UAVs 4 STEM

Using recreational drones for learning

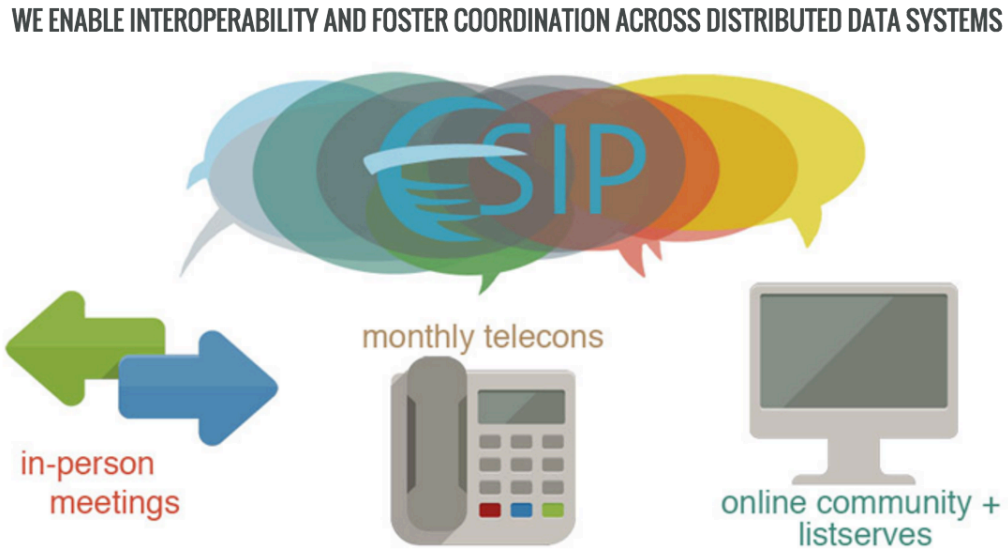
Federation of Earth Science Information Partners (ESIP)

Education Committee

March 22, 2016

Presenters: LuAnn Dahlman, NOAA
Dan Zalles, SRI

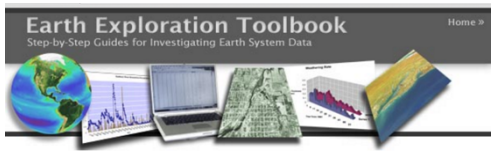
Earth Science Information Partners (ESIP) serves as an “intellectual commons” for member organizations—federal agencies, academics, entrepreneurs, and non-profit and for-profit agencies.



Community members span the range from researchers and instrument builders, data providers and stewards, to communicators and educators. Our common interest is in promoting the use and understanding of Earth Science data.

ESIP's Education Committee

Curriculum developers, instructors, evaluators, and educators in ESIP who promote the use of Earth Science data for learning



SRI International

U.S. Climate Resilience Toolkit

UNAVCO

picture post

Digital Earth Watch

WINDOWS TO THE UNIVERSE

EARTH UPDATE

Recognizing the similarities between data from drones and satellites, ESIP educators chose to develop three professional development sessions.

Two webinars and a workshop

Webinar 1: March 22 4 EDT	Webinar 2: April 26 4 EDT	Workshop: July 19, Chapel Hill, NC
UAVs 4 STEM Learn about real-world uses of drone technology for science and humanitarian efforts. Find out how you and your students can use recreational drones for STEM learning.	**Plan, Fly, Review: Documenting Drone Data** Get organized so you can learn something from every UAV flight. Learn best practices for documenting your flights, images, and science data.	**Test and Refine STEM Learning Activities** Fifteen successful applicants will receive a drone and a $200 stipend to test and refine activity ideas, and then use them with youth in the fall. The workshop will prepare attendees to facilitate drone-based STEM learning in clubs, classrooms, or science fair activities.

Please help us gauge educators' interest in using drones for education by responding to 3 or 4 questions in a survey.

