

Enhancement of Louisiana Marine Mammal Stranding Response
Through UAS

by

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Executive Summary

The Louisiana Marine Mammal Stranding Network is responsible for monitoring over 7,700 miles of coastline in the state for live, injured, and dead marine mammals. Since 2019, Audubon Nature Institute, through their Audubon Aquarium Rescue (AAR) program, is the only full-time participant in the network. Stranding operations occur all over the state, as far as five hours away from AAR's base of operations in New Orleans. In recent years, out-of-habitat dolphins displaced by hurricanes have become more frequent, presenting new challenges for the network.

This project assesses the potential of unoccupied aircraft systems (UAS), commonly referred to as drones, to help enhance AAR's marine mammal stranding response. UAS is becoming more common in marine mammal conservation and research, but is not yet widely used in stranding response. Research was conducted on current and historic program operations, UAS systems, and relevant policy and regulations related to UAS. Areas of potential improvement were identified based on need within the state and case studies were then selected to show how UAS could be applied to improve current activities or how UAS could have improved past rescues. Google Earth was used to measure distances and create visuals for the project.

Results demonstrate that UAS is a viable tool for AAR to use in marine mammal stranding activities. Incorporation of multirotor and fixed wing drones would expand current routine survey areas, open access to barrier islands that are currently too difficult to survey, provide significant time and cost savings compared to traditional survey methods, and enhance out-of-habitat stranding responses. Policy and regulation remain the biggest obstacles to UAS reaching its full potential within the stranding network. Federal Aviation Administration (FAA) rules like visual line of sight (VLOS) are more restrictive than the technology, which is capable of surveying much larger distances than regulations allow. Additionally, federal prohibitions on foreign made drones could pose problems for establishing a cost effective UAS program, as domestic drone producers are considerably more expensive.

Ultimately, the benefits of UAS outweigh the concerns, and AAR should move forward with development of a drone program for the Louisiana Marine Mammal Stranding Network.

Recommended next steps include UAS field testing in areas identified within the project, proper permitting, UAS training, and purchasing of the program's first drone.

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Introduction

Unoccupied Aircraft Systems (UAS), often referred to as drones, are becoming a common tool in the conservation space to help enhance research, monitoring, and data collection.¹ In Louisiana, the state's marine mammal stranding network² is working diligently to overcome obstacles in stranding response caused by an extensive and constantly changing coastline, natural disasters, and limited resources.³ Drones offer a potential solution to enhance the operations of the stranding network's primary response group, Audubon Nature Institute,⁴ aiding in the ability to provide adequate coverage for the state. This project seeks to assess the applicability of UAS to the Louisiana Marine Mammal Stranding Network and the diverse response areas and scenarios that commonly occur and prepare Audubon Nature Institute with the guidance necessary to help implement a UAS program within their stranding response efforts.

Methods

This project reflects a desktop review of the Louisiana Marine Mammal Stranding Network and how UAS could be applied to it. At no time was UAS deployed in the field to test it in simulated or real stranding response situations or on routine surveys. UAS specifications and results were converted from kilometers and meters/second to miles and miles per hour to reflect how Audubon Nature Institute operates.

Background information was gathered on the Louisiana Marine Mammal Stranding Network and Audubon Aquarium Rescue (AAR). Knowledge presented comes from first-hand experience gained in operation of AAR and participation in stranding response operations.

Research was conducted on current applications of UAS in stranding networks and with similar species encountered in Louisiana stranding operations. A basic cost comparison was done between UAS and traditional occupied aerial surveillance services available in Louisiana.

Information was collected on current regulations relating to UAS operations from federal and state agencies who oversee UAS, manage areas where stranding response occurs, and manage marine mammal stranding activities. Policy and current issues within the field of UAS were also reviewed.

Research was conducted on different UAS equipment to determine best fit for stranding network needs. Specifications were then collected for three models to compare flight time, hovering time, flight range, coverage, speed, wind resisted speed, and video transmission range. Cost was collected on 14 different models and packages for additional cost comparison.

Review was done of common, historic, and potential stranding areas within the network. This included beach survey areas, out-of-habitat (OOH) rescues, and barrier islands of interest along Louisiana's coast. Locations were selected based on current program survey areas, proximity to current survey areas, and areas of high interest based on accessibility and potential for strandings to be found. Measurements were conducted using Google Earth to calculate distance and area currently covered and distance and area that could be covered with addition of UAS into operations. Visual line of sight (VLOS) was set at ½ mile based on review of VLOS research to estimate expanded range of operations.⁵ Time savings of UAS was also estimated by comparing current surveys conducted by foot and motorized vehicle to UAS specifications. UAS speed was set at 26.8mph, the lowest maximum speed against wind amongst the three models,⁶ to reflect likely conditions operating along Louisiana beaches. Motorized response was set at 10mph to reflect Grand Isle speed limit,⁷ while foot speed was set at 2.9mph based on research conducted

on average outdoor walking speeds.⁸ Select cases were highlighted to demonstrate the applicability of UAS within the stranding network.

Grant funding was secured from Protect Wild Dolphins Alliance, Inc.⁹ to attend the Southeast Coastal Ocean Observing Regional Association (SECOORA) Drones in the Coastal Zone Workshop in Beaufort, NC to learn from the community of practice on UAS operations and current topics within the field.¹⁰ Time was also allocated while in Beaufort to visit the Marine Robotics & Remote Sensing (MaRRS) Lab at Duke Marine Lab to learn from team members located there and see UAS equipment firsthand.¹¹

Background

Louisiana Marine Mammal Stranding Network

Audubon Nature Institute is the primary marine mammal stranding response partner for the National Oceanic and Atmospheric Association (NOAA)¹² in Louisiana and is the only rehabilitation facility for marine mammals in the state.¹³ The stranding response and rehab program, known as Audubon Aquarium Rescue (AAR), has existed in some capacity since the opening of the Aquarium in 1990, but the current iteration of the program began in 2019. That year, the Louisiana Department of Wildlife and Fisheries (LDWF),¹⁴ ceased all stranding response work. Previously, LDWF and Audubon shared responsibilities, with the state employing a full-time coordinator and handling the majority of stranding response in Louisiana, with Audubon supporting live response calls and rehabilitation cases. Audubon made the decision to support all stranding response across the state, live and dead, for both marine mammals and sea turtles, setting an ambitious plan to build capacity across the state. In 2019, AAR had one full-time employee and received support from the veterinary team at Audubon. In

2024, AAR will have a four full-time positions, comprised of a stranding coordinator, assistant stranding coordinator, stranding biologist, and a veterinarian, as well as four seasonal stranding response technicians to assist in response across the state during spring, which is typically the busiest time of year for strandings in Louisiana.

