



NATIONAL MARINE  
SANCTUARIES



## AIRBORNE PLATFORM REQUIREMENTS FY 2006 – FY 2015

DRAFT  
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## Table of Contents

This report presents the estimated chartering costs to meet the existing and forecasted in-air requirements of the National Marine Sanctuary Program.

<b>Executive Summary</b> .....	<b>2</b>
<b>I. Introduction</b> .....	<b>4</b>
<b>II. Methods</b> .....	<b>5</b>
<b>III. Aircraft Configuration and Regional Mission Parameters</b> .....	<b>6</b>
<b>IV. Forecasting Requirements</b> .....	<b>14</b>
<b>V. Projecting Flight Hours</b> .....	<b>17</b>
<b>VI. Funding Methodology</b> .....	<b>21</b>
<b>VII. Projecting Funding Requirements</b> .....	<b>23</b>
<b>VIII. Conclusion</b> .....	<b>24</b>
<b>IX. Appendix</b> .....	<b>25</b>
<b>X. Aircraft Requirements by Site</b> .....	<b>41</b>

Cover Photo:  
NOAA Citation along the Big Sur Coast. Photo: Kip Evans



## EXECUTIVE SUMMARY

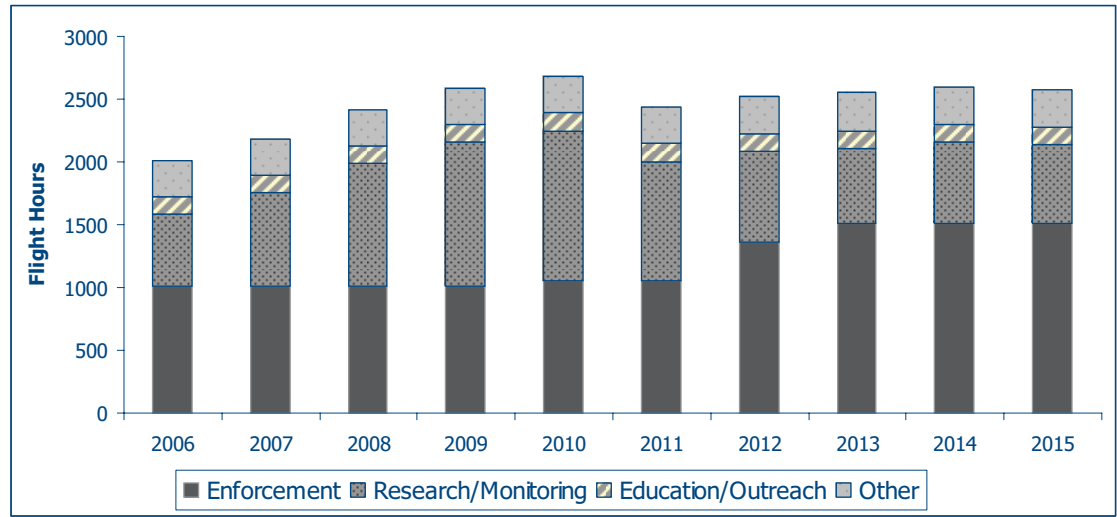
This report quantifies aircraft requirements for the National Marine Sanctuary Program (NMSP). It provides information in a format similar to the 2002 report, “Small Boat Requirements Study, 2003-2012.” During the past three years, significant changes within the sanctuary program and within the National Oceanic and Atmospheric Administration (NOAA) have elevated the requirement for a comprehensive NMSP Aviation Program to ensure safe, efficient and coordinated utilization of aviation assets, and to ensure site requirements are being met. Moreover, new information is available through updated site management plans to specify current and future aircraft use requirements.

The NMSP currently utilizes only one dedicated sanctuary aircraft, a Lake Seawolf amphibian supporting the Channel Islands National Marine Sanctuary (CINMS). Since 1997, CINMS has used the aircraft to monitor and evaluate marine resources and human activities within the sanctuary waters. Currently, the aircraft is providing critical enforcement flights for a newly established network of marine reserves. Other sanctuary sites occasionally charter aircraft support or work with agency partners who operate aircraft; however, there is currently no system-wide plan or other coordinated effort being implemented to maximize efficiency and utilization of these opportunities.

