UAVs for Research and Monitoring- Rapidly Evolving Technology

Part 1: Hyperspectral Imagery Acquisition in the Florida Keys- The Good Old Days (2012-2013): Large NASA-funded project.

Project PI: Stan Herwitz- NASA UAV Collaborative

Co-Investigators: Paul Carlson and Laura Yarbro, FWC/FWRI; Chuanmin Hu, David English, Minwei Zhang, Frank Muller-Karger, USF; Kim Yates- USGS

With Assistance From:

Tess Danielson, Chris McHan, Dan Carlson, Brian Durnan, Taj Knapp, FWRI Gerardo Toro-Farmer, Deanesh Ramsewak, Nelson Melo

John Merrill and Thorsten Mewes- Galileo Group

Steve Morris and Austin Howard- MLB Keith Nakanishi- NovaSol

Perry Kavros- Extreme Aerial Concepts

Hyperspectral Imagery Collection over Florida Seagrass Beds with UAVs and Piloted Aircraft: Objectives

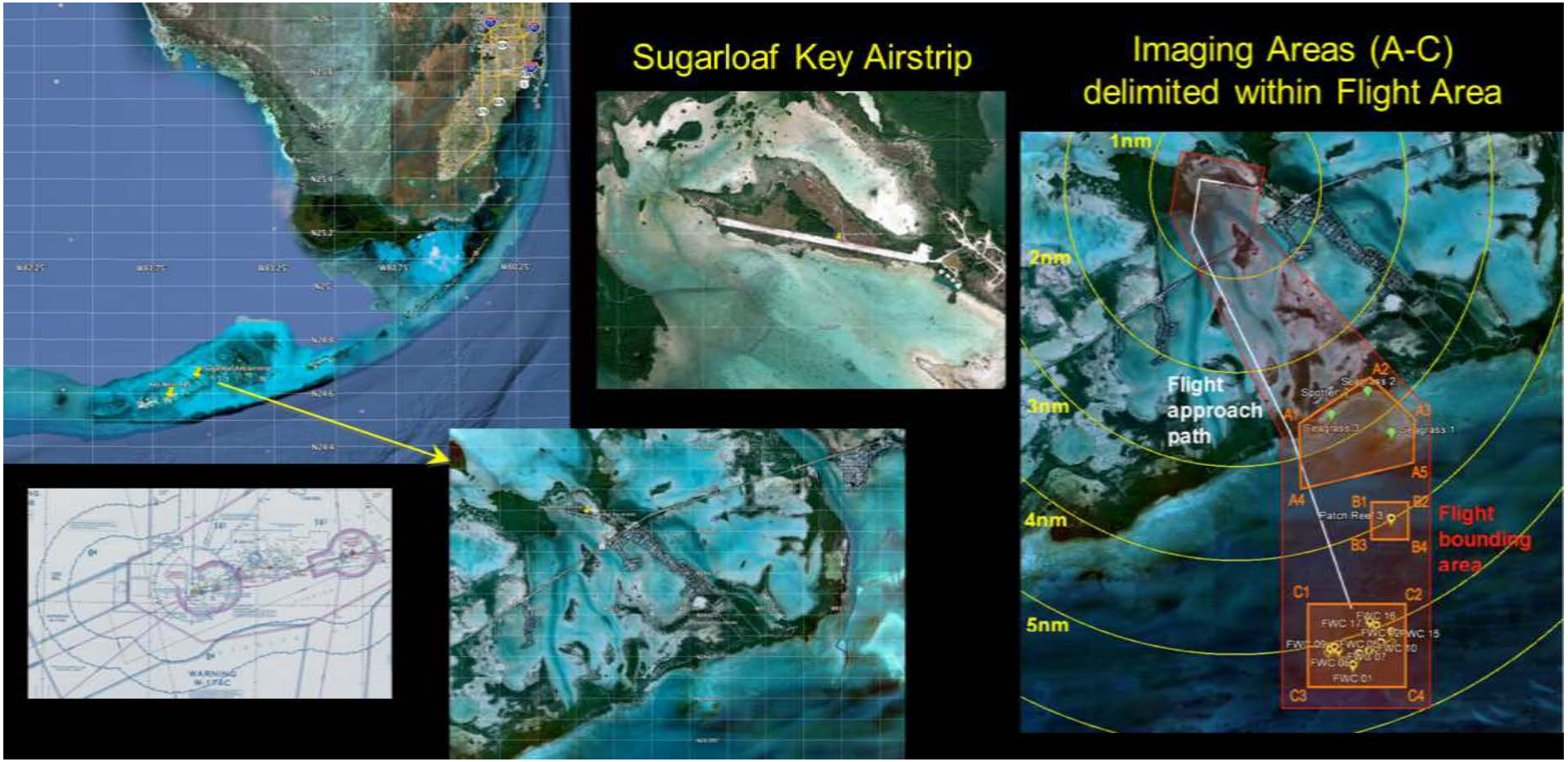
1. Large, Multi-Investigator Experimental Project with Technical and Scientific Objectives
2. Technical Objectives: Integrate platforms and sensors, Meet FAA requirements, Streamline logistics
3. Scientific Objectives: Collect multispectral imagery of seagrass beds and coral reefs, Extract abundance and health information.