Stranding Survey Areas

Audubon Aquarium Rescue is responsible for stranding response across the over 7,700 miles of coastline in Louisiana,¹⁵ which is steadily increasing due to aggressive coastal land loss of 100 yards every 100 minutes.¹⁶ While strandings can occur anywhere, the majority of reported strandings in Louisiana come from the two areas of the state with road accessible beaches: Grand Isle, located 2.5 hours south of New Orleans, and Cameron Parish, located approximately 5 hours away from New Orleans in the southwest portion of the state (Figure 1).

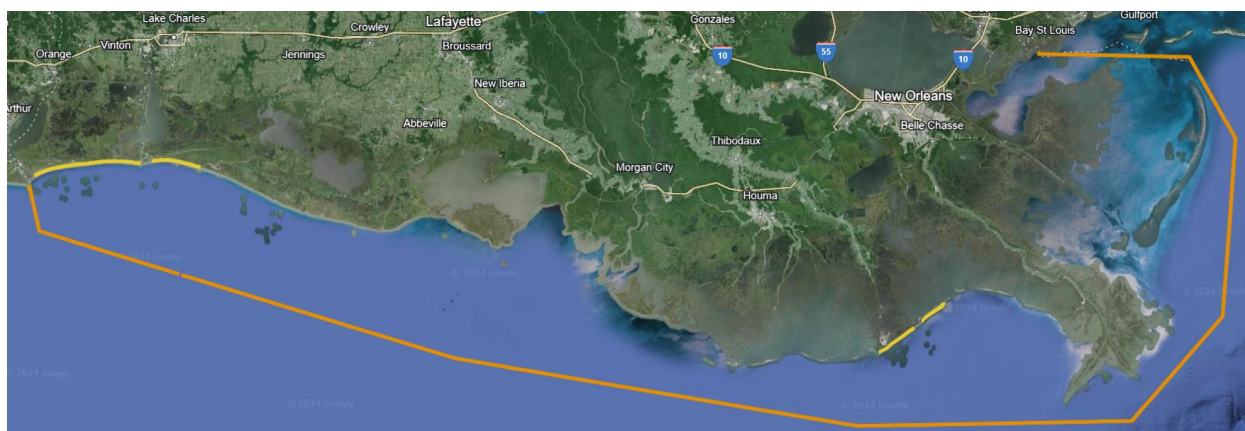


Figure 1. Map of Louisiana stranding response area. Orange line represents approximate border of the state and where strandings could occur. Yellow lines are the areas of Grand Isle (right) and Cameron Parish (left) where most stranding reports originate. Produced with Google Earth.

Grand Isle is the only inhabited barrier island in the state, providing some public support to the stranding network through volunteers and beach goers who can call in strandings to the NOAA hotline, which is one of the reasons reports are typically higher in this area. Public access is allowed on three out of the four beaches in the area: Grand Isle Beach, Grand Isle State Park, and

Elmer's Island Wildlife Refuge, managed by LDWF.¹⁷ The fourth beach, Wisner, is owned by a private land trust that has given AAR access to survey.¹⁸ Grand Isle is also one of the jumping off points to visit several other barrier islands in the area where strandings occur, but have little visitation. AAR currently lacks the resources to visit those islands and must depend on others to report any findings on those islands, which is sporadic at best.

A complete survey day in Grand Isle encompasses the state park, Grand Isle Beach, and Wisner, and takes approximately six hours. Equipment requires a UTV for the surveys and a truck and trailer to bring the UTV to different access points, as the beaches are not contiguous. Trucks are also not allowed on the beaches¹⁹ unless a stranding has been reported, so initial surveys are almost always done by UTV. Elmer's Island is only accessible by foot²⁰ for surveys, so reporting is limited to passive observation by beachgoers. If a stranding is reported, a UTV or truck can be taken onto the beach to investigate with permission from LDWF via an access agreement between Audubon and LDWF.

Southwestern Louisiana contains the most contiguous beach in the state and typically takes two days to survey. The area is sparsely populated, which limits public reporting of strandings. Cameron, historically a town of 2,000 people, has seen a 90% population decline since 2005 due to hurricane impacts.²¹ As a result, AAR has shifted to proactive surveying in the area to try and capture stranding data and is working to establish a permanent team on the western side of the state in the coming year. Trucks are allowed to access most beach areas, but the beaches are poorly maintained, making navigation difficult and UTVs the preferred method of surveying. Observers hired by NOAA for other stranding survey projects have lost equipment due to beach conditions and lack of community resources to respond to distress in a timely manner, making this area dangerous to operate in.

In total, AAR is able to consistently access and survey approximately 60 miles of Louisiana’s coastline throughout the year (Table 1).

Table 1. Primary survey locations and miles routinely surveyed.

Location	Survey Miles
Wisner	10.93
Grand Isle	7.58
Holly Beach	28.26
Cameron Beach	12.87
Total	59.64

Out-of-Habitat Responses

Out-of-habitat (OOH) common bottlenose dolphins (*Tursiops truncatus*) are the majority of live stranding responses in Louisiana since 2020.²² Marine mammals can become OOH in a number of ways. Louisiana’s marsh ecosystem can result in tidally stranded animals. These dolphins often work their way through the marsh during high tides searching for food and find themselves trapped in isolated pools without a way out once tides recede. Once tides return, dolphins can often work themselves back out so long as there are no obstructions in place, but intervention may occur if animals are in too shallow of an area or if tides are not high enough to open access back to open water.

The most common form of OOH marine mammal stranding in the state is due to weather events, primarily hurricanes and tropical storms.²³ Hurricane season runs from June-November²⁴ every year and Louisiana has been heavily impacted over the last four years.²⁵ This impact has also been seen in stranding response, leading to 11 confirmed live strandings across the state from hurricanes since 2020. These strandings can occur anywhere after a storm, but are often the result of storm surge pushing animals inland. As waters recede, dolphins likely seek out deeper areas of water, but those areas do not always lead back to open water. Louisiana’s coast has

many scars of development, including canal systems from both agricultural use and oil and gas exploration, that are both maintained and relics of the past.²⁶ Farmland is also common along the coast. These areas can contain ponds that act as a low point for a dolphin to find themselves in or, if flooded and protected by a levee, the farmland itself can essentially turn into a lake post-storm as surrounding waters recede, requiring dolphins to be rescued.²⁷ Audubon has found themselves in all of these situations, leading to incredibly resource heavy responses due to the unknown nature of each area and situation.

UAS Devices

Louisiana's stranding response needs vary based on the situation, making it likely that multiple and different pieces of UAS equipment will be needed throughout the state. Based on those needs, multirotor and fixed wing drones present the most viable options to support the variety of responses that unfold in Louisiana.²⁸ Multirotors are common in the recreational drone user space and readily available commercially. Multirotors offer flexibility, providing the ability to hover over areas for sustained surveying or to cover greater distances and areas to survey or search, while capturing video in real time for the pilot.²⁹ DJI is the largest drone producer in the world and offers many multirotor options.³⁰ DJI products are mostly prebuilt and include technology and features right out of the box that allow for easy and quick entry into the space. Fixed wing UAS provide the user with a drone designed to survey larger areas.³¹ Fixed wings typically have a longer flight time and maximum distance compared to a multirotor. While fixed wings on the market do not appear to come with payloads intact, they do provide flexibility in allowing the user to install and swap payloads based on need.³² The lack of video capability and live playback in fixed wings does limit their effectiveness in some stranding response scenarios, like live animal monitoring and UAS operations designed to identify strandings in real time.