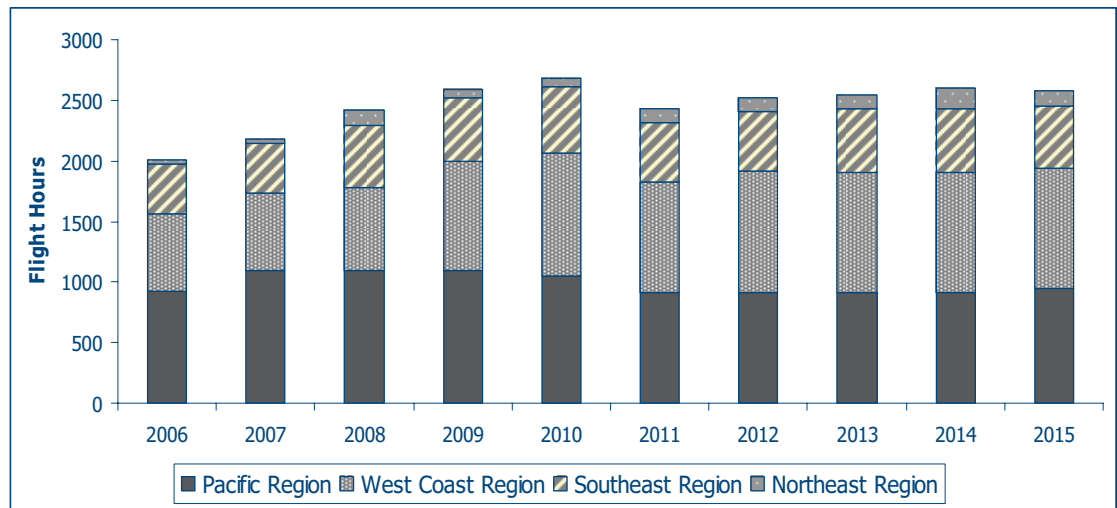
Within the next 10 years, aircraft demand for sanctuary support is expected to increase nearly tenfold. The annual requirement for flight hours is projected to exceed 2500 by 2015, with the largest needs occurring in enforcement and resource monitoring (see Figure 1 and Figure 2). This translates to a need for four regionally based sanctuary dedicated aircraft to support these requirements. These dedicated platforms reflect the maturity of the sanctuary program, the tremendous geographic span of the sites, and the increasingly complex nature of its responsibilities. Given the successful experience with CINMS Lake, the NMSP is now looking to expand that model to utilize aircraft tailored to the mission requirements and operating environments of sanctuaries. Further, program experience suggests the need for dedicated enforcement aircraft for the purposes of public recognition and safety.

While this report does not recommend specific aircraft models to meet the detailed requirements, it does identify types of aircraft that may meet the majority of regional needs in order to calculate funding requirements. In addition, while developing cost and configuration requirements, other technologies such as Unmanned Aircraft Systems (UAS) were not fully analyzed and may fill some specific mission needs. Cost estimates have been derived from historic Aircraft Operations Center data and are presented for each of three aircraft types. Total annual costs for implementation is approximately \$2M to support an annual flight program of 2500 flight hours. A phased-in approach is recommended with full implementation taking place in 2009.

**Figure 1. Flight Hours Required by Function over Time:**



**Figure 2. Flight Hours Required by Region over Time:**





## I. INTRODUCTION

In 1997, the Channel Islands National Marine Sanctuary (CINMS) initiated an Aerial Survey Monitoring Program to monitor and evaluate marine resources and human activities within the sanctuary waters. The Sanctuary Aerial Monitoring and Spatial Analysis Program (SAMSAP) provided vital information for the management of CINMS, most recently critical data for the successful establishment of a network of marine reserves. Currently, the aircraft is providing critical enforcement flights for the newly established reserves. Based in Santa Barbara, Calif., the CINMS utilizes a dedicated Lake Renegade Seawolf (N64RF) in support of CINMS and occasional support for the Monterey Bay National Marine Sanctuary (MBNMS).

The Seawolf amphibian aircraft is utilized for marine mammal and vessel traffic surveys, emergency response and enforcement flights. Special onboard equipment includes bubble and camera windows as well as a laptop computer and customized software linked to the aircraft Global Positioning System (GPS). Position information can be downloaded instantly to register the location of surveyed objects in sanctuary waters and displayed near real-time in a Geographic Information System (GIS) format. The data is archived to provide long-term trend analysis of visitor use, marine mammal distribution and abundance, and kelp forest health and patterns.