Click the live link in the Chat pane of GoToMeeting Control Panel, or type in this URL:

http://goo.gl/forms/vK3kvHPaGJ

Potential Outcomes

- Downloadable e-book of STEM activity suggestions for recreational drones
- Cadre of educators ready to facilitate activities and data management strategies
- Opportunities for follow-on data explorations involving other ESIP members

Clarifying what we mean by recreational drones

“Recreational drones”

- weigh less than a half pound
- do not need to be registered with the Federal Aviation Administration (FAA)
- usually cost less than $100
- can be considered as “toys”
- can not range beyond controller’s sight

FYI:
We use these several of these terms

Other names for drones

- Unmanned Aerial Vehicles or UAVs
- Unmanned Aircraft Systems or UASs
- Quadcopters / Quadrocopters
- Multi-rotors / Helicopters
- Fixed-wing drones
- Aerial robotics

Our goal is to help educators facilitate STEM learning. As we can't cover everything about drones, we made a conscious decision to omit:

- Teaching people how to fly drones (though we'll have a brief flight school at the workshop)

(lots of resources for flying already exist)

- Flying drones for commercial profit or a business

(these activities require special licenses)

- Building and / or coding drones

(great activities, but out of our scope)

As some of you are brand new to recreational drones, we want to offer just a few words about safety and civility

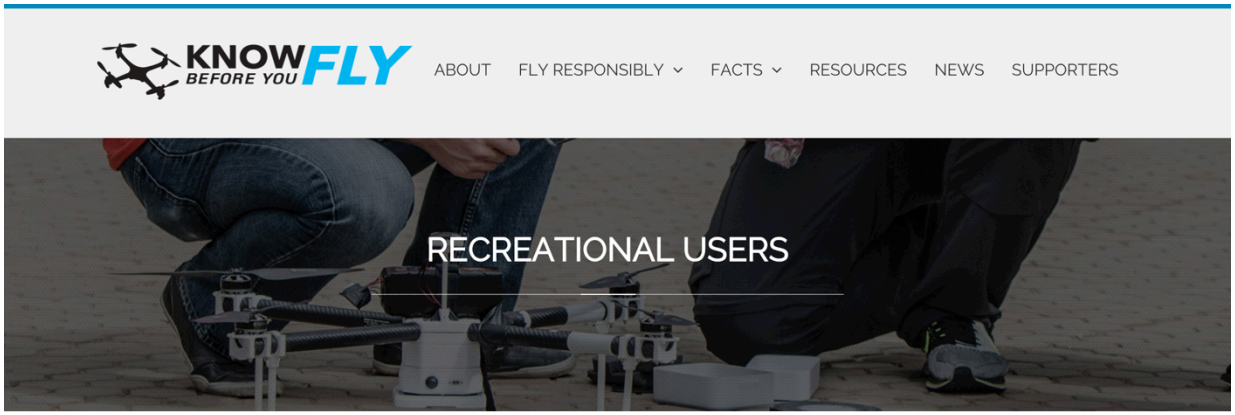
Safety first!