However, their range does make them more practical for surveying barrier islands, longer stretches of coastline, and disaster zones where access is either difficult or impractical due to the condition and location of the survey area. Video and images are the most important data to collect at this time for stranding response, which also limits some of the benefit to fixed wings, as the technology might not be used to its full payload potential. LiDAR³³ and other mapping features commonly associated with UAS use are not necessary at this time in stranding operations, although survey activities for stranding response could serve a dual purpose in the future to help document changes in Louisiana's coastline from land loss and after hurricanes.

Drone operations in Louisiana for stranding response would occur at or near sea level and with little to no interference from the landscape, which could help drones operate closer to their maximum specifications. Weather, particularly wind along the coast, is the environmental condition that is likely to be the greatest limiting factor for UAS effectiveness. Storms can develop rapidly in coastal areas during spring, the high point for stranding response, and would have to be monitored closely by stranding team members before determining if a drone should be used in any stranding response or survey.

After attending the Drones in the Coastal Zone Workshop and visiting with team members at the MaRRS Lab, three models of UAS were selected for comparison in this project: the multirotor DJI Mavic 3 Pro³⁴ and the fixed wing eBeeX³⁵ and WingtraOne Gen II³⁶ (Table 2).

Table 2. Comparison of maximum specifications for selected UAS.

Model	Flight Time	Hovering Time	Flight Range	Coverage	Speed	Speed w/Wind	Video Range
DJI Mavic 3 Pro	43min	37min	17.39mi	N/A	46.9mph	26.8mph	5.59mi-9.32mi
eBeeX	90min	N/A	22.99mi	1.92 square miles	68mph	28.6mph	N/A
WingtraOne Gen II	59min	N/A	Unknown	1.18 square miles	35.8mph	26.8mph	N/A

Each model provides different benefits on paper, though deployment in the field will be needed to truly compare them, especially the eBeeX and WingtraOne. Overall, the DJI Mavic 3 Pro appears to be the most versatile of the three and is likely to provide the greatest overall benefit to stranding operations. The ability to transmit live video is useful in all stranding scenarios, and the multirotor setup allows for easier launching and landing in a variety of situations, including boat based surveying. While battery life and range is more limited than the fixed-wing models, the ability to monitor live animals in real time makes the Mavic 3 Pro the best first piece of equipment for incorporating UAS into AAR operations.

Federal and State Regulations

UAS are currently regulated by the Federal Aviation Administration (FAA).³⁷ In 2016, the FAA implemented their “Small Unmanned Aircraft Systems (UAS) Regulations,” more commonly known as Part 107.³⁸ Part 107 sets rules for operations of UAS, providing restrictions on where and how to operate drones, including altitude, speed, and visual line of sight (VLOS). VLOS is perhaps the greatest limiting factor in UAS operations, as it sets the range for drone operations as within the unassisted eyesight of the operator.³⁹ The FAA does offer a waiver process for some restrictions within Part 107, but it is unclear how often they grant them.⁴⁰ Under Part 107, drones must be registered for a small fee of \$5 and drones must have their registration number attached to them. Additionally, in order to operate a drone under Part 107, one must become a certified remote pilot, which requires taking and passing an FAA test that covers topics like emergency

procedures, aeronautical decision-making and judgment, airport operations, and airspace classifications.⁴¹

In Louisiana, the Department of Transportation's Aviation Division manages UAS for the state, but mainly redirects users to the FAA and appears to defer to federal regulations.⁴² Louisiana does have eight laws related to UAS, though those are mainly about surveillance and voyeurism concerns and the establishment of fines and jail time if an individual enters into prohibited activities with a drone.⁴³ LDWF also has their own set of UAS restrictions related to lands they manage, which prohibits drone use on any wildlife management, refuge, or conservation areas under their jurisdiction.⁴⁴

NOAA has their own set of regulations for UAS and protected species.⁴⁵ Researchers intending to operate UAS under 100 feet around live animals must apply for a permit from NOAA in order to do so. Information requested from the applicant includes details on equipment, project design, and safety measures. FAA certification is also required to operate under a UAS permit granted by NOAA. Permitting is not required for UAS if operating above 100 feet or if the use is for deceased animal observations.⁴⁶

Application to Stranding Network Activities

Audubon Aquarium Rescue has the potential to be involved in a wide variety of stranding scenarios that may occur in Louisiana at any given time. Habitat, species, equipment, and desired outcome can all play a role in how a stranding response unfolds. These same considerations can also be applied to determining how UAS can be deployed to support stranding network activities (Figure 2), both historically and in future operations.

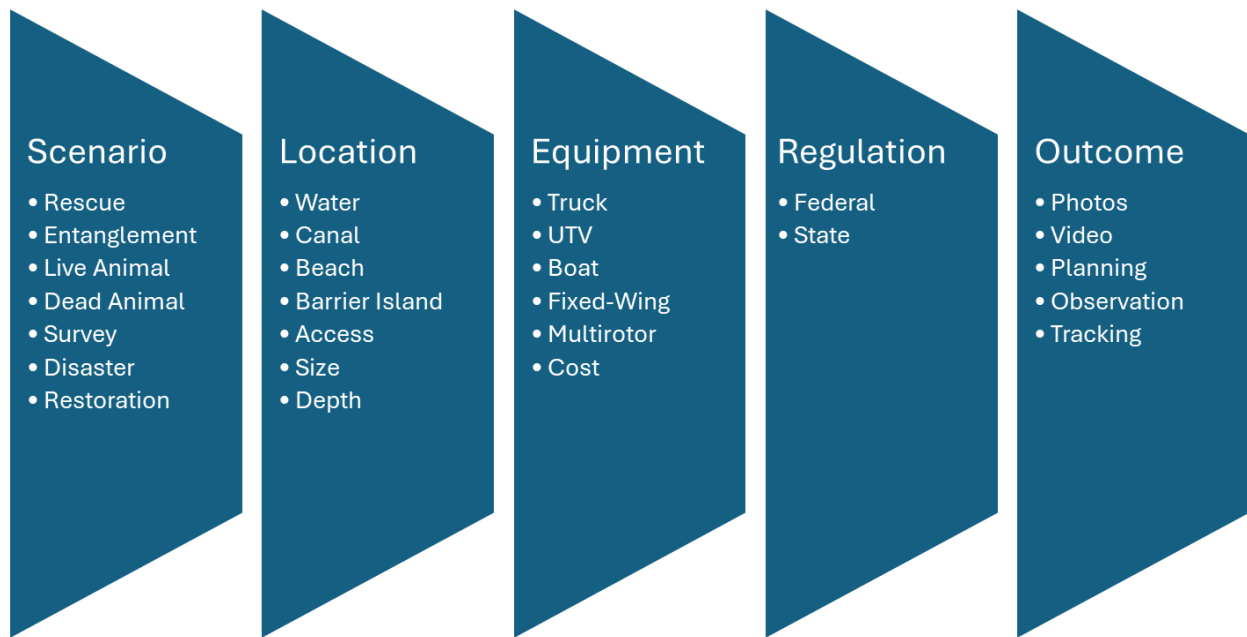


Figure 2. Five main considerations and the factors within each that go into determining how UAS could be applied to a stranding situation.

