
Moving People and Goods

Commercial Passenger Service

Commercial passenger service includes all scheduled passenger flights conducted by commercial airlines. Flying to visit family, go on vacation, or to attend a business conference are just some of the many reasons people use commercial passenger service. Of the 156.8 million scheduled commercial passenger person-trips by airplane taken in 2006 nationwide, approximately 60% were for leisure purposes and 40% were business travel.1

Commercial Passenger Service in Washington

At a Glance

- 16 Washington airports have scheduled commercial passenger service exceeding 2,500 enplanements annually.
- SeaTac and Spokane International Airports account for 95% of the state’s commercial passenger traffic.

In Washington, 16 airports are designated as Commercial Service airports that offer scheduled passenger service on commercial airlines and have in excess of 2,500 enplanements annually. In addition to these 16 airports, other non-Commercial Service classified airports may have charter commercial services, which are not shown on the map.

The most recent terminal area forecasts estimate 16.6 million annual scheduled commercial passenger enplanements in the state.2 Commercial passenger service is highly concentrated. Seattle-Tacoma (Sea-Tac) and Spokane International airports account for 95% of total statewide enplanements and 89% of large commercial carrier take-offs and landings.3

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1 Air Transport Association, http://www.airlines.org/Economics/DataAnalysis/Pages_Admin/DataAnalysis.aspx
2 FAA Terminal Area Forecasts for Washington in FY2010 equal 16,596,100 enplanements. Enplanements are counts of boarding passengers.
3 FAA Terminal Area Forecasts for Washington in FY2010; itinerant carrier operations.
Commercial passenger service is forecasted to grow at several airports across the state, including: Sea-Tac, Spokane, Tri-Cities/Pasco, and Bellingham. These airports have stable markets and are serviced by multiple carriers.

**How Does the User Benefit from Commercial Passenger Activity?**

**Commercial passenger service creates value for individuals by providing access.** Commercial passenger service offers access to places, markets, and resources around the state, country, and world. The reasons why a person takes a commercial flight vary greatly; so too does the value that each flight creates for a passenger.

The state’s 16.6 million enplanements roughly equal 33.2 million passengers flying into and out of the state’s public use airports. Recognizing the variety of trip purposes, it is safe to say that some of these represent extremely high-value trips to the user, while others do not.

**Millions of commercial passengers every year derive benefit from commercial travel.** It is not possible to know exactly how much value each passenger places on a trip, but to offer a sense of the potential magnitude of value creation it is possible to estimate how much passengers actually paid for their air travel. Using an average domestic airline itinerary fare of $340, the approximately 33.2 million commercial airline passengers flying in and out of Washington paid approximately $11.3 billion in commercial air travel in 2010.

**Summary**

- In 2010, there were about 33.2 million commercial service passengers arriving and taking off in Washington airports.
- Estimating an average fare of $340, passengers paid around $11.3 billion for air travel in 2010, a rough estimate of area B on the graph.
- For commercial travel, the demand curve would be expected to extend far higher than the generic graph to the right, showing that a handful of flights can create tremendous value for the passenger.
- The sheer volume of flights adds up to billions in value to the individual user.

The total user value (A+B) derived from commercial passenger travel is at least $11.3 billion. To estimate the value created in addition to what each passenger actually paid, one would have to know how each passenger valued his or her trip. Examples below show a range of trips and value they create.

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Some trips may create relatively little value for the passenger. For example, a person may decide to take a $99 weekend getaway flight, but had the price been more, he or she would have stayed in town.

Some trips may create a significant amount of value. For example, a daughter might place an extraordinarily high value on a trip to visit her ailing parent.

The vast majority of trips fall somewhere in between these two extremes. For example, air travel to go on vacation or to a high school reunion for which the traveler would have been willing to spend as much as $500 for a ticket, but he managed to book a flight for $250. In this example, the traveler valued the trip at $500, paid $250, and therefore kept $250 in excess value (also known as consumer surplus).

Even if the majority of trips are not large individual creators of value, the sheer volume of passengers on commercial flights creates a tremendous amount of value in aggregate. In addition, a small number of those trips, such as the daughter visiting her sick parents or a grandmother seeing her new grandson, are incredibly valuable to the passenger. Taking into account the volume of trips and the handful of high value trips, the total value that individuals derive from commercial passenger service quickly adds up to billions of dollars.
General Aviation: Business and Corporate Travel

Business/corporate travel is an important part of general aviation (GA)—a category of aviation that includes all civilian flights that are not scheduled flights offered by commercial airlines. Business and corporate travel in this category includes a range of travel, such as:

- The CEO of a Fortune 500 company flying in a company jet.
- The small business owner flying a single- or multi-engine aircraft.
- Clients using general aviation to get to and from businesses.

This range of business and corporate travel includes individuals using aircraft for transportation to conduct their business on behalf of themselves or their company, as well as corporate flights that utilize professional pilots to operate company-owned planes. What is not included in the following description are: business trips taken on commercial airlines, businesses who are in the business of aviation (chartered view tours, for example), and general aviation travel for personal reasons.

GA Activity in Washington

At a Glance

- All public use airports have GA operations.
- GA operations span across all airport classifications.

General Aviation Airports: Scaled by Operation Levels


Total GA activity spans across the state and accounts for the majority of the state’s total aircraft operations, representing a broad cross section of aircraft types and uses. All of the state’s 135 airports\(^5\) have GA operations, compared to the 16 airports in the state that are designated as commercial service airports. There were an estimated 2.9 million total GA operations\(^6\) (take-offs and landings) in 2010,

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\(^5\)There are currently 135 open public-use airports in Washington. WSDOT Aviation’s 2009 Aviation System Plan identified 138 such airports—three have since become private.

\(^6\) Includes itinerant and local operations.
which includes both operations that stay within a 20-mile radius of the airport (local operations) and those that leave the radius or land at another airport (itinerant operations). A concentration of GA activity is seen in the Puget Sound Region.

Washington GA operations are forecasted to grow to 4.4 million in 2030. The regions projected to exhibit the fastest growth in GA operations are Thurston and Whatcom Counties and Southwest Washington. The largest concentration of GA operations in the state is projected to remain in the Puget Sound Region.

**Business and Corporate GA Travel.** Business and corporate travel account for a portion of total GA aircraft and activity. Nationally, the FAA tracks the number of GA airplanes and total hours flown by primary use. In 2009, business and corporate travel was the primary use reported for about 15% of GA airplanes and accounted for about 20% of total hours flown. Applied to the 8,408 GA airplanes based at Washington’s public use airports, 1,350 airplanes is a rough estimate of the GA airplanes used primarily for corporate and business travel. This estimate of primary use gives a minimum number of aircraft that are used for business and corporate travel – it is likely many more aircraft that are reported to have a different primary use are also used for business or corporate GA travel for at least a fraction of the time.

**How Does the User Benefit from General Aviation for Businesses and Corporations?**

**GA creates value to businesses by providing access to markets.** All air travel—commercial and non-commercial—provides access to regional, national, and worldwide spheres that cannot be duplicated by other modes of travel. Some businesses simply could not operate without the access to markets, partners, facilities, and resources that air travel provides. For other businesses, air travel offers a competitive advantage that bolsters efficiency and profitability. An employee’s time is valuable to both the employee and the company. Air travel allows companies to schedule trips efficiently by flying on-demand and nonstop flights that increase an employee’s ability to conduct more business in a short timeframe than other modes of transportation.

**GA provides flexible access and is important to smaller, more rural communities.** General aviation provides access to destinations in a more flexible way than scheduled commercial service can for the corporate and business traveler. For small and rural communities, in particular, general aviation may be the fastest or only transportation option that connects the area to regional and global commerce. The access that a local airport and general aviation travel offers can affect a business’s willingness or ability to site a facility or an entrepreneur’s decision to establish and operate a business in a smaller community.

**The actual investment made for GA business travel and the willingness-to-pay for an important business trip add up to a lot of value to the user.** Investment in a business airplane, corporate jet, or

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7 Sources: FAA Terminal Area Forecasts, GA operations for NPIAS airports in FY2010 and WSDOT Aviation Information Database, GA operations, 2010.


airplane-sharing plan is significant and can range substantially depending on the aircraft type and frequency of use. For example, purchasing an airplane alone can cost between $10,000 for a used two-seater Cessna 152, $300,000 for a new four-seater Cessna 172, and $2.8 million for a TBM 850. In addition, there are significant ongoing costs, including operating costs, insurance, inspections, and eventual overhauls.