Information presented here is less about our scientific conclusions than it is a comparison of platforms and sensors with guidance for others considering UAV projects. Please email questions to paul.carlson@myfwc.com

Hyperspectral Imagery Collection over Florida Seagrass Beds with UAVs and Piloted Aircraft: Major Findings

1. UAV work at landscape scale is still developing
2. Range safety is still a critically important consideration- Numerous incursions despite FAA-COA and NOTAMs.
3. Platform, sensor, and GPS/INS integration are critical
4. Platforms and sensor must be matched to data needs
5. Remote sensing reflectance (Rrs) measurements require extensive *in situ* measurements for calibration and intensive post-processing
6. Scaling and comparing *in situ* measurements to remotely sensed data is challenging
7. Seagrasses and calcareous green algae (Halimeda, Penicillus, Udotea) have very different reflectance spectra in the NIR, but very little NIR escapes water > 1 meter deep.
8. Epiphytes and calcareous sediments on seagrasses and algae complicate comparisons between *in situ* and remotely sensed data.

First Deployment- May 2012- Sugarloaf Key, Florida (1)

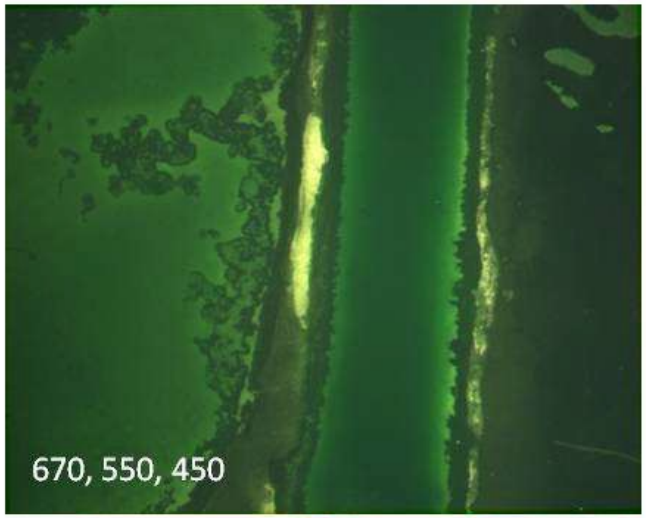


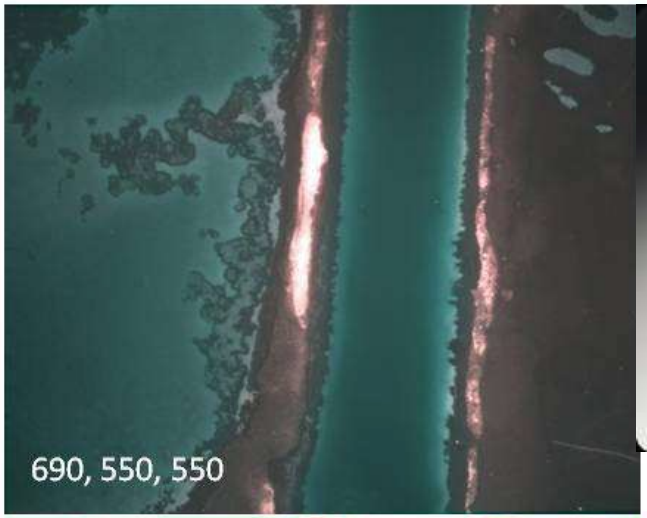
First Deployment- May 2012- Sugarloaf Key, Florida (2)