Coupling this methodology with the review of past and current operations, three key areas were identified that showed the greatest chance of improvement to stranding operations through the incorporation of UAS: increase in stranding survey areas, access to barrier islands, and OOH response support.

Increase of Survey Area

Stranding surveys are the most frequent activity undertaken by AAR to monitor for stranded marine mammals in Louisiana, but survey area is still fairly limited. UAS has the potential to increase survey area within the state by expanding the range of current survey activities and by opening up new areas previously inaccessible to surveying by AAR. By looking at current survey activities and areas of interest near them, 11 priority locations were identified that could become more accessible if UAS were incorporated into survey operations. Distance was

determined in two ways: true distance not covered by current survey, which does not take into account VLOS requirements, and distance that could realistically be covered with the addition of UAS under a ½ mile VLOS. For example, Holly Beach West survey route has 1.96 miles that the current survey team is unable to access via motorized vehicle. UAS would only extend the survey area by ½ miles under VLOS (Figure 3).



Figure 3. Yellow line indicates accessible survey area. Red line indicates area that is inaccessible. Blue line indicates UAS VLOS extended survey potential. Produced with Google Earth.

Some areas do align true distance with VLOS distance, like on the eastern side of Holly Beach (Figure 4) either because the extent of area in need of coverage falls within VLOS or because VLOS can be maintained by operating UAS from a vessel that is able to move in parallel with

the drone as it surveys.



Figure 4. Holly Beach East survey area (yellow) must be accessed by foot for the remaining 0.22 miles (red). The final 0.22 mile stretch could be surveyed instead by UAS, as it falls within VLOS. Produced with Google Earth.

The total true distance of the 11 priority locations is 23.58 miles. VLOS distance of ½ mile reduces the increased coverage area to 13.94 miles (Table 3). UAS could therefore increase survey area in the locations that AAR team members are currently operating in from 59.64 miles to 73.58 miles.

Table 3. Listing of 11 priority locations and their true distance, followed by distance that could be surveyed under VLOS.

Location	True Distance	VLOS
Holly Beach West	1.96	0.5
Holly Beach East	0.22	0.22
Cameron	2.41	0.5
Rutherford	1.3	0.5
Oak Grove Ridge	1	1
Grand Chenier	0.98	0.98
Timbalier Island	4.23	4.23
Snyder's Peninsula (Bay Side)	3.07	2.38
Snyder's Peninsula (From Wisner)	3.07	0.22
Elmer's Island	2.43	0.5
Grand Terre	2.91	2.91
TOTAL	23.58	13.94

Barrier Island Access

Included in the above is the potential to survey barrier islands for strandings with UAS.

Louisiana is home to several uninhabited barrier islands that have confirmed strandings reported over the years. Of particular interest to the program are the islands of Grand Terre⁴⁷ and Timbalier Island,⁴⁸ which are the nearest barrier islands to Grand Isle. Grand Terre is located immediately to the east of Grand Isle. It is separated by a small channel and easily accessible from Grand Isle by boat. Timbalier is to the west of Grand Isle, with access via Grand Isle or Cocodrie to the north. Both islands are frequented by recreational users and by government and conservation groups working on restoration activities,⁴⁹ but no consistent stranding surveys occur there or on any of Louisiana's other uninhabited barrier islands.

Barrier islands present unique challenges to getting accurate stranding data in Louisiana.

Audubon does not have the capabilities to routinely survey these islands, but it is suspected that far more strandings occur in these areas than is known. Even if a vessel could be brought out daily to land, there are no access points to get a UTV or motorized vehicle onto the island without the use of specialized landing craft, requiring surveys to take place by foot. Grand Terre is approximately 2.91 miles of surveyable beach, while Timbalier's surveyable area is approximately 4.23 miles, making walking time without vessel pick up nearly 6 miles for Grand Terre and almost 8.5 miles for Timbalier. Walking those distances with any frequency is highly impractical and likely outside of the realm of real possibility for doing more than a single survey a year on those islands.

UAS could finally make barrier island surveying somewhat practical for AAR. The areas of both Grand Terre (1.17 square miles) and Timbalier (1.29 square miles) fall within the range of a fixed wing's specifications. Additionally, the width of each island falls within ½ mile VLOS,

which would allow for team members to launch a multirotor UAS from a vessel on the more sheltered bay side of the islands and still be able to survey the Gulf side of the island where strandings are more common, while moving the vessel in tandem with the UAS to maintain VLOS along the length of the barrier island. If a stranding is identified during the survey, the team can then land on the island to investigate further (Figure 5).



Figure 5. Mapping of Grand Terre to determine area and width for feasibility of fixed wing operations and multirotor operations via a vessel.

Out-of-Habitat Response

While a fairly small amount of the work that AAR undertakes is live animal response, OOH is by far the most high profile and resource intensive activity the program undertakes.⁵⁰ These rescues require extensive planning and coordination to execute properly, pulling in stranding network

partners from across the country to assist AAR with response. UAS could be incorporated into OOH response in several ways to help increase the efficiency and effectiveness of operations. This will also be critical going forward, as OOH activities are likely to increase with climate change's impacts on the Louisiana coast, both in the form of land loss leading more dolphins into areas they should not be in and more frequent and intense hurricanes in the Gulf of Mexico that can easily displace animals far from their natural habitat.⁵¹

Case Study: Elmer's Island 2023

Some OOH cases can be in place for a significant period of time before a rescue can be attempted, leaving the stranding team in surveillance mode. One case occurred after Hurricane Ida in Grand Isle, LA.⁵² A mother and calf pair were identified in a coastal pond area. The system had tidal flow, so food and salinity was not an issue, but the animals were not leaving the area. The property owner noted that dolphins were not uncommon in the area, but usually made their way in and out, leading the team to suspect an obstruction or change in the landscape occurred from Ida's storm surge. Due to the estimated size and age of the calf, NOAA determined that a rescue needed to wait, so the team observed. The area the animals were in was approximately 0.14 square miles with only a portion accessible by road. There was no boat access on property, making visual observation from shore the only means of assessing the animals. When the dolphins moved out of the road accessible area, they fell out of sight, making observation impossible. This would lead to the team stationing for sometimes up to two hours to try and get a glimpse of the animals to determine well-being to help inform a response timeline. The use of UAS in this case would have likely enhanced scouting and response planning considerably. The distance from the end point of road access to the back of the property was 0.56 miles, which would have allowed for drone coverage within VLOS of nearly the entire response

area (Figure 6). This would have enabled the team to observe behaviors and movement patterns, and also share recordings of the animals with NOAA and other partners to help inform animal health and rescue planning. Time savings would have also been significant, likely reducing scouting time by nearly an hour.