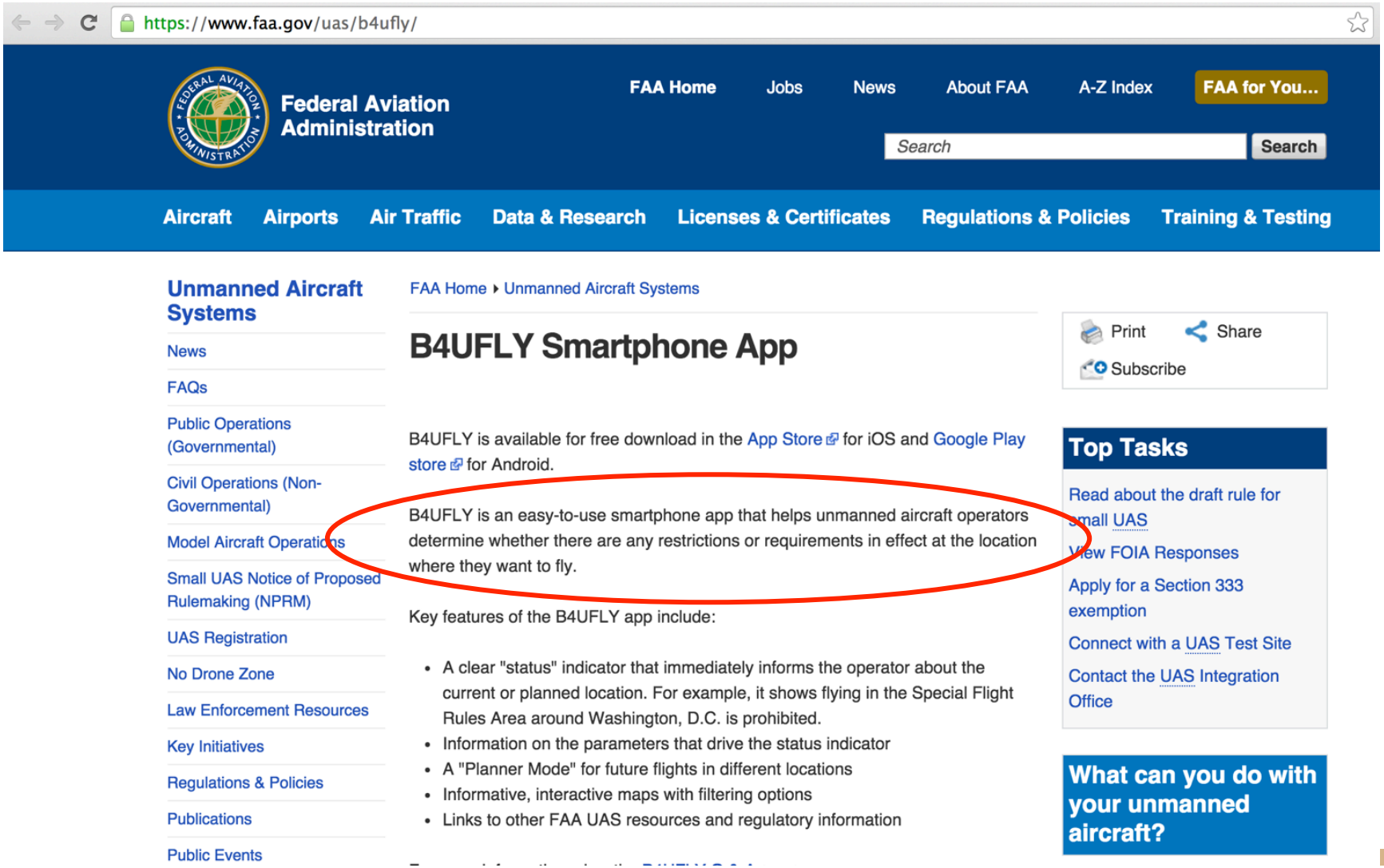
- ✓ Avoid wind.
- ✓ Develop skill by practicing at low altitudes.
- ✓ Fly only in safe places: set and observe boundaries that keep you and your drone clear of traffic and other hazards.
- ✓ Be alert! Don’t let enthusiasm overcome common sense.
- ✓ Whenever you perceive potential dangers, stop and change the situation.

The Federal Aviation Administration (FAA) sets rules about how we use our airspace.

Every aviator should visit the FAA's drone site:

Know Before You Fly http://knowbeforeyoufly.org/

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Key features of the B4UFLY app include:
A clear "status" indicator that immediately informs the operator about the current or planned location. For example, it shows flying in the Special Flight Rules Area around Washington, D.C. is prohibited.
Information on the parameters that drive the status indicator
A "Planner Mode" for future flights in different locations
Informative, interactive maps with filtering options
Links to other FAA UAS resources and regulatory information
Top Tasks
Read about the draft rule for small UAS
View FOIA Responses
Apply for a Section 333 exemption
Connect with a UAS Test Site
Contact the UAS Integration Office
What can you do with your unmanned aircraft?