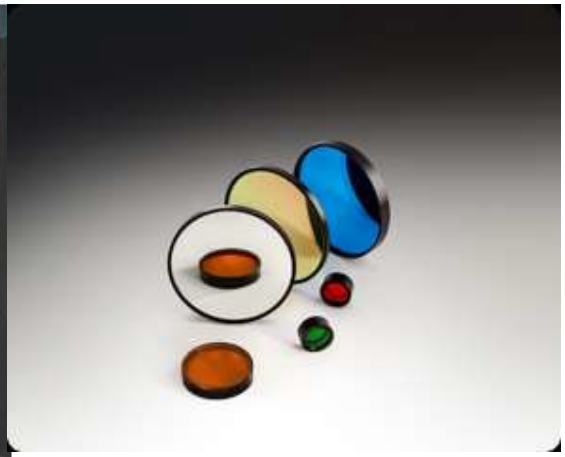
First Sugarloaf Key Deployment, May 2012
Bat-4 Fixed-wing UAV
Long endurance, flawless operation (2-8 kg payload, 4-10 hours)

Contact MartinUAV.com for more information on Batseries fixed-wing UAVs.

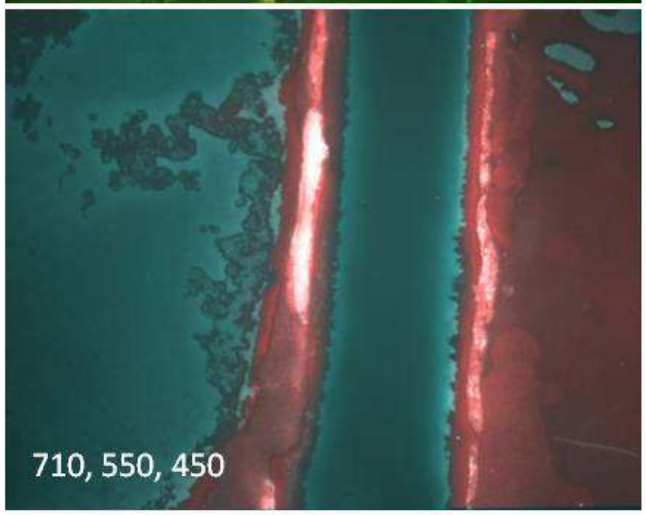
Deployment 1- Tetracam Mini-MCA Multispectral camera. Contact tetracam.com for more information. Note red and NIR reflectance of shallow seagrass in band combinations

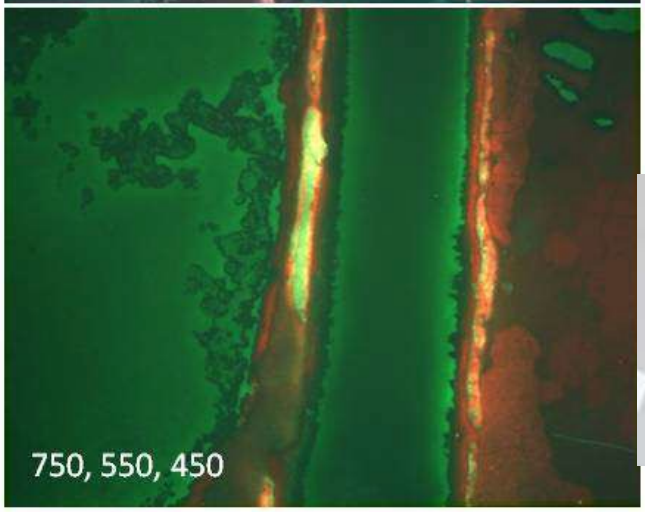






User-selected Andover bandpass filters





Second Sugarloaf Key Deployment- October 2012. NASA Sierra UAV- Endurance 10 hours, Payload up to 45 kg.