In addition to the amount businesses pay for general aviation travel, the extra value a user derives from a single flight depends on the flight.

- In some cases, GA air travel is simply more convenient. For example, a businessman may choose to fly instead of drive to a client location or office because it gets him home a bit earlier.

- In many instances, GA air travel makes businesses more competitive because it allows them to more effectively leverage scarce resources. For most businesses, an executive’s time or a group of employees’ time is immensely valuable. These businesses’ ability to compete hinges on their ability to make the fullest possible use of their employees’ limited time. Using GA travel allows for efficient scheduling of employee time and can improve productivity of employees en-route.

- In a handful of cases, a single flight generates a tremendous amount of value to the individual or business. For example, a last-minute flight of a corporate executive may be needed to seal a multi-million dollar deal. In the short term, that corporation would be willing to pay a large amount of money—some amount less than the value of the deal itself—to ensure their decision-maker gets to the right place and in front of the right person.

The aviation system supports business of all sizes across the state by offering on-call access to partners, suppliers, and clients, and in some circumstances can generate a tremendous amount of value for the user when time is of the essence.
General Aviation: Personal Transportation

This section focuses on the personal aspect of general aviation – individuals, families, or groups that fly non-commercial planes for their personal transportation needs. The state’s public use airports make personal transportation by general aviation possible, supporting a contingent of 26,627 active and certified pilots\(^\text{10}\) and those that ride with them. GA enables individuals, their families, friends, and groups to travel around the state, region, and potentially beyond. Flying for pilot training, business or corporate travel, or other business-related aviation activity is covered in other sections.

**GA Activity in Washington**

**At a Glance**

- All public use airports have GA operations.
- GA operations span across all airport classifications.

![General Aviation Airports: Scaled by Operation Levels](image)


Total GA activity spans across the state and accounts for the majority of the state’s total aircraft operations. There were an estimated total 2.9 million GA operations\(^\text{11}\) (take-offs and landings) in 2010, which includes both operations that stay within a 20-mile radius of the airport (local operations) and those that leave the radius or land at another airport (itinerant operations).\(^\text{12}\)

All of the state’s 135 public-use airports have GA operations, compared to the 16 airports in the state that are classified as Commercial Service airports. GA operations occur at all six classifications of airports. The map shows a concentration of GA operations in the Puget Sound Region.

**Personal GA Transportation.** Personal transportation uses account for a significant part of total GA aircraft and activity. Nationally, the FAA tracks the number of GA airplanes and total hours flown by primary use. In 2009, personal transportation was the primary use of about 68% of GA aircrafts and

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\(^{10}\) FAA, Airmen Certification System Active Pilots Summary, 2011.

\(^{11}\) Includes itinerant and local operations.

\(^{12}\) Sources: FAA Terminal Area Forecasts, GA operations for NPIAS airports in FY2010 and WSDOT Aviation Information Database, GA operations, 2010.
accounted for 36% of total hours flown. Applied to the 8,408 GA airplanes based at Washington’s public use airports, it is estimated that about 5,700 airplanes are primarily used for personal transportation.

How Do People Using GA for Personal Transportation Benefit?

GA is a key transportation option for individuals with time-sensitive transportation needs or traveling to and from communities with poor access via other modes of transportation. For individuals who must regularly travel to destinations more than a few hours away by ground, traveling instead by air can save valuable time. An air traveler’s reasons for travel are often not different than a driver’s – visiting relatives, seeing a medical specialist located far away, or traveling to an interesting vacation spot. The difference is in the time needed to make each trip—flying instead of driving can be the difference between spending a whole day traveling on each end versus being able to complete the entire trip purpose in a day.

For residents in some locations, GA travel may be the best, most efficient, or sometimes only option. While there are only 21 public use airports that offer commercial service in the state, all airports have GA operations. The access and mobility that GA transportation provides can affect an individual or family’s decision to locate to a smaller or more remote community in the state.

GA gives individuals the freedom to travel and access to other places. For a pilot, GA is a mode of personal transportation, which offers the freedom to travel more quickly than ground transportation and more flexibly than commercial passenger service. For some individuals, the freedom and comfort of flying oneself is a benefit in-and-of-itself.

Exploring the cost of airplane ownership to understand how much a user values personal transportation by airplane. One way to understand the magnitude of the value created for a user of personal GA travel is to take the perspective of one GA pilot and aircraft owner. A first step in estimating the user benefit derived from personal GA is outlining the costs of GA aircraft ownership.

As an illustrative example of the costs involved, consider a Cessna 152—a two-seater airplane often used for personal use. In 2010, the average cost of a used Cessna 152 in good condition was $22,500. Additional ownership costs include operating costs such as fuel and oil, insurance, storage, inspections, and engine overhauls. Together, the ownership costs for a typical pilot who flies about 100 hours per year range from $50 (with no loan payments) to $90 per hour (for an airplane with a $25,000 loan). Using the conservative $50 per hour, the costs of one person purchasing and owning a Cessna 152 for the first year of ownership is an estimated $27,500.

The value the user derives from using GA for personal transportation beyond the cost. The cost estimate is used to provide some order-of-magnitude sense of what an individual may, on average, pay

Summary
- GA is valuable as a mode of personal transportation, offering time savings, flexibility, convenience, and comfort.
- The cost of GA travel, and in particular GA airplane ownership, is significant.
- Beyond the cost, individuals derive additional benefit from using GA for personal transportation. The amount of benefit can vary by individual and by flight.

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for owning and using a GA airplane for personal transportation needs. In addition to what he or she actually pays, is the added value derived from the personal travel and in some cases, from airplane ownership.

Like other travel examples described in this section, the value a user gets from a flight can vary by person and by purpose.

- Examples of personal transportation could include flying to a vacation location, to visit family or friends elsewhere in the state, or to go to a doctor’s appointment.

- In a handful of cases, the value derived could be extremely high. For example, grandparents east of the mountains could fly to Seattle to see the birth of their grandchild.

These different types of value cannot be easily quantified and summed together to estimate a true picture of how public use airports benefit individuals through general aviation for personal transportation. However, by observing the numbers of airplanes used for this purpose in the state and the actual cost associated with each plane, and by recognizing the additional value that each user receives above and beyond what they actually pay, it becomes obvious that GA for personal travel generates significant value for those who use it.
Pilot Training and Certification

Public use airports support pilot training activities of individual pilots and the flight schools at which they train. A total of 26,627 pilots are active and certified in Washington and about 13% are certified as student pilots.\(^{15}\) There are six different categories of pilot certification—student, sport, recreational, private, commercial, and air transport—which correspond to different flying privileges, related to type of aircraft and other flying conditions. Flight training is a critical component of earning all levels of pilot certification, and a minimum amount of flight hours per year are required to maintain certification.

Flight training is one piece of a larger system of aviation education in the state—which includes the aviation high school, programs and degrees in higher education institutions, and specialized aviation training schools.

*Pilot Training in Washington*

**At a Glance**

- 47 public use airports have flight training activities.
- Flight training primarily occurs at commercial, community, and regional airports
  - There are also a few local airports and one rural essential airport.

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<th>Airports with Flight Training Activities</th>
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<td>Bellingham Intl</td>
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Flight training activity occurs at 47 public use airports across the state. Flight training, in some cases, is associated with a designated flight school. According to the WSDOT Aviation clearinghouse, there are 58 flight schools around the state,\(^{16}\) 22 of which are also recognized and certified by the FAA.\(^{17}\) The majority of these schools (38) are located in Western Washington. These schools include private, for-profit entities and public higher education institutions, such as Central Washington University and Big Bend Community College, among others.

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15 FAA, Airmen Certification System Active Pilots Summary, 2011.  
16 WSDOT Aviation, Aviation Information Clearinghouse, 2011.  
17 FAA Pilot School Locator, 2011.  

Sources:

- "Flight Training and Certification" in *Aviation Economic Impact Study: The User Perspective* | Technical Appendix E

March 2012
How Do Users Benefit from Pilot Training?

Flight training is a critical component in developing a skilled pilot workforce. All pilots—student, private, recreational, sport, commercial, and air transport—require flight training to earn and maintain their pilot certification. Flight training is, therefore, an essential part of cultivating a professional pilot workforce that can safely and skillfully fly different kinds of civil aviation flights—such as cargo, passenger service, search and rescue, and others.