Federal Aviation Administration

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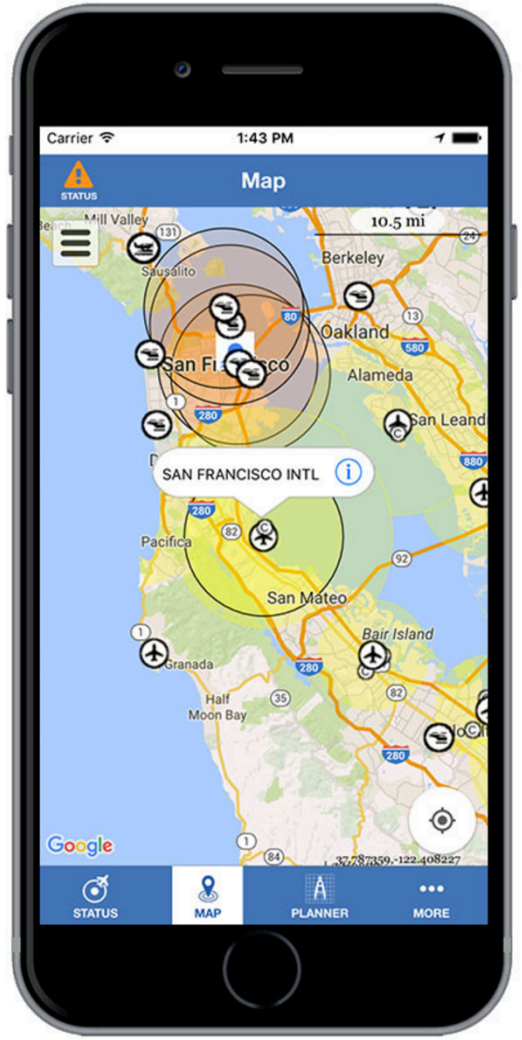

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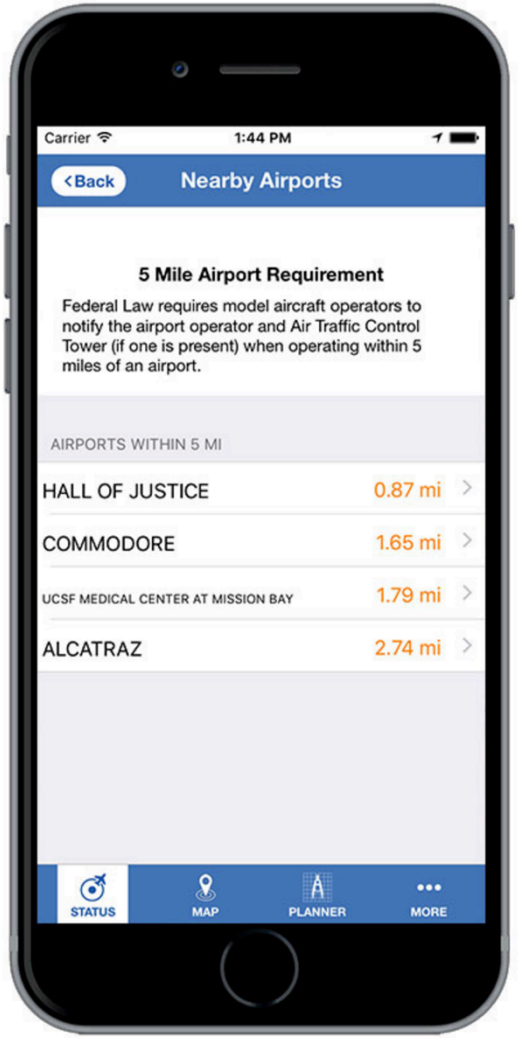

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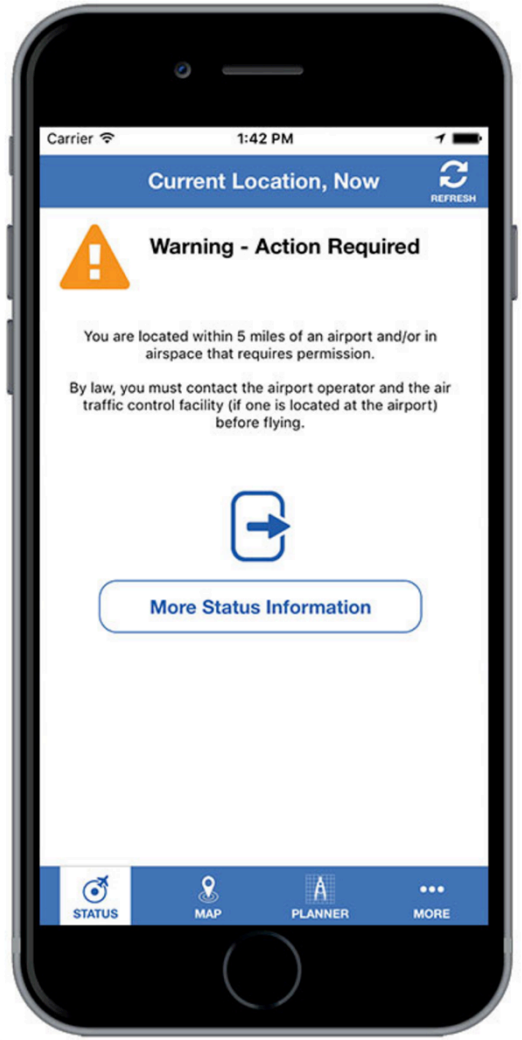