NOAA Lake Amphibian over Channel Islands National Marine Sanctuary. Photo: Channel Islands National Marine Sanctuary

Other sanctuary sites occasionally charter aircraft support or work with agency partners who operate aircraft; however, there is currently no system-wide plan or other coordinated efforts being implemented to maximize efficiency and utilization of these opportunities. The purpose of this document is to analyze the requirements for aircraft support by region in the sanctuary system and provide a comprehensive plan and budgetary figures for meeting the 100% requirements for aircraft within the National Marine Sanctuary Program (NMSP).

In 2002, the NMSP completed a comprehensive inventory and evaluation of all small boats owned and operated by the program. This effort documented the maturing nature of the Program and, consequently, the increased requirement for on-water support for site characterization, research and monitoring, education, enforcement, emergency response and other activities. As the 2005 review began, it was determined that an Aircraft Requirements Study be conducted concurrently with the updated Small Boat Requirements Study. This strategy was also shaped by several changes within NOAA and the NMSP since 2002.

## RECENT CHANGES WITHIN NOAA

### **New Administrative Requirements and Long-Term Planning and Budgeting.**

In 2003, NOAA redefined its long-term planning and budgeting process. The Planning, Program, Budgeting and Execution System (PPBES) require programs to quantify its resource needs for “sliding” five year periods (e.g., in FY05, PPBES focuses on resource needs for FY08-12). Beginning with the original small boat plan in 2002, the NMSP has been developing 10-year planning documents for most of its major thematic areas. The information presented in these documents is readily translated to the PPBES process – thus, it is one of the drivers for creation of an aircraft 10-year plan.

## RECENT CHANGES WITHIN THE NATIONAL MARINE SANCTUARY PROGRAM

### Deputy Director for Facilities, Safety, Vessels and Aircraft.

In 2003, the visibility and potential of aircraft was elevated through program reorganization and the assignment of an NMSP Deputy Director as program lead. This action formalized the disparate components of the program, established a mechanism for defining and investing in program-wide requirements, and centralized the ability to comply with agency and national standards. Additionally, it united aircraft and small boats within NMSP “facilities” so that infrastructure requirements are more tightly linked.

### Revised Sanctuary Management Plans.

The requirement for aircraft is derived directly from site-based management plans that direct the science, education, outreach, enforcement, maritime heritage and emergency response functions that meet the management objectives of that site. These plans are updated periodically and reflect the expanded capacity of each site to achieve elements of its mandated responsibilities. Within the past three years, 10 sanctuaries have been engaged in a public process to update their management plans, and by extension, to quantify those functions that require aircraft.

## II. METHODS

This report is modeled upon the recently updated Small Boat Requirements Study. It follows the same format and presents information under similar subsections – aircraft configuration, mission parameters, projected use requirements, and funding estimation methods. However, the methods used to develop this aircraft study are significantly different in some aspects, most noticeably in the funding and acquisition of assets. In the small boat study, it was assumed that the NMSP would purchase, operate and maintain the required on-water assets to meet the program requirements. For this aircraft study, it is assumed that the acquisition, operation and maintenance of all aircraft would be handled by the Aircraft Operations Center (AOC) or an appropriate charter operation. In this scenario, the NMSP would simply be paying for the utilization of the asset, simplifying the funding requirements.

**Figure 3. Sanctuary Management Resource Protection Functions that Require Aircraft**

Site Characterization	<ul style="list-style-type: none"> <li>• Shoreline mapping</li> <li>• Bathymetric and Topographic LIDAR</li> </ul>
Research, Monitoring, and Observing Systems	<ul style="list-style-type: none"> <li>• Living Marine Resource surveys</li> <li>• Vessel Traffic surveys</li> </ul>
Enforcement	<ul style="list-style-type: none"> <li>• Zoning enforcement</li> </ul>
Education and Outreach	<ul style="list-style-type: none"> <li>• Students, teachers, VIP in-air</li> <li>• Volunteer activities</li> <li>• Air shows</li> <li>• Media Opportunities</li> </ul>
Emergency Response	<ul style="list-style-type: none"> <li>• Spills and threat mitigation</li> </ul>

For calculating flight-hour requirements, a data collection template was developed to quantify, in a consistent manner, the existing and projected aircraft use requirements for each sanctuary. Figure 3 depicts the assessed use for each of the major functions that support sanctuary management – conservation science, enforcement, education/outreach and emergency response as well as other site-specific uses. In addition, the total number of flight hours historically utilized by each sanctuary was obtained by reviewing their operations records.