Learning to fly creates value for pilots in the forms of enjoyment, skill mastery, and freedom to pilots-in-training. In addition to a necessary skill and practice, flying can also bring personal enjoyment to pilots. The activity itself can be fun and rewarding, but can also be practical. Flying opens up a new mode of personal transportation and a freedom to travel. Like other recreational activities, users derive value from learning and mastering the skills needed to fly.

Pilot certification activities generate user value in the millions of dollars. Quantifying what individuals pay for pilot training is a starting point for answering the question: “how much value is created?” Training for pilot certification requires a substantial amount of financial and time investment. The exhibit shows that the average total flight time ranges from 35 to 70 hours and the average costs of certification range from $4,400 to $9,000, depending on the pilot certification level.

<table>
<thead>
<tr>
<th>Average Total Flight Time</th>
<th>Average Costs of Certification</th>
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<tbody>
<tr>
<td><strong>Private Pilot</strong></td>
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<tr>
<td>70 hours</td>
<td>$9,900</td>
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<tr>
<td><strong>Recreational Pilot</strong></td>
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<tr>
<td>50 hours</td>
<td>$7,700</td>
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<tr>
<td><strong>Sport Pilot</strong></td>
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<tr>
<td>35 hours</td>
<td>$4,400</td>
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To get at an order-of-magnitude estimate, let’s assume that all current active certified student pilots in Washington are currently working toward one of the certifications above. With about 3,600 student pilots, the average total flight time logged by student pilots would be between 126,000 and 252,000 hours. An estimation of how much the state’s student pilots pay for certification would be somewhere between $15.8 million and $35.5 million. This range gives an order-of-magnitude estimate for B, which is only a fraction of total value created for pilots in training, as seen in the exhibit below.
Summary

- Learning to fly creates value for pilots in the form of enjoyment, skill mastery, and freedom for the individual.
- There are 3,592 active and certified student pilots in the state.
- It is estimated that Washington student pilots would pay millions of dollars, in the range of $15.8 and $35.5 million, for pilot certification.
  - This is before trying to quantify the additional benefits (area A) individuals derive from the activity.

What's not included in the monetary estimate above is the additional value created for the pilot, which takes the form of skill attainment, professional and career development, as well as enjoyment. Actually how much that is worth is impossible to quantify exactly. However, a hypothetical example can show how quickly the individual values add up. If one imagines that a student pilot receives an extra benefit of just $5 per flight hour that adds up to an estimated extra benefit between $600,000 and $1.2 million created for Washington student pilots.
Air Cargo

Air cargo consists of both air freight, which includes all non-mail items shipped in the belly of passenger planes and on planes dedicated to freight, and air mail. Air freight makes up approximately 90% of total air cargo volume in Washington, while air mail composes the rest. There is not any particular type of cargo that is shipped by air instead of by ground. Items range from small, personal packages to large pieces of manufacturing equipment. The main differentiator is time-sensitivity—packages that need to be shipped quickly are shipped by air.

**Air Cargo Activity in Washington**

**At a Glance:**

- 11 airports reported air cargo activity in 2010.
- Airport Classifications:
  - 9 Commercial Service
  - 2 Regional Service
- Sea-Tac, Boeing Field, and Spokane International Airports account for 98% of the state’s air cargo activity.

**Air Cargo Service**

Cargo Volumes CY 2009 (Metric Tons):

- Seattle-Tacoma = 728,794
- Boeing Field = 405,817
- Spokane = 198,417


Eleven airports reported air cargo activity to WSDOT in 2010 in the form of air cargo volume measurements. This is likely a low estimate of the total number of airports that had air cargo activity, since some airports don’t have the technology to measure volumes. Nearly any airport that offers commercial passenger service can receive air cargo shipments as well.

Approximately 98% of the state’s reported air cargo activity occurs at Sea-Tac, Boeing Field, and Spokane International airports because they have frequent, widebody service that provides significant airlift capacity. The majority of cargo is fed into these airports from surrounding regions by ground transportation or regional feeder airlines.
How Do Users of Air Cargo Benefit?

Air cargo creates value for users by improving the speed and reliability of shipments. Air cargo benefits both businesses and individuals by facilitating fast movement of products, supplies, equipment, and other mail and packages. The types of shipments and reasons for sending them vary greatly, but they all have one thing in common: time-sensitive packages rely on air cargo. Value for each shipment is created in different ways and on different scales. For example:

- A factory in Moses Lake that experiences equipment failure can minimize downtime and lost revenue by flying in replacement parts or equipment instead of shipping by ground. Having an airport nearby (defined as in-town or within 90 minutes) makes cargo more reliable and provides flexibility for emergency shipments.

- Some air cargo shipments generate lower value to the user, but may occur in significant volumes. For example, a grandma who wants to send her grandson a package a few days before his birthday may pay $25 for air cargo to ensure that the package arrives on time. However, since the package wasn’t urgent, she may have only been willing to pay up to $30 before deciding ground shipping would be a better choice.

High-volume, low-value shipments and low-volume, high-value shipments add up to billions of dollars in annual value to air cargo users. It is not feasible to estimate the total value that air cargo provides to customers in a given year, as that would require knowing the maximum amount that each air cargo customer would have been willing to pay for his or her shipment. However, using estimates of the amount of cargo shipped in Washington, and the price of sending packages, it is possible to estimate an order of magnitude for the value that consumers place on air cargo services.

In 2010, approximately 1.1 million tons of air cargo, including both freight and mail, landed at or departed from Washington public use airports. This cargo included personal packages, urgent mail, and large machinery and equipment. The following examples strive to illustrate what 1.1 million tons of cargo represents in terms of value to a user of air cargo services:

- The most prevalent but lowest value creating air cargo shipments are personal packages. To an individual using air cargo services for personal packages, 1.1 million tons of cargo translates to an enormous number of uses. Sending a birthday present to a friend via air mail likely weighs less than 5 pounds. Approximately 1.1 million tons of cargo equates to more than 445 million 5-pound packages each year.

  Shipping a 5-pound package via second day air costs approximately $15 - $30, depending on the distance. Shipping 445 million packages at a conservative $15 per package equates to about $6.7 billion paid to ship this amount of freight, if all of it were these low-cost packages.

Summary

- Both business and individuals benefit from fast shipments.
- Shipments vary in the value they provide to users, from high-cost manufacturing equipment that keeps a business up and running, to personal gifts.
- The number of shipments combined with the cost of each equates to at least $6.7 billion paid in shipping costs each year.

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18 Aviation Information System Database
Many shipments create significantly higher value to the user than personal packages, such as large manufacturing equipment needed by a factory to continue operations. Every hour that such equipment is delayed results in costs to the manufacturer in terms of lost revenue and unused labor.

A piece of manufacturing equipment can easily weigh as much as or more than a family sedan (3,000-4,000 pounds), and a manufacturer may be willing to pay upwards of $10,000 per shipment to ensure business is back up and running as soon as possible. These kinds of high-value shipments can quickly add up to a cumulative value much higher than in the previous example.

Using the conservative estimate of personal shipments, it’s estimated that Washington’s public use airports support an industry that individuals and businesses value at least $6.7 billion each year. It is likely that the true value that consumers get from air cargo service, if truth were told about the maximum amount they would have paid for those shipments, is much larger.
Blood, Tissue, and Organ Transportation

The transportation of donated blood, tissue, and organs by air is an essential piece of the state’s medical network. Although all of these industries serve to bring needed medical supplies to processing centers and eventually to patients, they each have a distinct purpose, set of needs, and method of operating:

- **Blood Donation.** Blood collected from a donor needs to arrive at the processing lab within five hours of collection. Chartered aircraft are used when the collection site is more than five hours from the lab by ground. The blood donation industry also uses commercial airlines to bring samples of processed blood into labs for testing, which is generally less urgent. Blood products are then sometimes shipped through an air freight service to customers in need of processed blood products.

- **Tissue Donation.** Donated tissue includes bone, skin, heart valves, and tendons, all of which must be harvested within 24 hours of the donor’s death. If the donor is out of the area of the regional tissue processing center, the donor tissue is transported to the center via chartered aircraft to be processed and frozen. Once tissue is scheduled for transplant, it is flown on commercial airlines or air freight carriers to the transplant site.