Sensor
medical
sensor
tactical

Deployment 3, Sugarloaf Key, May 2013, Vision-II JetCopter, Novasol hyperspectral sensor with integrated GPS/INS

Xtreme Aerial Concepts Vision-II JetCopter UAV

Airframe: Jakadofsky
Power Plant: 14 hp turboshaft turbine
Rotor Diameter: 10.5 ft
Empty Weight: 50 lbs
Payload with fuel: 80 lbs
Gross Weight: 130 lbs
Speed: Hover to 45 knots
Range: 1 mile (line of sight)

NovaSol Hyperspectral Sensor System

NovaSol

Selectable Hyperspectral Airborne Reconfigurable Kit (SHARK)

visNIR Micro HSI Sensor

PC-104 Based Data Acquisition System

Inertial Navigation System

- VisNIR microHSI™ sensor
  - 400 nm – 1000 nm
  - 30 FOV fore optic

Piloted aircraft with Specim AISA hyperspectral sensor- flew several times for each deployment- Sugarloaf Key study area

Conclusions- Part 1

Use fixed-wing UAVs for endurance and large areas. MLB Bat-4 very dependable. Use rotor craft UAVs for smaller areas and areas with little or no runway space.

Sensor integration times are limited by forward speed of fixed-wing UAVs or piloted aircraft, reducing signal:noise ratio of hyperspectral sensor data.

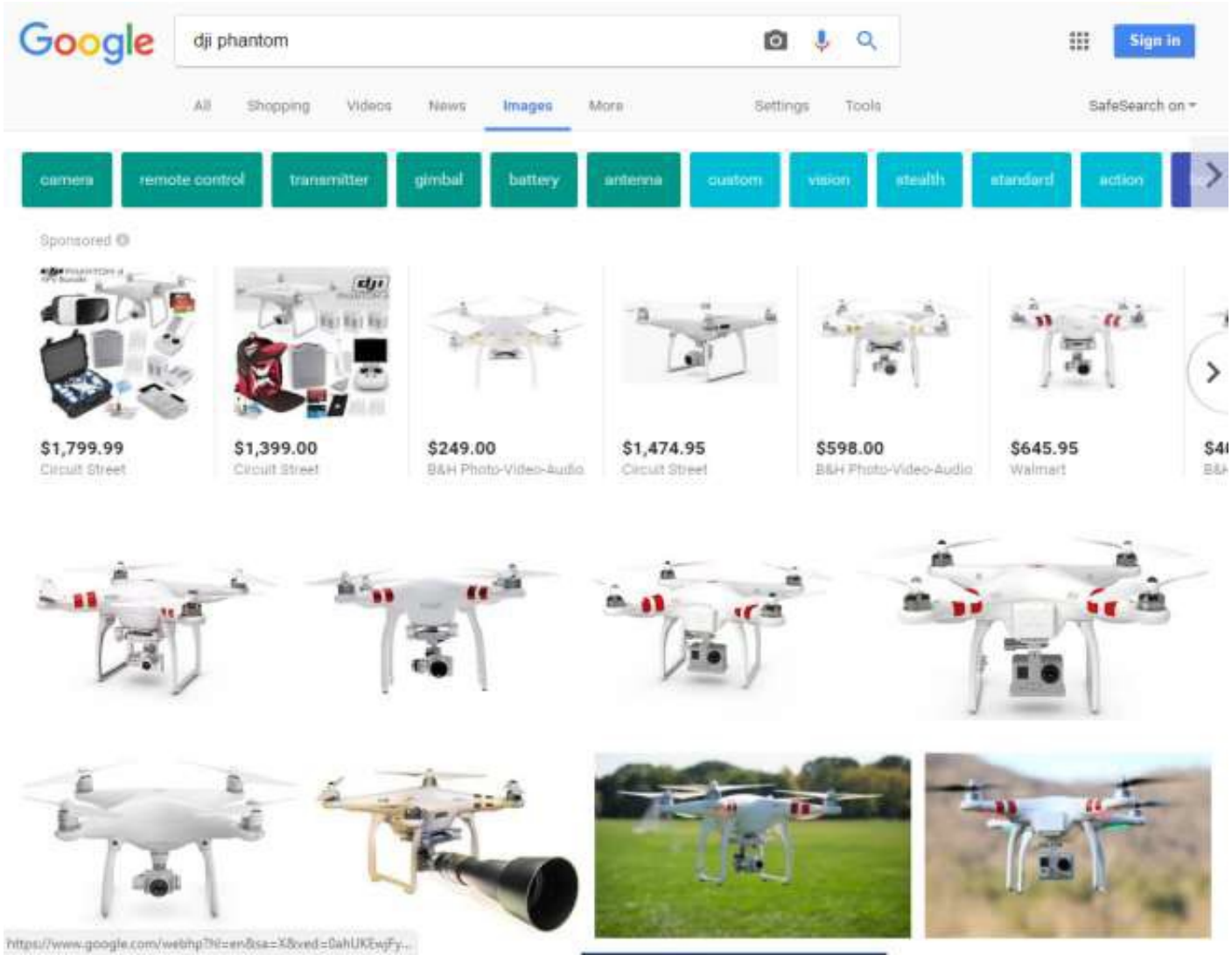
Rotorcraft traveling at slower speeds can support longer sensor integration times at the expense of area covered.