Federal Aviation Administration

Additionally, please check for specific restrictions in parks, near sensitive facilities, and places where you might disturb wildlife.

We encourage you to follow the "Golden Rule" +25% when considering where to fly your drone

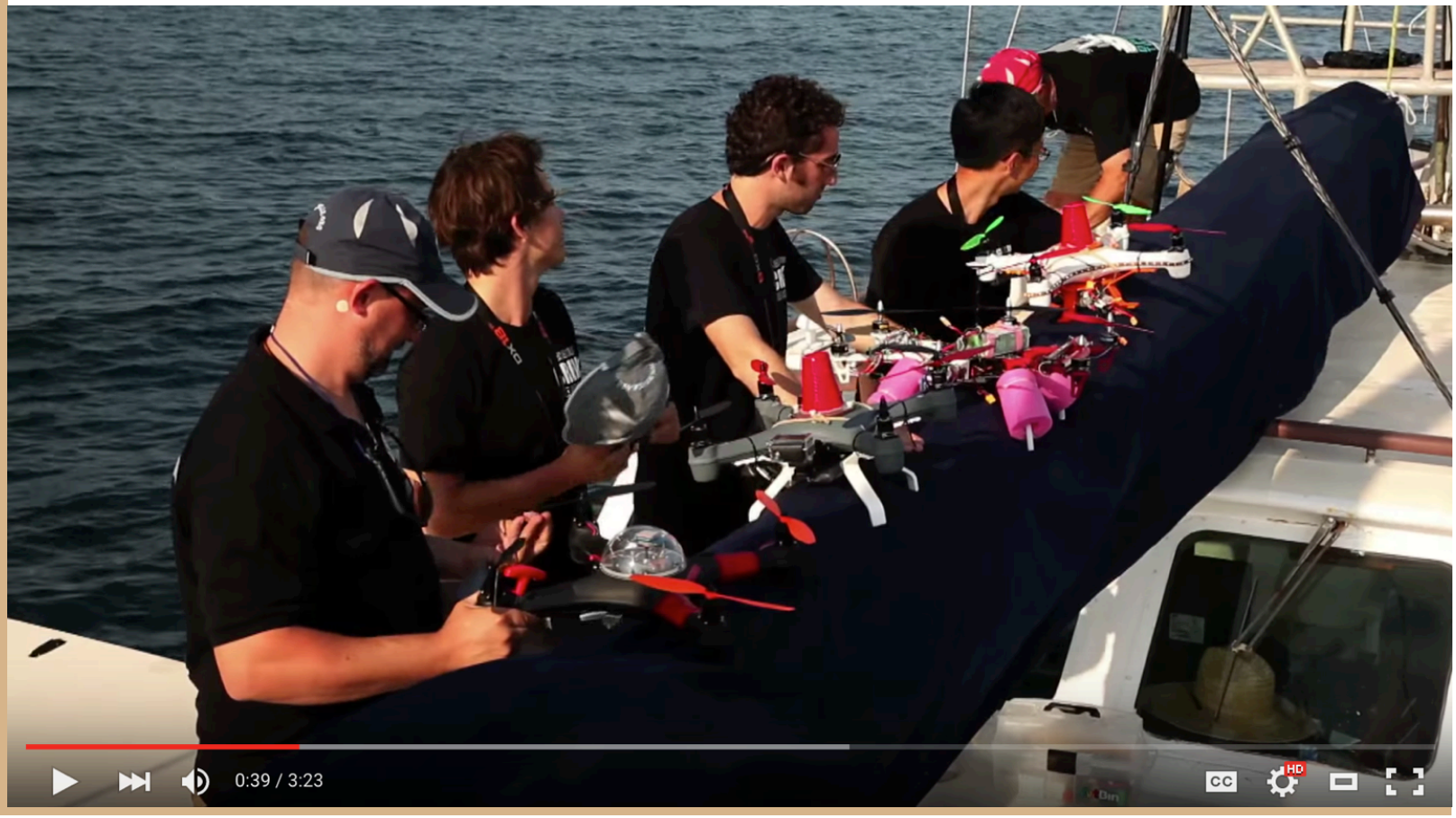
Consider if you would (or could) be concerned at seeing a drone in particular situations…