- **Organ Donation.** Organ recovery and transplant companies use air transportation to fly teams to the location of a donor to recover organs, to transport organs back to the processing centers, and to transport organs to eventual transplant recipients. Companies use both commercial flights and chartered flights, depending on the specific circumstances. Commercial flights are more cost-effective and are used if possible, but sometimes an aircraft must be chartered if commercial flight service is not available or the schedule doesn’t work.

*Blood, Tissue, and Organ Transportation Activity in Washington*

Most of the processing centers and main hubs for redistributing blood, tissue, and organs to patients are located near Washington’s urban centers, including Seattle, Spokane, and Tacoma. Flights occur to and from these locations when donated products are located too far away for ground transportation to reach them while they are still viable.

While the processing centers are centralized in urban areas, residents from throughout Washington benefit from the valuable materials managed and delivered by each. Donated blood, tissue, and organs serve patients throughout Washington.

*How Does Transporting Blood, Tissue, and Organs by Air Benefit Individuals?*

The blood, tissue, and organ donation networks are important pieces of medical infrastructure that keep Washingtonians alive and healthy. All three of these donation networks support doctors and hospitals in serving patients in Washington at the highest possible level. Having access to air transportation allows these networks to function quickly and efficiently and reduces waste of extremely valuable materials by enabling fast transportation and processing times.
The value derived from each flight ranges from donated blood at the low end to a heart being delivered to a patient at the high end. The amount of value being created by any given flight depends on the product being flown and the needs of the end patient:

- Donated blood is the most commonly used of the three items. While it is inherently important to transport blood in a timely manner to make sure it does not go to waste, no flight is transporting a specific blood unit to a specific patient. Most blood is kept in blood banks, and the cycle of blood transfusions and donations balances out the supply and demand.

The Puget Sound Blood Center (PSBC) is the largest blood center in Washington. In FY 2010, PSBC chartered approximately 325 flights to bring freshly donated blood into its processing center for processing and storage. The majority of these flights arrive at Boeing Field or SeaTac, but originates from all around the state.

- Donated tissue flights range from lower value flights that bring non-dedicated tissue into labs for processing, up to highly valued flights delivering donor parts such as heart valves to recipients who need that tissue to survive.

The Northwest Tissue Center provides tissue services for the State of Washington. Each year, the Center charters approximately 10 urgent flights sending recovery teams to a donor to retrieve tissue. The Center also charters about 200 flights per year bringing donors or donor tissue directly to the processing site. The Center’s recovery sites in Washington are in Renton and Spokane.

- Donated organs are on flights with extremely high value to the patient receiving the transplant. An organ being flown to a processing center or to a patient is time-sensitive. For organs such as heart, lungs, and livers, the transplant is likely contributing to saving a patient’s life.

Life Center Northwest, an organ recovery company that serves all of Washington, estimates they make about 20 flights per year bringing organs into their Seattle processing center from Eastern Washington. While these flights happen in smaller numbers than blood and tissue because of the rarity of organ needs and donations, each flight generates significant value to the recipient that quickly adds up.

Although the value of individual flights ranges greatly, the cumulative benefit of these three networks is huge. Donated blood, tissue, and organs save and improve lives across Washington State. Aviation supports these networks by providing transportation quick enough to harvest viable donations in adequate time and transporting processed products to transplant patients.
Protecting People and Resources

Medical Air Transport

Medical air transport is used to transport patients from rural areas to urban hospitals, often because the patient has experienced traumatic injury or a medical emergency, such as cardiac arrest, pregnancy complications, or respiratory distress. These patients require specialized care and need to be treated at a hospital ranked Level I or II on the acute care rating system, reflecting a hospital's concentration of specialists and advanced technologies. These high level trauma centers are usually concentrated in urban areas due to the high cost of new technology and economies of scale with a large patient base.

In the case of a serious medical event, time is of the essence. Both helicopters and airplanes are used to transport patients so they can reach an adequate hospital more quickly than by ambulance. Medical air transport is used in two ways:

- **On-scene responses.** Immediately after a traumatic injury or medical emergency, responders attempt to stabilize the patient and transport them by ground or air to the highest level trauma center within 30 minutes. On-scene responses are infrequent and usually accomplished by helicopter.

- **Inter-facility transfers.** Once the patient reaches the first hospital, medical staff evaluates him or her and determines if the patient should be transferred to a higher level trauma center. Inter-facility transfers are where medical air transport is used most often.

  Airplanes are generally faster and more reliable than helicopters for these types of flights, especially in inclement weather and when crossing high altitudes. On longer flights, airplanes are preferred due to their greater speed and lower cost. Helicopters are sometimes used for shorter trips.

Medical air transport is also sometimes used in the reverse—to transport specialists and their supplies to rural hospitals to provide specialized care on-site instead of moving a fragile patient.

**Medical Air Transport Activity in Washington**

There are seven Level I and Level II hospitals in Washington. The only Level I hospital is Harborview Medical Center in Seattle, and there are six Level II hospitals located in Vancouver, Bellingham, Spokane, Tacoma, Wenatchee, and Walla Walla. Most emergency medical air transport activity in the state occurs in transporting patients from rural areas to one of these urban hospitals.
MEDICAL AIR TRANSPORT

At a Glance:

- There are a total of 21 airports that reported this activity in 2010.
- Airport Classifications:
  - Commercial
  - Community
  - Rural Essential
  - Regional
  - Local
- Medical air transport flights bring patients from rural locations into urban trauma hospitals.

Airports Reporting Medical Transport and Air Ambulance Activity

How Does Medical Air Transport Benefit People and Communities?

Medical air transport creates value for users by saving lives and improving outcomes. Patients are transported via medical air transport for two very important reasons:

- They receive specialized care more quickly than if they were transported by ground.
- They receive more effective care than if they were treated at their local hospital.

Reducing the time it takes to receive effective care improves outcomes for patients by saving lives, reducing recovery times, and minimizing long-term disability. Without an airport, the technology and specialists at the few urban hospitals would not be available to rural residents. Because of these substantial, life-changing impacts, the value created for direct beneficiaries each year is substantial.

In addition to the value to medical air transport users, entire communities derive value from having medical evacuation capabilities nearby. Having this option available in a community can impact where families and business decide to live and locate.

Summary

- Patients receive specialized care quickly and more effectively when air transported to high level trauma centers.
- Reducing the time between injury and care improves outcomes and saves lives.
- More than 3,500 patients directly benefit from medical air transport in Washington each year.
- Each transport creates significant value.
- Families and businesses make location decisions based on having fast access to high level care available in a community.
Each medical air transport trip is highly valued by the user. Although the number of people airlifted each year is a small portion of Washington’s population, these cases are uniformly the most severe and many are a matter of life and death. Medical air transports are for injuries or events that have a time-critical element; the level of treatment during the first hour after a heart attack, head injury, or severe burn can save lives and prevent long-term disability.

In Washington, approximately 15,720 trauma injury events occur each year and 1,630 of these patients are carried by medical air transport, including 990 by helicopter and 640 by airplane. This is only a portion of the total patients that benefit from medical air transport, because it does not include those who suffer from other medical emergencies, such as cardiac arrest. Airlift NW, the state’s largest medical air transport provider, transported more than 3,500 total patients in 2010.

A 2007 study estimated that air transport of major trauma patients saves approximately 5.6 more lives per 100 patients than ground transport for similar trauma severity. To conservatively estimate the benefit of public use airports, this analysis applies that rate to the number of trauma patients above transported by airplane only, since helicopters may not have relied on the airport system. Using this estimate, medical air transport by airplane results in at least 36 lives saved per year in Washington. This estimate likely understates the total, as it does not include lives saved from medical emergencies beyond traumatic injury. Additionally, many other transported patients were not in danger of dying, but medical air transport prevented long-term disability and reduced the need for future medical care or long-term support.

It is difficult to assign a numerical value to how an individual values something as important and complex as life or health, but lives are generally valued at extremely high levels. For example, when governments consider investments to improve public safety, they do so with an understanding that, from the perspective of the community, a single life saved is worth something in the range of $3 million to $8 million dollars. The impacts of a life lost are felt by family members and by whole communities. Imagine a mother whose daughter is severely injured while hiking in the Cascades—how much is the flight that flew the girl to Harborview for life-saving treatment worth to her? And, how much is the availability of this service, which brings a sense of safety and well-being to all, worth to the residents and visitors of the community as a whole? Even residents who never use the service benefit from its availability.

Medical air transport flights are one of the biggest and most important sources of value creation at many rural airports. Although they may happen infrequently at the level of the individual airport, such a high level of value is created for the user of each flight that it quickly adds up to astronomical levels of user-level value statewide.