Position accuracy- determined by GPS/IMU accuracy and integration with sensor data- is essential.

Cameras such as Tetracam Mini-MCA or Micro-MCA provide inexpensive multispectral imagery but georeferencing is required.

Piloted platforms are still more cost-effective than UAVs for many applications.

Part 2: The New Age of Quadcopters



DJI Phantom Flights, Tampa Bay, December 2016

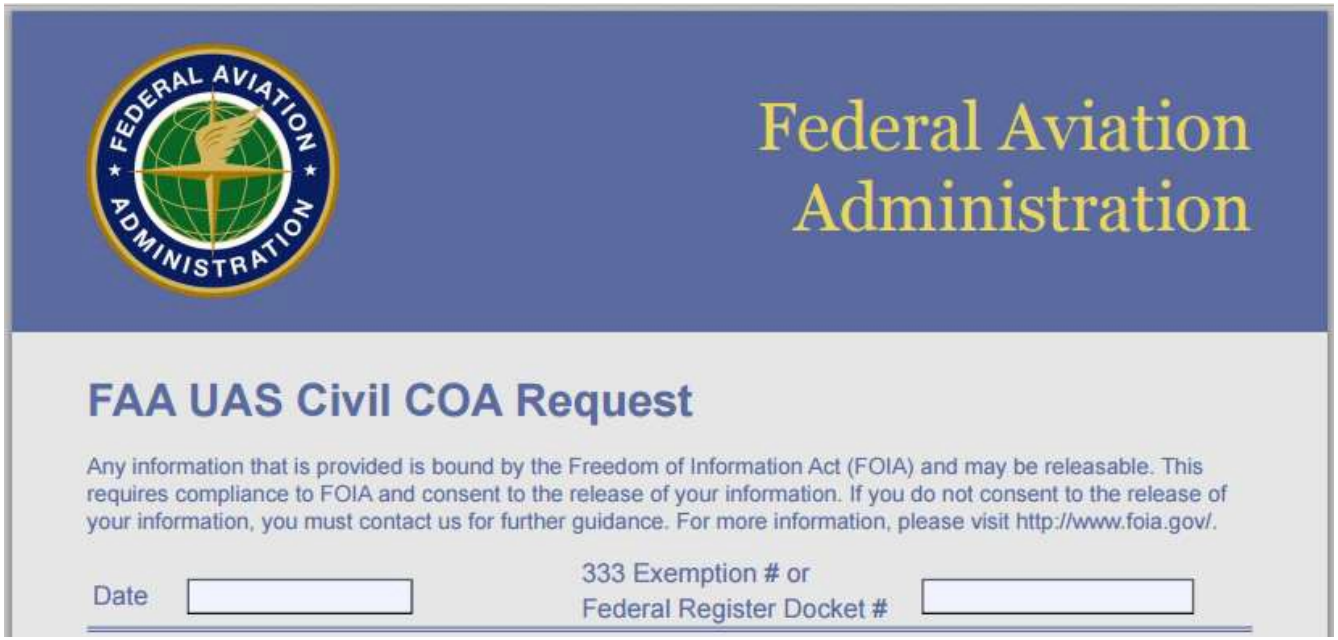
Pilot is not an FWC employee, has FAA Remote Pilot certificate, observing FAA rules for uncontrolled airspace.