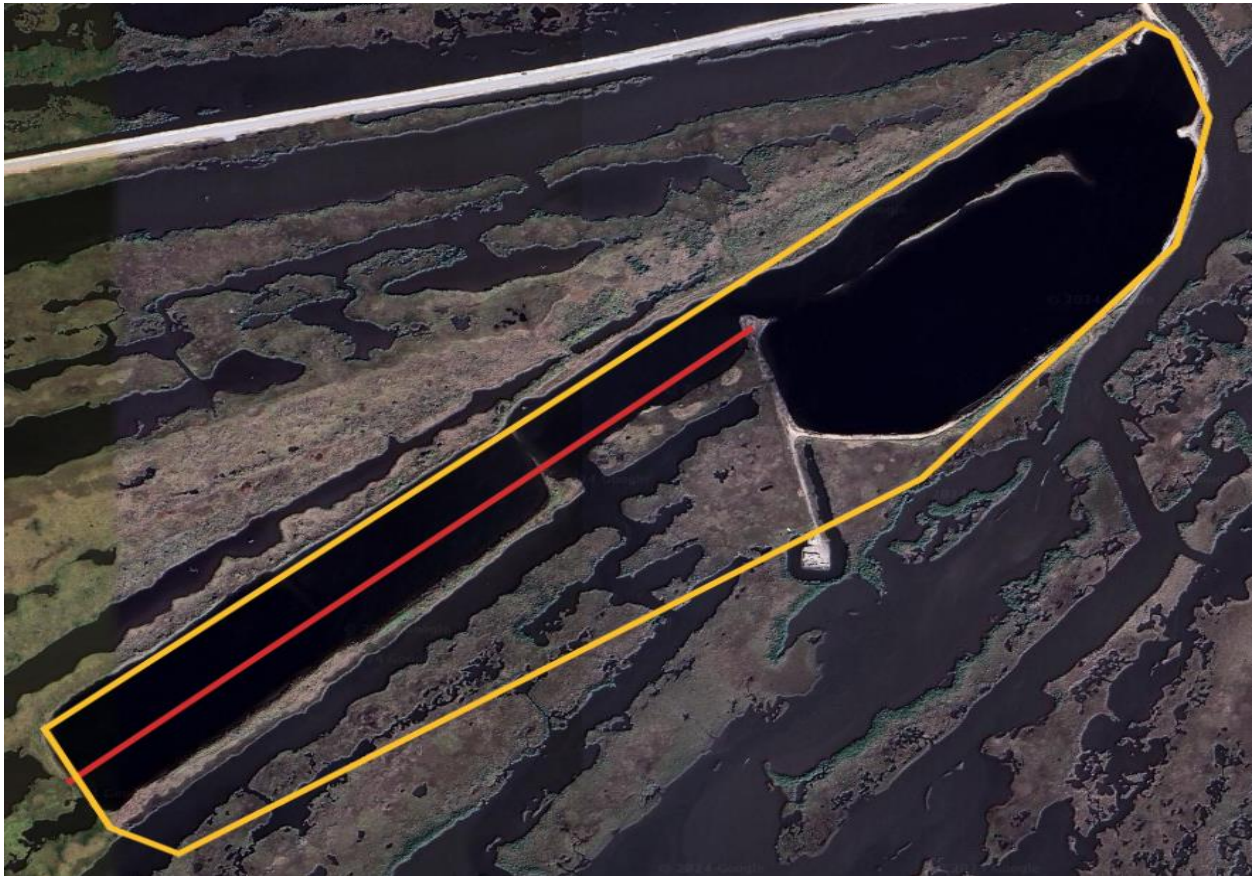


Figure 6. Elmer’s rescue response area. Total area is outlined in yellow. The red line indicates VLOS coverage that could have been achieved with UAS. Produced with Google Earth.

Additionally, a rescue is more than just the capture and relocation of the animals, but also getting to them. OOH rescues, especially those occurring due to storms, require a significant amount of scouting, often in difficult situations. Coastal areas in Louisiana have limited access points, with sometimes only a single road being the way in and out. Boats can often be a better way to

traverse Louisiana, but debris can clog waterways, leaving them difficult to navigate. Waterways can also change post-storm, with navigable channels becoming clogged with debris or sediment, and new waterways being opened due to cuts barrier islands or through the marsh.⁵³ The team relies heavily on Google Earth to scout the terrain in areas that cannot be seen or accessed easily. In the Elmer's 2023 case, the area the animals were located in was too large and deep for safe capture by hand, so vessels were brought in to assist. Maps available to the team did not represent the current landscape due to changes from Hurricane Ida, leading to delays in accessing the area and damage to one boat which prevented it from being able to assist in the rescue. These issues ultimately led to the first attempt being called off. Aerial surveillance via UAS could have been used to help determine the best path through the marsh to the rescue site, either in advance of operations or during. Knowing that marine mammal stranding response can occur quickly after a tropical event,⁵⁴ reliance on systems like Google Earth may not provide an accurate enough picture of the area, making drones even more valuable to help collect information to better inform rescue operation needs.

The aforementioned canal systems of Louisiana are located throughout the coast and are one of the most common places to find OOH animals post-storm. In 2020, southwest Louisiana was hit by hurricanes Laura and Delta, two storms with nearly identical paths.⁵⁵ Out of the seven OOH rescues AAR completed, five were animals found in canal systems. These reports often come from community members returning to the area or from electrical linemen working to reestablish power, who often have a higher vantage point that allows them to spot displaced animals more easily. However, that means that animals are typically spotted only near areas with roadway access. Audubon suspects that animals were also OOH in canal systems and low-lying areas that were never found due to an inability to access these areas. It would be impossible to survey all

areas post-storm with only UAS and traditional flyovers would be more practical, but the ability to use UAS to better scout the canal systems and the areas surrounding the canals could be vital to finding and rescuing more animals in the future.

Case Study: Pumpkin Ridge 2020

The hurricanes that battered Cameron Parish in 2020 stranded three dolphins, a single animal and a mom and calf pair, in an approximately eight mile canal system near an area called Pumpkin Ridge.⁵⁶ The dolphins were suspected to have been pushed in by storm surge via the Mermentau River, but the canal system they became stranded in once waters receded had no access back to the river. Teams were able to spot the dolphins from a roadway that ran parallel to most of the canal, allowing for relatively easy scouting.