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22 Washington State Department of Health
23 Air versus ground transport of the major trauma patient: a natural experiment. McVey J, Petrie DA, Tallon JM. Department of Emergency Medicine, Dalhousie University, Nova Scotia, Canada.
Search and Rescue

Search and rescue uses aviation for two distinct purposes:

- **Searches for overdue or missing aircraft.** When an aircraft is reported missing or late, or if its emergency locator transmitter (ELT) is activated, aerial search and rescue teams are dispatched to locate and potentially assist the aircraft. Searches for missing aircraft are divided into two categories: small-scale and full-scale. Small-scale searches cover events where searchers have a good indication of the size and location of the search area. Full-scale searches are when an aircraft has been reporting missing, but there is little indication of a probable or last location.

- **Searches for missing persons.** Airplanes and helicopters are also dispatched when a person is reported missing, such as hikers lost in one of Washington’s many mountainous recreation areas.

**Search and Rescue Activity in Washington**

**Missing aircraft.** The WSDOT Aviation Division is the legislatively-designated agency with jurisdiction over aerial search and rescue operations. WSDOT Aviation carries out its responsibilities with a few dedicated staff and a large force of volunteers and partners, such as the Washington State Patrol, Washington Emergency Management Division, US Coast Guard, and US Air Force Rescue Coordination Center, Washington Air Search and Rescue, the Civil Air Patrol, and county sheriffs across the state.

Aviation’s search and rescue program is split into six Emergency Operations Districts, each of which has a designated control airport and supporting refueling airports. Search and rescue planes come from many different airports because of the widespread volunteer support.

**Missing persons.** Search and rescue operations for missing persons are coordinated by the local law enforcement agency with jurisdiction over the search area, usually with the county sheriff as coordinator.

**Maritime search and rescue.** The US Coast Guard is responsible for maritime search and rescue operations for both missing aircraft and missing persons. Their jurisdiction extends from the high-tide line seaward, although about 5% of their searches extend inland when they are requested by a state or local agency.
**At a Glance:**

- There are 6 Emergency Operations District control airports, and 20 airports designated as fuel centers.
- Airport classifications include Regional, Commercial, Community, and Local.
- A large portion of search and rescue activity is centered in the Cascade and Olympic mountain ranges, due to the rugged terrain.

**Search and Rescue: SARDA Control Airports and Fuel Centers**

**How Does Aerial Search and Rescue Benefit Individuals?**

Aerial search and rescue saves and improves lives by quickly covering large areas. Airplanes and helicopters are used in searches for missing planes and persons because flying is the quickest and most effective way to search large areas:

- Aerial searches provide a more expansive view than ground searches, allowing searchers to see more locations at once.
- Aircraft travel more quickly than ground vehicles, increasing the amount of area that can be covered in a given time.

These advantages of aerial search help find missing aircraft and persons more quickly than ground-based search alone. The sooner a missing person is found, the better the outcome due to reduced exposure to harsh conditions and more timely medical treatment.

Each search and rescue mission provides extremely high value to the missing person(s). Although search and rescue is not a high-volume activity, each person whose life is saved or improved by an aerial search and rescue effort values that event at an astronomically high level. When someone is missing or injured in the Washington wilderness, time is of the essence. Many of these events happen in the high altitude regions of the Cascade and Olympic mountain ranges, where the risk of freezing to death or contracting hypothermia is great if a person is not found quickly.

**Summary**

- Aerial search covers large areas quickly and efficiently to find missing persons and aircraft as fast as possible.
- Minimizing the time a person is lost saves lives and improves outcomes.
- At least 5 to 50 aerial search and rescue events occur in Washington each year.
- Each person found by search and rescue places an extremely high value on that service.
Each year, WSDOT Aviation participates in between 5 and 50 search and rescue efforts, for downed aircraft, missing aircraft, or by lending aerial assets to other search agencies. Additionally, local law enforcement agencies participate in more searches that the state is not involved in. It cannot be said that each of these searches results in a saved life, but for a high portion of the searches, a life is saved or improved through quick discovery.

It’s difficult to quantify the how an individual values a life or improved health, but people generally value their own lives and the lives of their family members at extremely high levels and would pay almost anything to prevent harm. If even only a small portion of the search and rescue efforts each year result in saved lives, the high value of each of those lives quickly adds up to considerable levels of value statewide.

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24 WSDOT Aviation Division Search and Rescue Study Team Report.
Firefighting

Wildfires are one of Washington's most damaging natural disasters each year, resulting in the destruction of more than 55,000 acres of land in 2010.\(^{25}\) Many of these fires occur in densely forested, difficult to access locations. The most efficient and effective way to fight these fires are with the help of aircraft. Aircraft contribute to firefighting in four ways:

- **Aerial Fire Detection.** This is when aircraft are flown to either look for fires after possible activity has been reported, or after events that are likely to cause fires such as lightning strikes in forested areas. Operators generally use airplanes, as they are more cost-efficient and faster than helicopters for surveying large areas, and are cheaper than maintaining and staffing lookout towers.

- **Aerial Suppression Coordination.** During firefighting activity, fixed wing aircraft are often used to direct firefighting aircraft as well as ground personnel using their expansive vantage point.

- **Aerial Personnel and Supply Delivery.** Many of the areas in Washington most at-risk for wildfires are on undeveloped land that is heavily forested and has complex terrain. Both helicopters and airplanes are used to deliver firefighting personnel to fires where ground access is limited to begin fire suppression as quickly as possible. This delivery is either “smoke jumpers” that parachute out of airplanes, or helicopters setting down near the fire to deliver firefighters, food, water, or equipment.

- **Aerial Firefighting.** Aircraft are used to directly fight fires by dropping water or retardant when the terrain is too steep or dangerous to put firefighters on, or when the flame activity is too intense for firefighters to get close enough to be effective. Both airplanes and helicopters are used for this purpose. Airplanes are generally used to drop retardant when they have access to a nearby base airport. Helicopters can be used to dip water out of nearby bodies of water and are used when high levels of precision are necessary or when there is not a usable runway near the site of the fire.

**Aerial Firefighting Activity in Washington**

Wildfires in Washington generally occur in large forested areas located on the Olympic Peninsula, in Eastern Washington, and around the Cascade Mountain range. Different agencies are responsible for fighting fires based on the geographic location of the fire, including the National Park Service, the US Bureau of Land Management, the US Forest Service, the Bureau of Indian Affairs, and the Washington State Department of Natural Resources. Most agencies contract with operators to charter aircraft as needed, although the US Forest Service, Bureau of Indian Affairs, and Department of Natural Resources operate their own aircraft.

The US Forest Service also operates fire bases at particular airports, which house fuel, supplies, and aircraft in locations near common fire areas for fast response.

Three of the airports below, Methow Valley, Sullivan Lake, and Stehekin State, were originally constructed by the US Forest Service for the specific purpose of supporting firefighting operations. These three airports, as well as 6 others regularly used for firefighting, are managed by WSDOT Aviation.

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\(^{25}\) National Interagency Fire Center
At a Glance:

- There are 20 airports that reported wildland firefighting activity in 2010.
- Airport Classifications:
  - Rural Essential
  - Regional
  - Commercial
  - Local
  - Community

Airports Reporting Wildland Firefighting Activity in 2010

How Does Aerial Firefighting Benefit the State, Communities, and Residents?

Aerial firefighting is one of many tools that protect people, personal property, and natural resources from wildfire. Wildfires damanged approximately 55,000 acres of land in Washington in 2010, including national forests and private homes. Wildfires are expensive to the state and its residents, with costs that include:

- Direct costs such as the cost of suppression, damage to private property and infrastructure, loss of timber, and aid to evacuated residents.
- Rehabilitation costs such as restoration activities for watershed, mitigating the increased chance of flood and landslide from loss of timber, and management of invasive species and erosion.
- Indirect costs such as lost tax revenues, loss in property values, payments to families of killed firefighters, and increased healthcare costs for injured firefighters and citizens.

Summary

- Wildfires damaged approximately 55,000 acres of land in Washington in 2010.
- The total cost of wildfire includes suppression costs, damage to personal property and natural resources, rehabilitation of land and ecosystems, and other indirect costs.
- Aerial firefighting is an important tool used to reduce the total impact of wildfires in Washington.