Stormwater Detention Site- St. Petersburg

Blind Pass- Gulf of Mexico, St. Petersburg, FL

Part 3: Safety Requirements

UAVs operate in the National Air Space (NAS) under Certificates of Authorization (COAs)- Currently only available to public agencies.

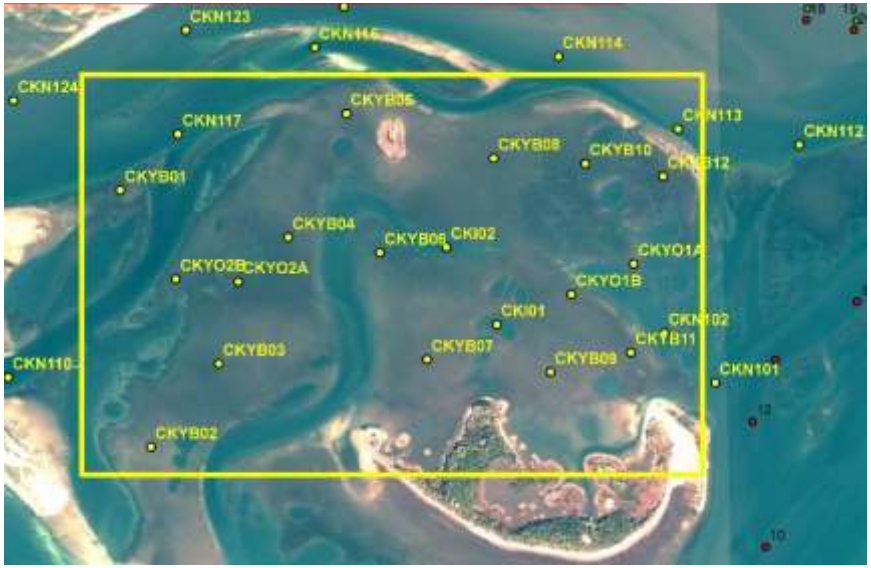


FAA will release a formal policy on commercial UAV operations fall 2015. Exemptions are available under "Section 333." Over 2000 applications have been made, 400 have been granted.

FAA COA Requirements

FAA COA Requirements: Pre-approved flight plans, Detailed performance specifications, Lost communications response, Lost link response, NOTAMs, Continous observation, Continuous communication with range safetyofficer.

Despite elaborate protocols, incursions in NOTAM-defined area by civilian aircraft occur.



Regulations

Use of small UAVs (< 50 lbs) is regulated separately from large UAVs. COA's might not be required, but the pertinent rules depend on the intended use.

www.faa.gov/uas/faqs Is a good place to start With links to the Small UAS rule (Part 107), A flight planning app Called B4UFLY, and Information on the FAA UAS pilot test.

Recreational Flying

Recreational flying- defined “for enjoyment, not for work”

Special Rule for Model Aircraft (PL 112-95, Section 336)