However, the area in question contains many miles of canals, most of which can't be surveyed from roadways or are not easily accessible by boat. In this instance, a canal system was located within VLOS from the roadway operations were taking place on. This system was considered a high priority due its proximity to known animals, but no dolphins were spotted from the roadway, which provided a limited vantage point into the canal. Deployment of UAS from the road could have provided survey coverage of an additional 1.25 miles of canal system, helping to ensure animals were not missed while response teams were in the area (Figure 7).

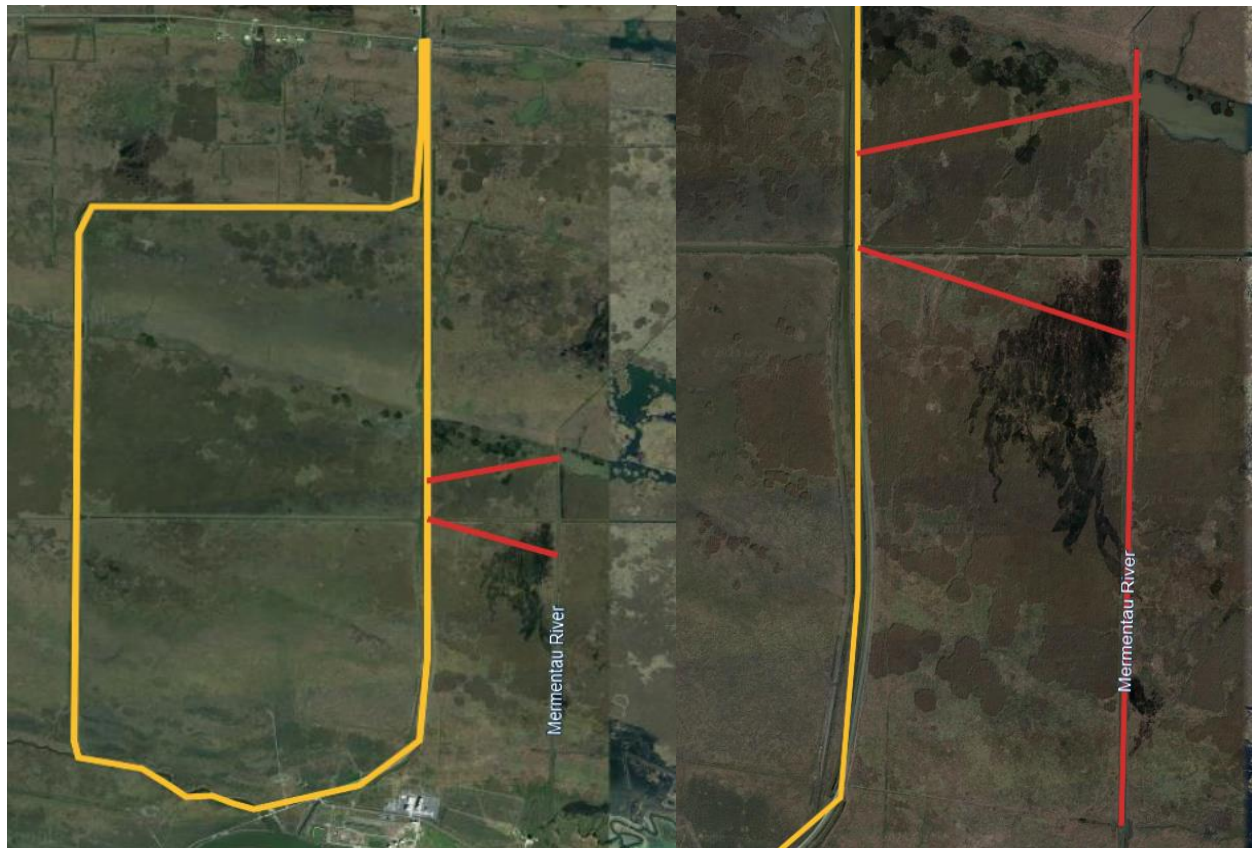


Figure 7. Left image shows canal area highlighted in yellow and red lines that demonstrate VLOS from road. Right image is zoomed in of rescue area with new canal system in red that would have been accessible with UAS. Produced with Google Earth.

Cost Savings

This project was not intended to be a cost/benefit analysis of UAS implementation within the Louisiana Marine Mammal Stranding Network, though some assumptions can be made based on the results of the research conducted. UAS implementation is unlikely to yield considerable programmatic cost savings. In fact, UAS appears more likely to increase annual operating costs since survey range will be expanded, especially if barrier islands become more accessible and the associated costs that come with that, including vessel purchase and/or rental and fuel. But the

overall benefit of increased range of operations and data collection outweighs the cost, especially in a state with so much area to cover.

However, when compared to traditional survey aerial survey methods, UAS can provide considerable savings if they can meet project needs. Fly overs take more planning and coordination and have a significant cost. Volunteer pilots and groups do exist, like SouthWings,⁵⁷ but those are best suited for covering larger areas, are not intended for frequent use, and still require more planning than is commonly afforded in stranding response. Hiring a service is an option, but the cost for routine surveying makes that untenable for most programs, including AAR, without significant external funding. An aerial flight tour out of New Orleans can run for \$320.00 an hour, with a one hour minimum.⁵⁸ While that figure is not excessive in price for occasional use, Audubon conducts beach surveys in Grand Isle five days a week during the months of April, May, and June, for approximately 60 survey days every spring, bringing the minimum cost of manned flight support to \$19,200 for only that part of the state during the spring stranding season. If a similar rate were to be found for the Cameron Parish survey area over a similar timeframe, that would push annual costs for manned aerial surveillance to a minimum of nearly \$40,000 per year. By comparison, a UAS program consisting of both a DJI Mavic 3 Pro⁵⁹ and eBeeX⁶⁰ would have a start up cost of approximately \$25,000, making UAS a much more affordable option to implement aerial surveillance into operations than manned aircraft even if equipment needed to be replaced annually.

Time Savings

UAS has the potential to reduce stranding response time considerably, especially in situations where motorized access is limited or terrain prevents easy incursion by foot. Drones can move

faster than vehicles on beaches, where speed limits are routinely limited to 10mph either by conditions on the beach or by law.⁶¹

Case Study: Elmer's Island

Elmer's Island is a 2.43 mile stretch of beach in a priority stranding area where motorized access is restricted unless a stranding is reported, leaving surveying by foot the only option (Figure 8).



Figure 8. Elmer's Island survey area. Produced with Google Earth.

Survey by foot takes approximately 100 minutes out and back, leaving the area routinely without surveying due to time constraints on staff. Use of a motorized vehicle, if allowed, would take approximately 30 minutes. However, UAS provides significant time savings, and could survey

the area in roughly 11 minutes, almost a third of the time it takes to survey with a motorized option (Table 4).

Table 4. Comparison of Elmer’s Island survey time using different methods.