Forecasted (projected) use requirements through 2015 were based, primarily, on updated management plans recently completed (or significantly underway) at several sanctuaries. In many cases, the requirements for aircraft can be

extrapolated directly from these management plans which describe the extent of monitoring, education, enforcement and other resource protection functions required during the next five years. For those sites not engaged in management plan review and for all sites needing to forecast aircraft needs 10 years from now, the sanctuary “life cycle” model provided a consistent framework for this assessment. The life cycle defines six stages of sanctuary evolution and for each stage, defines the capacity (and by extrapolation, the aircraft requirement) expected at each sanctuary to fulfill its mandated responsibilities for resource management and protection.



Lake Renegade Seawolf flies over Channel Islands National Marine Sanctuary in one of several sanctuary aerial monitoring surveys. Photo: NOAA

### III. AIRCRAFT CONFIGURATION AND REGIONAL MISSION PARAMETERS

The type of aircraft required for each sanctuary region will be based on the type, size, speed, range, and airport runway length needed for each mission profile. The aircraft should be a multi-mission, flexible platform that can support the full suite of operations in each region. Visual surveys are typically flown at lower altitudes and slower speeds. A standard profile for a living marine resource survey or vessel traffic survey would be a five to six-hour flight, flown at 1,000 feet and 120 knots. For remote sensing work, the aircraft should be able to work up to an altitude of at least 25,000 feet. Required range and duration will be region-specific in order to operate in the entire sanctuary geographic area. Table 1 describes the regional sanctuary program requirements.

Table 1. Regional Sanctuary Program Requirements

Region	Sanctuary Area (sq nmi)	Living Marine Resource Survey	Aerial Enforcement	Vessel Traffic	Emergency Response	Remote Sensing	Logistical Support	Marine Debris
Northeast	974	Y	Y	Y	Y	Y	N	N
Southeast	2,931	Y	Y	Y	Y	Y	N	N
West Coast	9,120	Y	Y	Y	Y	Y	N	N
Pacific*	100,560	Y	Y	Y	Y	Y	Y	Y

\*- includes Papahānaumokuākea Marine National Monument

## AIRCRAFT CONFIGURATION AND INSTRUMENTATION

A basic configuration for any aircraft expected to meet the minimum requirements of an NMSP platform should include:

- Seating for two flight crewmembers and three to four scientific personnel;
- Multi function display for trackline navigation, coupled with the aircraft autopilot;
- Marine VHF radio (to provide communication with shipboard activities);
- Communication/intercom jack at each workstation and for each crew member;
- UHF and HF radio communication;
- Isolated intercom system for flight crewmembers; and
- Traffic Alert and Collision Avoidance System (TCAS).

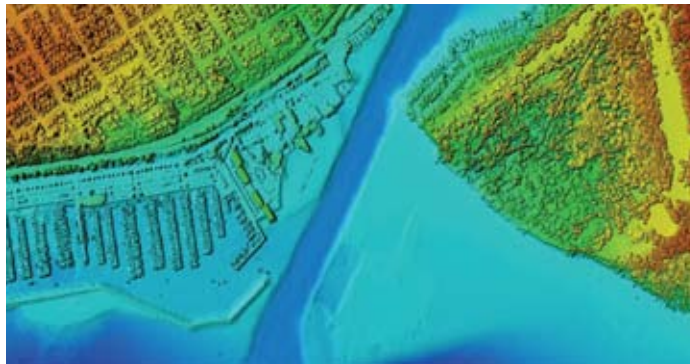
In addition, other configurations and instrumentation requirements are needed for different types of NMSP missions and are outlined in Table 2.