Fly within line of sight

Give way to piloted aircraft

Provide prior notification to airports within 5 miles

Fly a UAV < 55 lbs

Register the UAV with FAA

Fly below 400 ft AGL

Daylight operations only

Don’t fly near people or stadiums

Operation in controlled airspace requires ATC approval

Flying for Work or Business

"Part 107" Rule Applies

Remote Pilot in Command required

Fly within line of sight

Give way to piloted aircraft

Provide prior notification to airports within 5 miles

Fly a UAV < 55 lbs

Register the UAV with FAA

Fly below 400 ft AGL

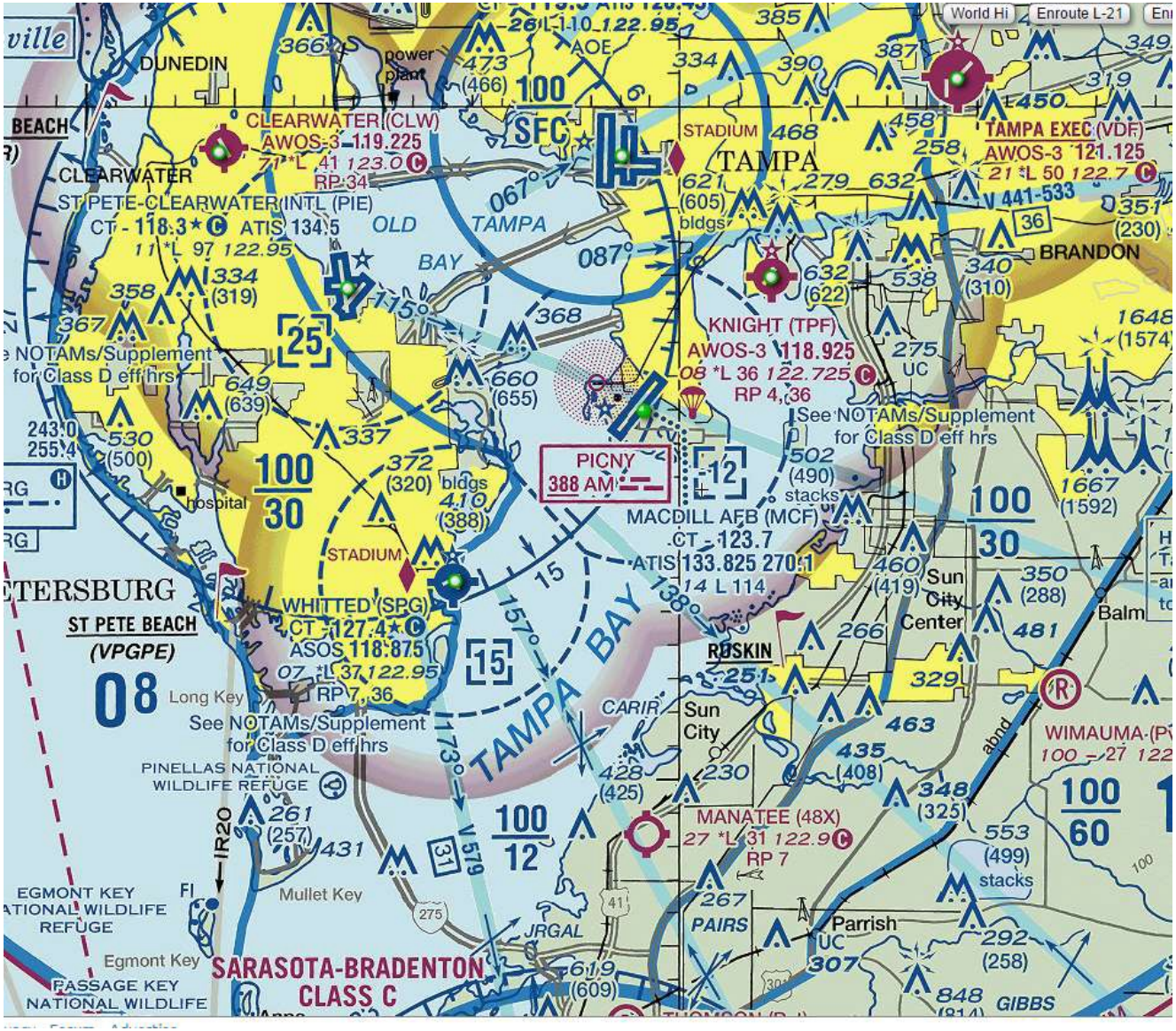
Do not fly near people or sports venues

Daylight operations only, 3-mile visibility required

Operation in controlled airspace requires ATC approval

https://www.faa.gov/uas/media/Part_107_Summary.pdf

Tampa Bay area



FAQs

Can I fly a model aircraft or UAS over a stadium or sporting events for hobby or recreation? No. Federal law restricts UAS from flying at or below 3,000 AGL within a 3 nautical mile radius of any stadium.

Do I have to notify all airports within five miles of where I want to fly recreationally? Yes, you must contact any airports (including heliports and sea-based airports) and air traffic control towers within five miles of your proposed area of operations.

Can an airport operator object to model aircraft flights near an airport? Yes, an airport operator can object to the proposed use of a model aircraft within five miles of an airport if the proposed activity would endanger the safety of the airspace. However, the airport operator cannot prohibit or prevent the model aircraft operator from operating within five miles of the airport. **Unsafe flying in spite of the objection of an airport operator may be evidence that the operator was endangering the safety of the National Airspace System.**

Sierra crashed in the Beaufort Sea in July 2013. An expensive loss, but nobody died, underscoring the utility of UAVs in hazardous environments.

Please email questions to paul.carlson@myfwc.com