If the sight of a drone is likely to disturb people or wildlife, don't go there.

What are some ways you think drones can be useful for society (for example, in research, public service, or business)?

Drones can go places that people can’t (or shouldn’t!)

Drones can support research

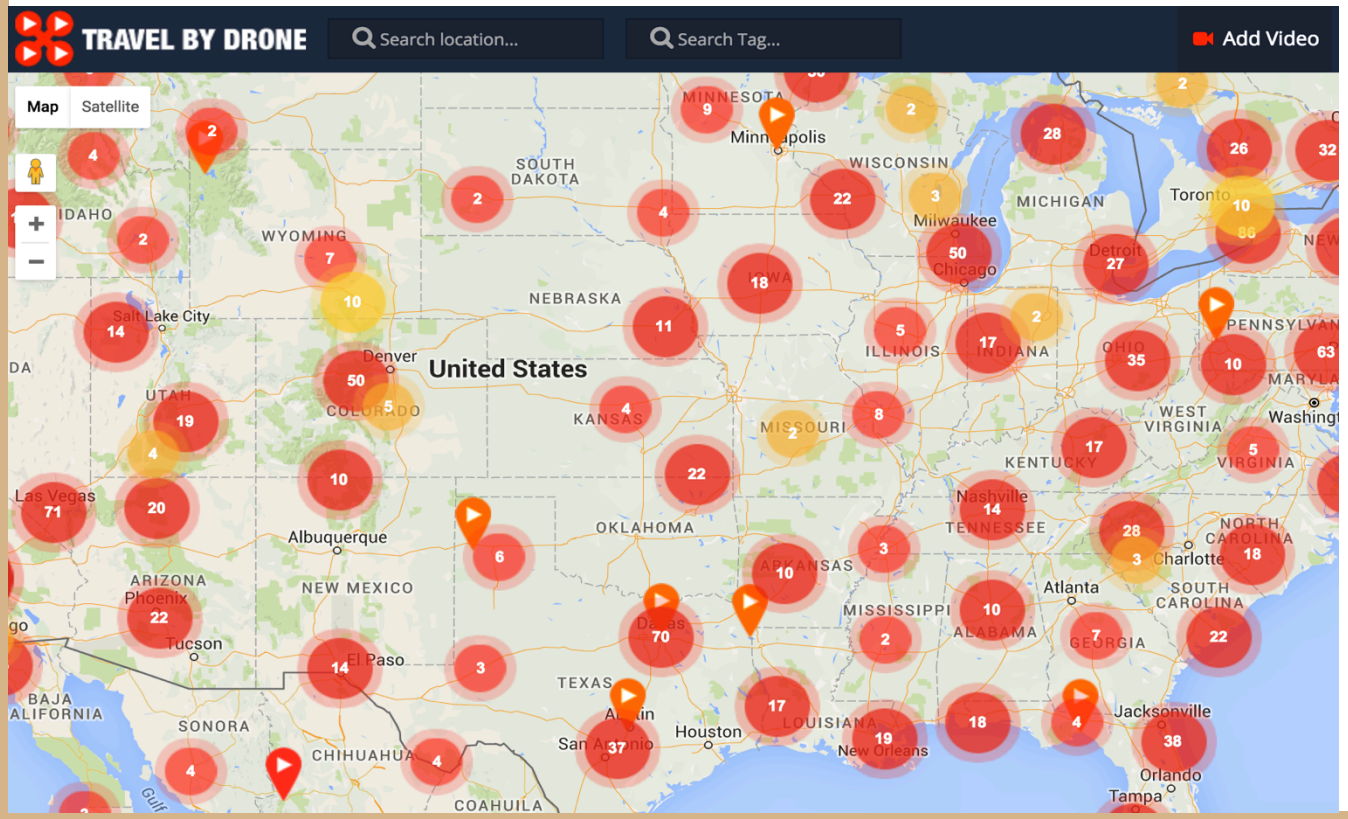


Drones may be useful in saving money for agriculture

Micromappers.org: Software enables people around the world to analyze video from drones to support disaster recovery

This is an organized group that offers humanitarian support for disaster recovery. For more info, see Digital Humanitarians

TravelByDrone.com:
Watch drone videos people have uploaded. These may inspire ideas for learning activities



The examples we just showed are from mature projects. We recognize you might want to start a bit simpler…

Sample Activity Idea

What payload can my UAV carry?

Materials: Set of washers or bolts
String
Balance, or a food or postal scale

Small sensors that measure environmental conditions such as temperature, air pressure, and location are becoming widely available. Can your drone carry these into flight?

Design and conduct an experiment to find a practical limit on the payload mass your UAV can carry. Consider the Sample Data Table at right: expand as necessary to capture data from multiple trials. Use graphics, videos, or photographs to document your results.

Sample Data Table

	UAV only	UAV + Payload #1	UAV + Payload #2
Mass			
Ability to launch (good, fair, poor, fail)			
Ability to maneuver (good, fair, poor, fail)			
Payload mass			

Sample Activity Idea

How do payloads affect battery life and flight time?

Materials: Set of washers or bolts
String
Balance, or a food or postal scale

Lifting a payload of sensors on your UAV takes energy. Will adding sensors to your drone reduce your flight time?

Design and conduct a controlled (fair) experiment to measure how different payloads affect the duration of your battery power for flight. Describe your methods and collect data in an organized table. Graph your results and produce graphics that explain the tradeoffs between payload mass and flight time.