### Visual Surveys

For sanctuary visual surveys and enforcement flights, aircraft should be configured with a high wing and bubble type or large observer windows including a camera window. A high wing design allows unobstructed downward visibility during trackline surveys for identifying vessels, marine mammals, etc. Bubble windows provide observers a field of view from directly underneath the aircraft to the horizon. These type of windows are preferable to large flat observer windows to ensure trackline visibility and prevent an under aircraft “blind spot.” A camera window provides the ability to open or remove part of the window to allow observers to shoot video or still photography un-obscured by plexiglass. For these types of surveys, scientific power requirements are limited to minimum AC power for laptops, cameras, etc. The aircraft should be equipped with an accessible GPS antenna to integrate with survey software.

### Remote Sensing

For NMSP remote sensing missions, the aircraft should have no less than three fuselage apertures of different shapes and sizes to accept optical windows or structural plates that serve as mounting locations for a variety of remote sensing instruments. At least two standard nineteen-inch instrument racks should be easily mountable and reachable within the cabin for instrumentation. Optical windows in the aircraft floor can be located either side by side, or directly behind each other. Optical windows must have defogging and heating capability. The optical windows need to have specific characteristics so as not to limit resolution and performance of the mapping systems. One of the optical windows in the fuselage



Topographic and Bathymetric LIDAR data merged. Photo: Jason Woolard

needs to be easily removable for use with instrumentation due to the fact that the sensor will be affected by optical properties. A pressurized vessel in which the sensor hangs inside the vessel may be employed. In addition the aircraft should be equipped with an L1/L2 GPS antenna and an upward looking mounting plate to support a radiometric sensor for atmospheric modeling. The various types of instruments that may be carried in support of these

missions require electrical power supplied by the aircraft. The aircraft scientific power system should provide at least 400 amperes of 28VDC power for scientific systems. Of that power, inverters should be able to provide up to 50 amperes of 115VAC. Both DC and AC power should be available at drops in at least four locations in the cabin, close to where scientific equipment is anticipated to be installed. Control switches and monitoring gauges for this system should be installed in the cockpit. An on-board Auxiliary Power Unit (APU) would allow for running instrumentation while on the ground to support conducting tests and calibration, as well as providing power for scientific systems during engine start. In addition, supplemental cooling of the cabin and cockpit is required so crew and instrumentation can effectively operate in warmer climate areas.

### Special Requirements

A larger than normal aircraft cargo door would provide unrestricted access for loading and unloading of equipment and instrumentation. An aft ramp that allows for roll-on/roll-off capability is required to create a true logistical support and emergency response platform.

Table 2. Required Configuration/Instrumentation

	Bubble/Observer Windows	Camera Window	High Wing	Scientific Power	Multiple Sensor Ports	Moving Map Display	Instrumentation Rack	Large Cargo Door / RO-RO
Mission Type								
Enforcement	x	x	x			x		
LMR Surveys	x	x	x			x		
Vessel Traffic	x	x	x			x		
Emergency Response	x	x	x	x	x	x	x	x
Remote Sensing				x	x	x	x	x
Logistical Support								x
Marine Debris	x	x	x			x		

### Mission Profiles and Flight Parameters

The type of aircraft required for each sanctuary region will be based on the type, size, speed, range, and airport runway length needed for each mission profile. The aircraft should be a multi-mission, flexible platform that can support the full suite of operations in each region. Visual surveys are typically flown at lower altitudes and slower speeds. A standard profile for a marine mammal or vessel survey would be a five to six hour flight, flown at 1,000 feet and 120 knots. For remote sensing work, the aircraft should be able to work up to an altitude of at least 25,000 feet. Required range and duration will be region-specific in order to operate in the entire sanctuary geographic area.

## NORTHEAST, MID-ATLANTIC & GREAT LAKES REGION

The Northeast, Mid-Atlantic & Great Lakes region includes three sanctuaries, Thunder Bay, Stellwagen Banks and, *Monitor* National Marine Sanctuaries, all relatively small in size. Flight support for this region requires a platform capable of performing medium range offshore surveys of long duration. There are sufficient airfields and aviation services throughout the region. Tables 3, 4, 5 and 6 describe the regional mission parameters.