Aerial firefighting is one of many tools that local, state, and federal governments use to reduce the impact of wildfires in Washington. Although it may only contribute to a small percentage of total firefighting and fire prevention activity, it is a key piece of how wildfires are managed, and in some cases is the only way to extinguish a fire quickly.
National Security

Aviation and public use airports play a role in national security, especially in a border state with a large military presence like Washington. Although the majority of military activity happens at federally-owned airports that are outside the scope of this project, Washington’s public use airports help bolster national security in the following ways:

- **Airports support border security.** Airports directly and regularly help protect Washington’s international borders by supporting US Customs and Border Patrol in conducting aerial surveillance and searches for illegal border crossing activity.

- **Airports support military operation.** Airports are one of many supporting pieces of infrastructure that enable Washington to have a significant military presence. Although the military does operate their own airports in Washington, on occasion, having additional airports in other geographic locations is beneficial. Some airports serve as backup or dual-use airports for the National Guard, while others are used for training operations for the Navy and other branches of the military.

**National Security Activity in Washington**

Examples of airports being used in national security roles include Paine Field serving as a backup for loading aircraft carriers at the Everett naval base and Moses Lake Airport serving as a location for Special Forces training activities. Moses Lake is useful for many types of trainings due to its relatively unencumbered airspace and long runway length.

**How Do Citizens Benefit from Supporting National Security?**

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<tr>
<th>Public use airports actively enable valuable border patrol activities.</th>
<th>Summary</th>
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<tr>
<td>US Customs and Border Patrol is the United States’ first line of defense against illegal immigration, terrorism, human trafficking, and transport of illegal goods such as drugs and weapons. Airports are only one piece of infrastructure that supports this agency, but in certain instances they are instrumental in providing Border Patrol with key capabilities.</td>
<td><strong>•</strong> Airports support valuable border patrol activities preventing illegal border crossings and smuggling.</td>
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<tr>
<th>Public use airports support Washington’s military cluster, which is a significant economic center in the state.</th>
<th><strong>•</strong> Airports support Washington’s defense cluster, a multi-billionaire industry employing over 100,000 people.</th>
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<td>Beyond the obvious interest that all US residents have in ensuring effective national defense, Washington State sees significant economic impacts from defense facilities. Washington’s defense-related economic activity includes over 100,000 personnel and more than $7.9 billion in spending by military installations in Fiscal Year 2009, including approximately $5.2 billion in pay and compensation. These expenditures go to many different sectors of the economy, including building construction, engineering services, and physician services; and benefit counties including King, Pierce, Kitsap, Whatcom, Snohomish, Island, Yakima, and Spokane. All of this economic activity benefits the state and its residents by improving Washington’s economic vitality. The support that the defense industry receives from public use airports is integral to effective military operations. The availability and effectiveness of these airports as backup and training facilities is important in maintaining and growing the defense industry in Washington.</td>
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Emergency Preparedness and Disaster Response

State, regional, and local jurisdictions create emergency preparedness plans that outline how agencies should respond in case of serious emergencies such as earthquakes, volcanic eruptions, flooding, or terrorist attacks. Public use airports often play important roles in these plans, due to their large land area, flexible space, and geographic distribution. Airports are used in the following primary ways in case of an emergency:

- **Resource and Response Team Staging Centers.** During a disaster, supplies such as medicine, water, and food need to be distributed to affected people. Airports are often designated as the staging center for these commodities due to their size and accessibility. Staging areas also serve as a location from which response teams such as search and rescue or utility crews can be gather, coordinated, and dispatched.

- **Delivery Centers for Incoming Aid.** Following a catastrophic event such as an earthquake, it is likely that many pieces of local infrastructure such as roads, highways, and bridges will be damaged and potentially impassable. This destruction prohibits federal agencies or other areas of the state from sending help to the affected region by ground. Most communities have an airport within a useful distance where supplies, water, food, and rescue personnel can be delivered in a timely manner.

- **Bases for Firefighting, Search and Rescue, and Medical Evacuation.** These are basic functions that airports serve during non-emergency times, but become extremely important during catastrophes. The volume of search and rescue missions, number of injured persons requiring medical evacuation, and instances of urban and rural fire increase, especially after earthquakes. All airports near the site of a disaster become potential bases for search and rescue, medical, and firefighting services.

**Emergency Preparedness and Disaster Response in Washington**

The State of Washington has designated 16 public use airports as potential emergency response staging areas. These airports, shown on the map below, are spread throughout the state. Which airport is eventually used depends on the location of the emergency and the size of the response needed.

In Washington, the two most common types of disasters are floods and earthquakes, which are a more common occurrence in Western Washington than in the rest of the state.
**At a Glance:**

- There are 17 airports designated as staging areas
- Airport Classifications of these airports:
  - 10 Commercial
  - 6 Regional
  - 1 Local

**State Potential Response Staging Areas**

[Image of map showing State Potential Response Staging Areas in Washington state.]


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**How Does Using Airports for Emergency Preparedness and Disaster Response Benefit Citizens?**

Airports benefit people in emergency situations by supporting responding agencies in providing care and supplies to affected communities. Airports are helpful during emergency response for many of their intrinsic qualities:

- Airports are large, flat areas of land ideal for erecting temporary buildings such as shelter or supply warehouses. Their large size also enables them to act as staging areas for first responders needing large places to organize and await assignments.
- Airports have built-in access to other communities and states that can provide delivery of supplies, personnel, or medical services.
- Airports are often centrally located to multiple communities, providing an efficient stepping-off point for on-site responders.

Federal, state, and local emergency response plans are vital to protecting Washington’s residents and infrastructure in case of disaster. Well-coordinated and timely responses save lives and help return the community to normal. Airports, given the above reasons, are a key piece of infrastructure that governments use to develop effective plans. Their availability for this purpose and the value of being prepared benefits all residents of Washington, even if disaster never strikes.

**Aviation allows for specialized disaster response that would not be possible from the ground.** During Washington’s most common natural disasters, floods and earthquakes, aviation plays a particularly vital role

- During the flooding in Western Washington in 2007 and 2008, aviation was used to rescue people stranded on rooftops and to survey the extent of the damage. WSDOT estimates that about 450
people were rescued from rooftops in 2007 alone. Aviation was also used to take photos of the damage to accelerate the application to FEMA to declare a federal emergency.

- The area is also at risk for large seismic events in the future. After a serious earthquake, aviation will likely provide much of the mobility and response capability for weeks, especially in metro areas like Seattle where much of the roadway is elevated or built on fill.
Supporting Research

Scientific Research

Research institutions, universities, and state, local, and federal agencies have found uses for aviation in diverse fields of scientific research. Some of the main research that uses aviation in Washington is:

- **Wildlife Studies.** Aerial surveys of wildlife are used to study population sizes, migratory patterns, habitat destruction, and to track tagged animals. The state and federal departments of fish and wildlife and research universities are the most prevalent users of aerial surveys in Washington. They track animals including deer, moose, bears, grouse, goats, and bats. Some aerial surveys are done using visual observation, while others are flown with tracking equipment to record the location of pre-tagged animals.

- **Aviation Technology.** Washington’s large aerospace industry and public use airport system support many research institutions’ and state efforts related to aviation, such as efforts to increase aircraft fuel economy and alternative fuel use. Many planes testing new equipment or alternative fuel are based at or flown from Washington’s public use airports.

  This is an area that will likely grow going forward because of increasing state and federal attention. One example of a future study is the state Department of Natural Resources’ pilot project to create jet fuel from wood waste and mill residue from Washington’s timber industry.

- **Land and Resource Studies.** Aviation, and more specifically aerial photography, is used to capture images of areas of interest over time to study how a forest, crop, or body of water is changing over time. The information provided from an overhead view can be used by researchers to understand how our geography is changing and what future impacts might be if trends continue.

*Scientific Research Activity in Washington*

Aviation-based scientific research happens throughout Washington State. Much of the research into aviation technologies happens in the Puget Sound Region, where prominent aircraft manufacturers and suppliers are based. Wildlife and land studies occur where populations of interest are located—ranging from mountain goats in the Cascade Mountains to salmon in the Columbia River.

Research activity can occur from any type of airport, since aircraft used range from helicopters to seaplanes to small jets.