Sample Data Table

	UAV only	UAV + Payload #1	UAV + Payload #2
Payload Mass			
Flight time (trial 1)			
Flight time (trial 2)			
Flight time (trial 3)			
Average Flight time			

Sample Activity Idea

How are UAV images the same as and different from satellite images?

Materials: Digital satellite image of your location
UAV with a camera

Take a close look at a satellite image of a place where you can fly your UAV. What can you see? What can't you see?

Use your UAV to take images of the area you examined: compare and contrast what you see in the two images. Prepare a graphic showing the satellite view and a UAV view of the same place, and document the qualitative and quantitative differences between them. Use a chart, a Venn diagram, and/or a graph to explain differences and similarities in the two kinds of images.

Sample Comparison Chart

	Satellite Image	UAV Image
Extent of image (area covered)		
Smallest visible feature (spatial resolution)		
Cost to capture image		
Practical temporal resolution		
Examples of effective uses for each platform		

Do you have activity suggestions?

What kind of learning activities or research projects can you imagine students using drones for?

Additional activity suggestions

Take pictures of the same thing from two different points of view.
Identify similarities in the picture to align them
Generate a red/blue composite to produce a 3D visualization

Can you figure out how high your drone is during its flight?
(What methods give the best estimates for drone height?)
Place a marker of a known size on the ground.
Use an inclinometer?

Devise an experiment to measure your drone's average land speed.

Use your drone to check out something that isn't readily visible. (Set up a type of scavenger hunt where you ask things like "what object is on the roof?" or "submit a picture of an island in a pond."

Choose a location and take repeat photography to document change.
Pre-requisite: How can you fly your UAS to the same height and location on multiple occasions for time series photos? Which is the most accurate method?