Method	Speed (mph)	Elmer's Round Trip (miles)	Total Time (minutes)
Motorized	10	4.86	29.16
Foot	2.9	4.86	100.5517241
Drone	26.8	4.86	10.88059701

Other Potential Uses

There are a wide variety of data gaps within the Louisiana marine mammal community that UAS could assist with. Information about the state’s dolphins is inconsistent. Audubon is currently involved in a project designed to recommend an adaptive management strategy for Louisiana’s coastal and estuarine dolphin stocks, which will likely include traditional methods of population assessment like photo identification and aerial surveying. Research has been conducted that demonstrates UAS has potential for both population health monitoring⁶² and photo identification⁶³ in bottlenose dolphins. Louisiana could be an ideal location for additional field testing of these practices over the coming years.

Additionally, Audubon is also the lead partner for NOAA in Louisiana on sea turtle stranding and response. Surveying done with UAS on beaches and barrier islands could also be beneficial to sea turtle stranding response and data collection in the state.

UAS Limitations

UAS does have limitations within Louisiana for stranding response. Even with a beyond visual line of sight (BVLOS) waiver from the FAA,⁶⁴ technology might be too limited for certain types

of response. A lack of ability to get real time data from fixed wing units is problematic if trying to confirm strandings to determine if response is needed or for observation of animals in an OOH setting. Multirotors might be able to transmit live video, but battery life may prevent them from tracking animals over larger distances for prolonged periods of times.

Case Study: Pecan Island 2021

Pecan Island was a 2021 OOH rescue in southwest Louisiana. A single dolphin was identified in an approximately 16.8 square mile area (Figure 9) without access to open water, likely displaced by hurricanes in 2020, triggering a rescue operation. The area in question was difficult to access for scouting, requiring staff to coordinate boat access and property access with local landowners to use a road that provided some inward ground route into the area. While UAS could have helped extend the range of staff scouting capabilities from shore, this location was too large for UAS operations even if BVLOS were granted, as the survey area would exceed or push UAS limits for distance, range, and coverage, leaving traditional scouting with small boats the best option for surveying the area and monitoring dolphin movements.

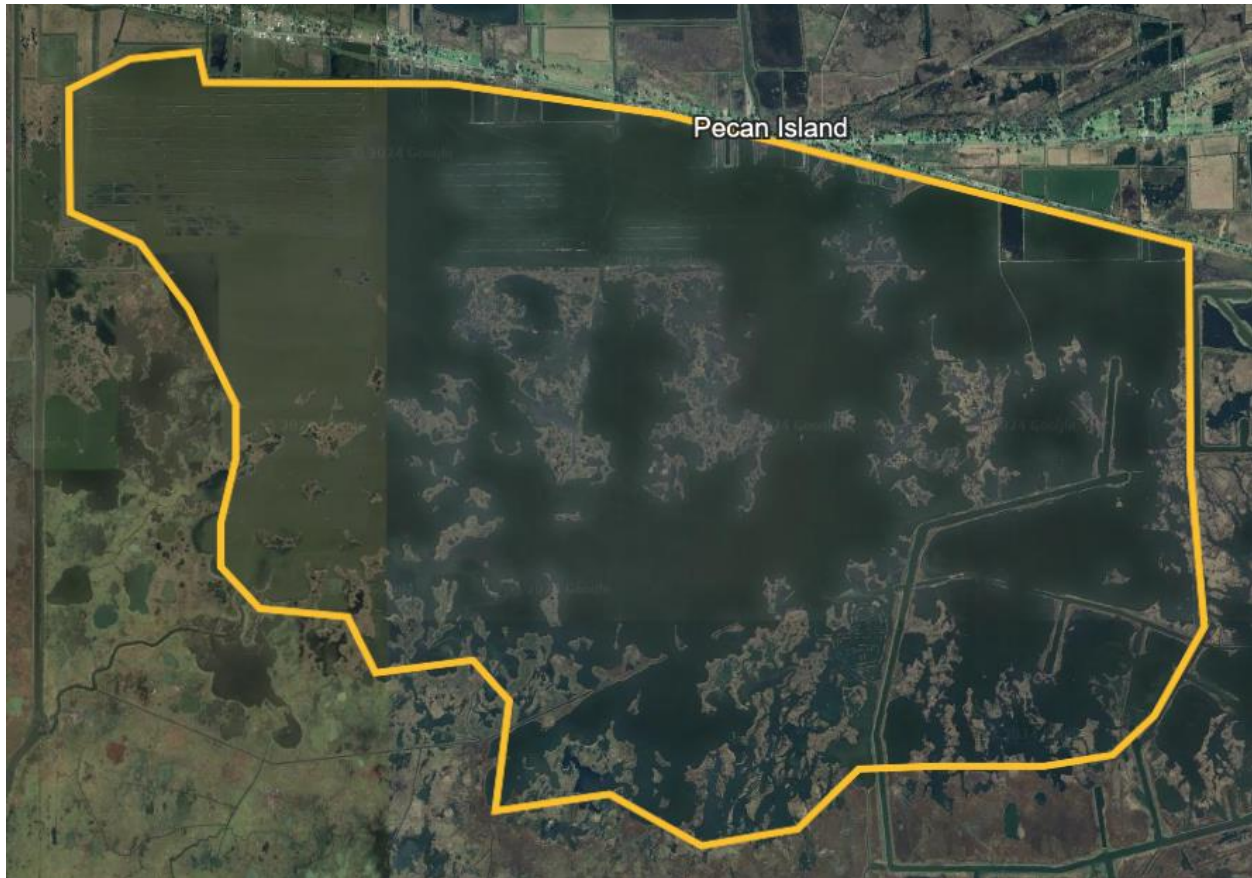


Figure 9. Outline of Pecan Island rescue area. Produced with Google Earth.

FAA rules also prohibit drones from being used during emergency or rescue operations, including hurricanes.⁶⁵ This could complicate or prevent their use during post-disaster stranding response and scouting for OOH animals, which would negate one of the projected best uses of UAS in the state to support the stranding network.

Water clarity might limit some applications as well. Louisiana's inshore and nearshore waters are best described as brown and have very low visibility. Most marine mammals are spotted when surfacing for air and are difficult to track otherwise. Since even the best drone camera doesn't

have x-ray vision (yet), Louisiana's environmental conditions may make UAS less effective at marine mammal monitoring than in areas with higher visibility.

In a yet to be published study from stranding colleagues in Alabama, researchers found only a slight increase in carcass detection from drone use compared to traditional survey methods. The study was controlled, using marine mammal decoys placed by researchers who then sent out trained responders to find them. However, the objectives of the study may not be fully relevant to Louisiana, as UAS would be used to increase and complement current stranding capacity and methods, not replace them.