*How Do Researchers and Individuals Benefit from Using Aviation for Scientific Research?*

Aviation benefits science by enabling research and learning that, in many instances, could not be undertaken without flight. The value derived from any single research flight is difficult to quantify because information learned from one piece of a larger research project can vary widely in significance at the end of the day. However, given the broad range of research fields that use aviation, the cumulative benefit from enabling this research extends our scientific knowledge and increases Washington’s presence in the science community. Examples from the fields noted above of how Washington’s most common uses of aviation in scientific research provide benefit are:
Increased understanding of our natural environment. Tracking wild animal populations using aviation helps researchers understand information ranging from population size of endangered species to seasonal migration patterns. This information can be used to support wildlife conservation efforts and environmental regulations that plan for Washington’s future. Aviation is similarly used to monitor the State’s natural features, such as forest acreage and water levels.

Improved aviation technology. Current aviation-related research projects in Washington are on the forefront of reducing the environmental impacts of aviation. Projects to improve the fuel efficiency of aircraft will reduce fuel usage and greenhouse gas emissions, while efforts to develop alternative fuels will help the aviation industry move away from petroleum products.

The examples of value creation above are only a subset of the total aviation-supported scientific research happening in Washington. The research conducted and projects supported by aviation contribute to greater knowledge and scientific understanding.

Summary

- Many types of research could not be completed without aviation.
- Increasing the level of scientific understanding brings specific solutions and general benefits to the world.
- Washington benefits from knowing more about the natural world and improving aviation technology.
Aerial Photography

Aerial photography is used by government, businesses, and individuals to see the big picture: an aerial photograph can show perspective, detail, and orientation that can’t be captured from the ground. The uses for aerial photography are varied. Some of the more common uses include:

- **Government.** The State of Washington, through the state Department of Transportation (WSDOT) Aerial Photography Division, uses aerial photography for activities including transportation planning, environmental monitoring, and forestry applications.

- **Private Business.** Many private companies, such as natural resource management firms, use aerial photography to design and plan, document and monitor progress, and troubleshoot solutions.

- **Individual Use.** Individuals may take aerial photographs using their own equipment, or hire an aerial photography company to take photos for personal use, to sell for profit, or to settle property line disputes.

Both helicopters and fixed-wing aircraft are used for aerial photography. Helicopters have an advantage in being able to fly lower and slower than fixed-wing aircraft, but fixed-wing aircraft are many times cheaper to operate and can go to higher altitudes.

*Aerial Photography Activity in Washington*

Aerial photography can occur at all airport classifications and from any type of aircraft. WSDOT bases their aerial photography plane at Boeing Field.

*How Do Users Benefit from Aerial Photography?*

Aerial photography creates value for users by providing information that, in many instances, cannot be developed in any other way. In today’s data-driven world, most individuals and institutions in Washington rely on maps and spatial information developed from aerial photography. Aerial photography creates tremendous value to the photographer in relation to its cost. Being able to see from above using a quick flight takes little time and money, and the cost is usually borne by a single entity such as state government. The pictures and the information that result from this cost benefit a large cross-section of the community. Some examples of how aerial photography benefits different users are:

- **Design and Construction.** WSDOT does a significant amount of its aerial photography to support highway design. Aerial photographs of construction sites can be compiled in a process called photogrammetry to create accurate 3D maps used to design bridges, intersections, and roadways. These aerial photographs save time and labor costs of mapping out an area using ground measurements. Additionally, photographs can be taken throughout the construction process to monitor progress and check for issues.

  Private companies also monitor the progress of their construction and improvement projects through aerial photography.

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**Summary**

- Aerial photography is a quick and efficient method of understanding large spatial areas.

- Both private firms and public agencies use aerial photography to support their missions.

- Aerial photography is commonly used to plan, design, and monitor projects; estimate resources; and assess damage.
• **Environmental Monitoring.** When a ship in the Columbia River is leaking oil, the oil stays on top of the water and is visible for a set period of time. Using aerial photography, the state can photograph the full expanse of the oil leak in one shot, and have the perspective and scale of the surrounding area and known distances to estimate the full impact of the oil pollution.

• **Estimating Resources.** Many industries employ expert aerial photography interpreters to gain advanced knowledge from aerial photographs. For example, photographs of forested areas can be used to quickly estimate the amount of board-feet in a stand of trees, what types of trees are in the forest, and how tall the trees are. In another example, an aerial photograph of a quarry or gravel pit can be interpreted to determine how much soil has been moved and how much rock has been extracted.

• **Natural Disaster Damages.** After an area of the state has been damaged by fire, flood, earthquake, or landslide, the state can document the disaster and begin to estimate total damages using aerial photographs. These photographs allow the state to see the big picture and understand the breadth and depth of the natural disaster.

The level of aerial photography activity in the state is difficult to quantify, since many of the planes used serve other purposes as well, and many are rented or leased by multiple businesses or individuals. As an example, WSDOT Aerial Photography does about 80-100 aerial photography flights per year using their one fixed-wing aircraft. This aircraft is specifically for mapping, and has a purpose-built camera bolted to its floor.

Private businesses and individuals conduct many times this many flights per year, given the flexibility of their equipment and the numerous reasons for taking photographs.
Supporting Industry

Aircraft Manufacturing

Washington State is a global leader in the aerospace industry and in the subsector of aircraft manufacturing, which includes manufacturing of entire airplanes, aircraft engines and parts, and other aircraft parts and auxiliary equipment. Public use airports are key pieces of infrastructure that support the aircraft manufacturing industry by enabling flight testing activities and by facilitating receipt and delivery of aircraft.

The analysis presented below discusses how the users of airports – in this case the aircraft manufacturing businesses – benefit. In the Study’s industry-level analysis, the broader relationship between the state’s airport system and business is examined, including how this industry benefits communities and our region.

Aircraft Manufacturing in Washington

At a Glance

- 20 airports
- Airports by classification:
  - 7 Commercial
  - 7 Regional
  - 3 Community
  - 3 Rural Essential

Airports with Airplane Parts Manufacturing

Aircraft manufacturing is a part of the larger aerospace industry, which in Washington is comprised of more than 650 companies and more than 82,000 skilled workers. The greater Seattle area has one of the highest concentrations of aerospace firms in the world, and Washington has the highest concentration of aerospace workers in the nation.\(^{27}\) Boeing, the largest and most well-known of these companies, has major commercial airplane production facilities in Everett and Renton, but the state’s airplane manufacturing activities extend beyond Boeing and include smaller companies specializing in

http://www.choosewashington.com/industries/aerospace/Pages/default.aspx
small aircraft manufacture, aircraft parts manufacturing, and aircraft refurbishment, among other businesses.

A total of 19 public use airports report activity related to airplane part manufacturing and include commercial, regional, community, and rural essential airport classifications. The majority of airports identified with airport part manufacturing activity are clustered in the Puget Sound Region, but Eastern Washington shows a substantial amount of activity as well.

**How do Aircraft Manufacturers Benefit from Public Use Airports?**

Airports create value to these businesses by supporting aircraft manufacturers’ production process. Public use airports are facilities that are integral to the aircraft and aircraft part manufacturing process. For example, Boeing uses public use airports—including Harvey and Boeing Fields—to conduct flights prior to the sale and shipment of commercial airplanes to customers.

Public use airports support a key state industry worth billions of dollars. In 2009, the gross business income of aircraft manufacturing totaled $34.8 billion. In addition, aircraft part and equipment manufacturing had a gross business income of $2.6 billion in 2009.\(^2\) To remain a vibrant industry, aircraft manufacturing must be supported by a variety of services and infrastructure. The availability and effectiveness of public use airports is an important part of that equation. In the short-term, airplane manufacturers would place tremendous value on having the use of an airport to facilitate their operations and the delivery of their product. From a longer-term perspective, it becomes clear that the availability and effectiveness of public use airports is key to maintaining the industry as a force in the regional economy.

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\(^2\) Department of Revenue, Gross Business Income for NAICS code 336411 (Aircraft manufacturing) and NAICS codes 336412 and 336413 (Aircraft engine and engine parts, and other aircraft parts and auxiliary equipment manufacturing) in 2009.
Agriculture

Aviation supports agriculture through the aerial application of crop treatments. Nationally, aerial application accounts for almost 25% of crop protection applications.29 These applications treat weeds, pests, insects, and fungal outbreaks in crops. In addition, aerial application can also be used to fertilize and seed crops early in the planting season. Approximately 88% of aircraft used in the industry nationwide are fixed-wing aircraft and 12% are helicopters.30

Aerial application is an alternative to trucks and ground rigs to apply crop treatments. Two reasons why farmers may choose aerial over ground application are:

- **Time-sensitivity.** Once a problem is identified in the field and a prescription is determined, application may need to occur quickly to avoid crop damage. Aerial application can cover crop area more quickly than ground rigs. Many aerial applicators guarantee same day or next day service.