Additional activity suggestions

How does temperature affect battery life/flying time? (Can you fly longer in cold or warm temperatures?)
What other factors affect the maximum flight duration?
Devise a fair test to see how long you can fly on a fully charged battery in different temperature conditions.
Make a data table to record the conditions and results of each trial

Can your UAS receive radio signals through wood? brick? glass? metal?
Devise a fair test to find out which materials interfere with the signal from your controller to your UAS.
Make a data table to record the conditions and results of each trial
Consider conducting similar tests with other remote devices (Bluetooth computer mouse, cordless telephone, other RC toys)
Produce a graph to show any differences.

What is the maximum distance (range) at which you can control your UAS?
Go to a football field and test various distances.
Devise a fair test to find out which materials interfere with the signal from your controller to your UAS.
Make a data table to record the conditions and results of each trial
Experiment to decide how many trials it takes to get reasonably consistent results.
Consider conducting similar tests with other remote devices (Bluetooth computer mouse, cordless telephone, other RC toys)
Produce a graph to show any differences.

Additional activity suggestions

Challenges

Build a single mosaicked image to produce a photo-realistic map of a park or school.

How often might you need to update the map to ensure that it remains up to date?
Would it remain the same in each season?

Take a payload of a minimum weight to a specified height and drop it with a parachute.

Social facets of using drones

Develop a survey to find out how people feel about people flying recreational UAS around your school.
What are their biggest concerns?

Use what you learn to create an pamphlet, poster, or presentation to inform stakeholders of the benefits UAS offer. Check which messages are the most effective at changing attitudes toward flights

Take UAS photos to document phenological changes

Consider using Nature's Notebook protocols to become familiar with observable changes in plants and animals in different seasons or through a year. How would you modify the protocols to make observations with your UAS?

Compare approaches for getting photos from above

(Do virtual or real comparisons to evaluate the use of each method for a specific aerial photo task)
Sample data table:

	Tethered balloon	Kite Aerial Photography	Unmanned Aerial System
Materials needed?			
Total Cost Estimate?			
Best weather conditions for use?			
Weather conditions to avoid for use?			
Relative risk of damaging platform?			
Number of flights equipment lasts?			
Best uses for platform?			

Extend STEM learning by exploring related Earth Science data

We also plan to build on projects of other ESIP members

At the summer workshop, we'll invite ESIP groups to offer lightning-style presentations (just 5 minutes long) about their products to help educators identify commonalities among activities with UAVs, uses of imagery from satellite instruments, and the value of organizing and preserving data.

After we compile, test, and refine a set of activity suggestions, we will seek a small amount of funding to have them formatted into an attractive e-book. We anticipate promoting the free download of this book among educators, homeschoolers, and hobbyists via ESIP.

Abstract submitted for NSTA Regional Conference Presentations

Using recreational UAVs (drones) for STEM activities and science fair projects

Engage students in STEM using the “it” toy of the year: Unmanned Aerial Vehicles (UAVs or drones). Try free teacher-developed activities for STEM learning!

The FAA estimates that more than 1 million recreational UAVs (drones) were received as gifts over the last holiday season! These "toys" that cost less than $100 usually weigh less than half a pound, so don't require FAA registration, and generally can't fly out of the controller's sight. Seeing the world from above can stimulate curiosity and give students a reason to engage in many facets of STEM learning.

In this session, we’ll distribute materials that describe how students can test their drones’ capabilities, monitor the environment with onboard cameras and attached sensors, and set up data systems to organize their flight, image, and sensor data. In your hands, these suggestions can turn into exciting classroom activities or help you facilitate winning science fair projects.

Please tune into our next Webinar
April 22
4 PM Eastern

Consider applying to participate in our workshop
July 19
Chapel Hill, NC

Webinar: Plan, Fly, Review: Documenting Drone Data

Get organized so you can learn something from every UAV flight. Learn best practices for documenting your flights, images, and science data.

Workshop: Test and Refine STEM Learning Activities

Fifteen successful applicants will receive a drone and a $200 stipend to test and refine activity ideas, and then use them with youth in the fall. The workshop will prepare attendees to facilitate drone-based STEM learning in clubs, classrooms, or science fair activities.

Details at http://esipfed.org/node/9052

We will email everyone who indicated their interest when the workshop registration / application process is available.

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