Politics and Policy

UAS technology is not the major limiting factor in making drones a highly effective tool for marine mammal stranding response in Louisiana. For the most part, UAS can fly far enough to cover many common stranding areas that are currently surveyed via motorized vehicle or foot, survey entire barrier islands from a single launch point, and scan large areas after a disaster to inform rescue operations. Regulation and policy are the biggest hurdles to truly successful UAS use in Louisiana. The FAA's VLOS rule greatly prohibits the potential of the technology in the field, especially for survey work, where drones could replace the need for traditional survey methods in some parts of the state and unlock miles of new areas for surveying.

State policy does not appear to be an issue for the operation of drones for stranding response, as the areas where drones would operate are likely to be remote and with limited human activity in the vicinity. However, LDWF's prohibition of UAS on their managed lands could be problematic, as Elmer's Island is a prime candidate for drone surveys. While Audubon currently has an access agreement for Elmer's, it does not include UAS and it is unclear at this time if LDWF is granting UAS waivers for their management areas.

Drones might not be commonly thought of when it comes to geopolitics, but they are firmly caught up in tensions between China and the United States. DJI is a Chinese company and the global leader in drone production.⁶⁶ However, foreign surveillance fears have pushed DJI into the spotlight, with claims that the company is associated with the Chinese military.⁶⁷ While these allegations have not been confirmed, conservative policy makers have taken to the message and successfully included restrictions on foreign made UAS for certain federal agencies in the FY 24 National Defense Authorization Act (NDAA).⁶⁸ National security interests have also led to the creation of the Blue UAS Cleared List.⁶⁹ Blue UAS are drones that meet Department of Defense standards for security. The companies and models listed are approved for use by federal agencies and those who work with federal agencies.

Blue UAS options appear to have less information available about them than commercially available drones through companies like DJI, likely due to having less users or users that are tied to military and law enforcement operations. This makes it more difficult to assess best options, especially when cost considerations are at play, as most prices must be requested. Many of the Blue UAS options also appear overkill for the needs of this project, as they are heavily geared towards military and law enforcement clients, not those working in conservation or research. This is apparent not only in the drones themselves, which are often equipped with night vision, thermal, and the ability to carry heavier payloads, but in the marketing of many brands, which heavily feature military personnel being supported by their products. The existence of Blue UAS itself may even be driving the market to develop drones with military and law enforcement clients in mind, making drones for other uses less likely to be developed, leading to other fields that work to support the federal government being forced to purchase equipment that is not practical for their needs.

Currently, NOAA is required to follow NDAA guidelines for UAS when purchasing and using equipment themselves. However, programs operating under a federal stranding agreement, like AAR, are not required to follow NDAA guidelines, so long as funds used to procure UAS are not from federal sources. Even though NOAA doesn't currently require Blue UAS drones be used by those operating under federal stranding agreements, the current political climate might make that decision for them in the coming years, with legislation being pushed in Congress that could prevent DJI from being used by any federal agency and broadening the scope of what that entails, including limits on contractors.⁷⁰ From a Louisiana perspective, the state government is highly conservative and has the potential to pass very restrictive laws at the state level even if no federal laws come to fruition.

Restrictions on federal funds being used for DJI products could make a UAS program more difficult to launch for AAR, as the majority of funding for marine mammal work in Louisiana comes from federal sources. Audubon typically receives funding from the John H. Prescott Marine Mammal Rescue Assistance Grant Program, an annual federal grant of up to \$150k,⁷¹ and from NOAA via Deepwater Horizon Trustee Implementation Group (TIG) restoration project funds.⁷² Both funding sources primarily support operational expenses for stranding response in the state, leaving little room for large equipment purchases to be built into the budget. DJI products have a lower financial barrier to entry and would likely be able to fit into one of Audubon's Prescott or TIG budgets. However, the inability to spend federal funds on DJI would require Audubon to generate funds from elsewhere to procure the equipment. While Blue UAS products would be an allowable expense on federal funds Audubon uses to operate their stranding program, the increased expense of those options (Table 5) may make it difficult to

include them in any funding source since it would likely require a reallocation of operational funding to purchase the UAS, which would then impede other program operations.

Table 5. Cost comparison between DJI products and Blue UAS approved products.

DJI	Price
Mavic 3 Pro	\$ 2,199.00
Mavic 3 Pro Cine Premium Combo	\$ 4,799.00
Mavic 3 Pro Fly More Combo	\$ 3,889.00
Mavic 3E Worry-Free Plus Combo	\$ 5,326.00
Mavic 3T Worry-Free Plus Combo	\$ 7,366.00
Average	\$ 4,715.80
Blue UAS	Price
Freefly Astro Base Kit	\$25,254.80
Freefly Astro Map Essentials Kit	\$32,254.83
Inspired Flight IF1200A	\$31,000.00
Parrot ANAFI USA RGB/Thermal	\$ 7,000.00
Skydio X10	\$15,000.00
Teal 2	\$15,809.04
Teal Golden Eagle	\$14,800.00
eBeeX	\$20,000.00
WingtraOne Gen II Package	\$19,900.00
Average	\$20,113.19
Average Multirotor Only	\$20,159.81

Sources: DJI Products,⁷³ Freefly,⁷⁴ Inspired Flight,⁷⁵ Parrot,⁷⁶ Skydio,⁷⁷ Teal,⁷⁸ eBeeX,⁷⁹ WingtraOne.⁸⁰

DJI products meet the majority of program requirements to successfully enhance stranding response operations in Louisiana. They are readily available and could be deployed into the field quickly. Most importantly, they are cost effective, especially for a program with limited funding sources. Blue UAS products are exponentially more expensive to get the same, and possibly less, functionality, than their DJI counterparts, making it much harder to justify the cost/benefit of incorporating this type of technology into program operations.

Next Steps

The results of this project provide enough guidance to help inform next steps of how to best develop a UAS program for AAR. Audubon Nature Institute has access to a certified drone pilot with multirotor equipment who can help AAR assess UAS in simulated stranding scenarios in key areas identified within this project to help determine further applicability. Testing is likely to include deployment of dolphin decoys on beaches and in water to test detection at different altitudes and at different speeds to determine best practices for carcass and live animal detection with UAS. If initial field testing shows promise, then planning can proceed with UAS program development, including Part 107 training and testing for staff, application to NOAA for permitting, UAS purchasing, and implementation in the field.

Conclusion

The Louisiana Marine Mammal Stranding Network has to contend with a diverse array of challenges and AAR's small team carries the brunt of that burden. New tools are needed to help improve efficiency of program activities and the incorporation of UAS can enhance marine mammal stranding response in the state, though there are more limits than originally anticipated. The FAA's rules on VLOS prevents drones from replacing most stranding survey activities. While the technology is readily available and fairly affordable, NDAA restrictions could greatly increase the price of implementation. Still, drones could help expand survey areas, providing an increase in valuable data to inform marine mammal health and population status in Louisiana. Use in OOH rescues could save time in both scouting and operations and be especially useful when searching for animals after tropical weather events. UAS is not going to solve all the issues with stranding response in Louisiana, but it has a high likelihood of becoming a valuable tool to improve the state's stranding network operations.

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