- **Avoid crop damage and soil compaction.** Ground rigs can damage the crops themselves and cause soil compaction. This can be more of an issue for certain types of crops and at certain points during the growing season.

**Aerial Application for Agriculture in Washington**

In Washington, approximately 7.6 million acres, or 18% of the state’s total land area, is cropland. The state produces around 300 commodities and ranks first in the U.S. for production of apples, sweet cherries, pears, red raspberries, and hops. Agricultural activity is concentrated in Eastern Washington. The top five counties in agricultural sales in 2007—Yakima, Grant, Benton, Franklin, and Walla Walla—account for 55% of the state’s total agricultural sales.31

Aerial application supports agriculture. Nationally, about 25% of cropland is treated using aerial application. Applying the same percentage to Washington would suggest that an average of 1.9 million acres in the state are treated each year. Aligning with the agricultural season, aerial application typically begins in March and ends in October or November, with a peak season between April and August.

There are 19 public use airports that support agricultural spraying, located primarily in eastern Washington.32 In addition, unlike many other activities described in this section, aerial applicators also frequently use private airports and landing strips for their operations.

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At a Glance

- 20 public use airports support agricultural spraying.
- 16 out of 20 are Local or Community airports.
- The other 4 are Commercial, Regional, or Rural Essential.
- There is a geographic concentration in Eastern Washington.

Source: WSDOT Aviation Database, 2010; BERK, 2011.

How Do Farmers Benefit from Aerial Application?

Aerial application creates value for farmers by insuring valuable crops against damage. Aerial application is one of many tools used by farmers to successfully seed and grow healthy crops for sale. Farmers benefit from the state’s aviation system in two ways: (1) by using aerial application when circumstances require it and (2) by knowing that aerial application is an option and they have a safety net for their crop. In other words, public use airports create value when actually used for aerial application and they create option value for farmers who consider aerial application an important safety net.

Aerial application supports a multi-billion dollar industry. In 2007, Washington agricultural sales totaled around $6.8 billion. In order for the state’s multi-billion-dollar agricultural industry to remain vibrant, it must be supported by a variety of services and infrastructure. Aerial application, and the public use airports that facilitate that service, are an important piece of that puzzle.

From the perspective of a single farmer facing an outbreak of weeds endangering his wheat crop, what is aerial application worth? The farmer would not be willing to pay more than the crop itself is worth, but would likely pay a high percentage of the crop’s worth to avoid losing it entirely. Depending on the crop,
that the value that farmer places could range, for example, from $298 for one harvested acre of spring wheat to $10,576 for one harvested acre of blueberries.\textsuperscript{33}

From the perspective of a farmer who does not need to use aerial application in a given year, there is also some value created— the "insurance" value associated with eliminating certain catastrophic risks — by having the option to use aerial application in the event of an outbreak.

In sum, the state’s aviation system, through the tool of aerial application, helps support Washington’s valuable agricultural industry.

Flying for Recreation

Aerial Sightseeing

Public use airports support a number of recreational activities, including aerial sightseeing. Aerial sightseeing includes view tours provided by a number of modes of aerial transportation, including airplanes, seaplanes, helicopters, gliders, and hot air balloons.

Aerial Sightseeing in Washington

There are 12 public use airports that report aerial tour activities around the state. The majority of these airports are located near bodies of water, with a concentration in the northwest part of the state.

At a Glance

- 12 airports have aerial tour activities
  - 6 commercial airports
  - 3 regional airports
  - 3 community airports

Source: WSDOT Aviation Database, 2010

How do Participants in Aerial Sightseeing Benefit from Public Use Airports?

Sightseers value their experience in the sky. Recreational activities such as aerial sightseeing bring benefits to those who participate in them. These benefits include increased mental wellbeing and happiness from doing something that brings enjoyment and social benefits from doing an activity with others. Aerial sightseers experience spectacular views and a new perspective to a place.

These experiences all create value to the user, and these industries are supported by the public use airports where these activities take place.

Summary

- Sightseers derive benefit in the form of enjoyment and excitement in the air.
- The average cost of an aerial tour is in the hundreds of dollars.
- Airports enable these activities and experiences for a relatively small segment of the population.

March 2012
A single aerial tour can cost hundreds of dollars. Although not the most common recreational activity, aerial sightseeing is one of many activities that make up the state’s tourism industry.

The people that participate in this activity pay in the hundreds of dollars for each tour. What a person actually pays for these activities gives some sense of how much a person values that activity. The cost of an aerial sightseeing tour varies by company, location, and flight time. A range of two plane-based sightseeing operators in Washington is provided below.

### Aerial Sightseeing Costs

<table>
<thead>
<tr>
<th>Operator</th>
<th>Duration</th>
<th>Price Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kenmore Air (20 min to 2 hours)</td>
<td>$89 - $179</td>
<td></td>
</tr>
<tr>
<td>San Juan Island Air (20 to 60 min)*</td>
<td>$59 - $139</td>
<td></td>
</tr>
</tbody>
</table>

*Minimum of two ticket purchase.

Sources: Kenmore Air (http://www.kenmoreair.com/sub_content.php?content_type=33); and San Juan Air Tours (http://www.scenic-flights.com/schedule.htm), 2011.

These costs only provide an order-of-magnitude sense of what people actually pay for aerial sightseeing. These numbers do not capture the extra benefit—beyond the price paid—derived from aerial sightseeing.
Skydiving

Public use airports support the recreational activities of skydiving and parachuting. These activities create enjoyment for participants and require airports to serve their customers.

Skydivers typically jump from airplanes, but helicopters and hot air balloons are also sometimes used. Skydivers jump from between 3,500 to 13,000 feet above the ground depending on the type of jump. The most common first jumps include: a tandem jump, an accelerated freefall jump, and a static-line and instructor-assisted deployment.

Skydiving in Washington

Skydiving. In Washington, there are four drop zones—or skydiving centers—that are members of the United States Parachute Association, a voluntary and self-regulating membership organization: Kapowsin Air Sports, Skydive Snohomish, Skydive Toledo, and West Plains Skydiving. Three of these—Skydive Snohomish, Kapowsin Air Sports, and Skydive Toledo—operate on public use airports in Western Washington. West Plains Skydiving operates out of a private airfield fifty miles west of Spokane.

At a Glance

- 3 public use airports have skydiving and parachute drop activities.
  - 2 regional airports
  - 1 community airport
- Located in Western Washington

Airports with Skydiving and Parachute Drop Activities


How do Skydivers Benefit from Public Use Airports?

Skydivers derive benefit from their experience in the sky. People participate in recreation activities—such as skydiving—because they derive benefits from them in the form of enjoyment and wellbeing. For skydivers, benefits may come from the adrenaline rush, speed, and views that result from the experience.

This experience creates value to the user, and skydiving is an industry that is supported by and takes place at public use airports.

**A single skydive jump can cost hundreds of dollars.** Skydiving is not a very common recreational activity. For example, approximately 400,000 people—or 0.13% of the population—in the US skydive for the first time.

However, the people that do participate in these activities pay in the hundreds of dollars to do so. What a person actually pays for these activities gives some sense of how much a person values that activity. The table below shows the average cost of a single skydive jump is between $100 and $350, depending on the type of jump.

<table>
<thead>
<tr>
<th>Skydiving Costs</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Tandem Jump</td>
<td>$150 - $250</td>
</tr>
<tr>
<td>Accelerated Freefall</td>
<td>$250 - $350</td>
</tr>
<tr>
<td>Static-Line/Instructor-Assisted</td>
<td>$100 - $200</td>
</tr>
</tbody>
</table>

Sources: USPA, [http://www.uspa.org/AboutSkydiving/HowtoStartSkydiving/tabid/530/Default.aspx](http://www.uspa.org/AboutSkydiving/HowtoStartSkydiving/tabid/530/Default.aspx);

These costs only provide a sense of what people actually pay for these recreational activities; they do not measure the extra value people derive from skydiving.

**Summary**

- Skydivers derive benefit in the form of enjoyment and excitement in the air.
- The average cost of a skydiving jump is in the hundreds of dollars.
- Airports enable these activities and experiences for a relatively small segment of the population.