**Table 3. Northeast, Mid-Atlantic & Great Lakes Region Mission Parameters**

	Altitude (MSL)	Velocity (Kts)	Range (NM)	Duration (HRS)	Minimum Length of Runway for Operations (FT)	Scientific Instrumentation Payload (LBS)	Scientific Crew or System Operators
<b>Requirement</b>							
<b>Marine Mammal Surveys</b>	1,000	120 - 250	500	5	5,000	1,000	2
<b>Vessel Traffic / Human Use</b>	1,000	120 - 250	500	5	5,000	1,000	2
<b>Remote Sensing</b>	4,000 - 25,000	140 - 250	500	5	5,000	1,500	2
<b>Enforcement</b>	1,000 – 5,000	140 - 250	500	5	5,000	1,000	2
<b>Emergency Response</b>	1,000 – 5,000	120 - 250	500	5	5,000	1,500	2
<b>Logistical Support</b>	N/A	N/A	N/A	N/A	N/A	N/A	N/A

## SOUTHEAST, GULF OF MEXICO and CARIBBEAN REGION

The Southeast, Gulf of Mexico and Caribbean region includes three sanctuaries, Gray's Reef, Flower Garden Banks and Florida Keys National Marine Sanctuaries. The Florida Keys National Marine Sanctuary, by far the largest in this region, drive the requirements for this region. Stretching 220 miles from Key Biscayne to the Dry Tortugas, Florida and surrounding approximately 1,700 small islands, the Florida Keys sanctuary offers a relatively benign flight environment with the exception of offshore work. There are adequate airfields and aviation services to support flight operations along the island chain.

**Table 4. Southeast, Gulf of Mexico and Caribbean Region Mission Parameters**

	Altitude (MSL)	Velocity (Kts)	Range (NM)	Duration (HRS)	Minimum Length of Runway for Operations (FT)	Scientific Instrumentation Payload (LBS)	Scientific Crew or System Operators
<b>Requirement</b>							
Marine Mammal Surveys	1,000	120 - 250	750	5	5,000	1,000	2
Vessel Traffic / Human Use	1,000	120 - 250	750	5	5,000	1,000	2
Remote Sensing	4,000 - 25,000	140 - 250	750	5	5,000	1,500	2
Enforcement	1,000 – 5,000	140 - 250	750	5	5,000	1,000	2
Emergency Response	1,000 – 5,000	120 - 250	750	5	5,000	1,500	2
Logistical Support	N/A	N/A	N/A	N/A	N/A	N/A	N/A



## WEST COAST REGION

The West Coast Region includes five sanctuaries situated between Santa Barbara, California and Neah Bay, Washington and include Channel Islands, Monterey Bay, Gulf of Farallones, Cordell Bank and Olympic Coast National Marine Sanctuaries. These sites are comprised of remote offshore islands and long stretches of sparsely populated, undeveloped shoreline. While the great distance between these sanctuaries prevents the easy sharing of research vessels, it poses no great difficulty for sharing an aircraft. The large geographic areas covered by some of the sanctuaries, such as the 4,000 square nautical miles of Monterey Bay necessitate a platform capable of extended range. There are sufficient airfields and aviation services throughout the region.

**Table 5. West Coast Region Mission Parameters**

	Altitude (MSL)	Velocity (Kts)	Range (NM)	Duration (HRS)	Minimum Length of Runway for Operations (FT)	Scientific Instrumentation Payload (LBS)	Scientific Crew or System Operators
<b>Requirement</b>							
Marine Mammal Surveys	1,000	120 - 250	1000	5	5,000	1,000	2-3
Vessel Traffic / Human Use	1,000	120 - 250	1000	5	5,000	1,000	2-3
Remote Sensing	4,000 - 25,000	140 - 250	1000	5	5,000	1,500	2-3
Enforcement	1,000 – 5,000	140 - 250	1000	5	5,000	1,000	2-3
Emergency Response	1,000 – 5,000	120 - 250	1000	5	5,000	1,500	2-3
Logistical Support	N/A	N/A	N/A	N/A	N/A	N/A	N/A



## PACIFIC ISLANDS REGION

The Pacific Islands Region includes two sanctuaries and one national marine monument. These include the Hawaiian Islands Humpback Whale, Fagatele Bay located in American Samoa and the Papahānaumokuākea Marine National Monument. The Hawaiian Islands Humpback Whale sanctuary is comprised of 1,035 square nautical miles spread out over five separate areas through the main Hawaiian Islands. Suitable airports and aviation services are readily available.

The Papahānaumokuākea Marine National Monument is one of the most remote areas in the Pacific. An enormous area, it encompasses the marine waters and submerged lands of the Northwestern Hawaiian Islands extending approximately 1,200 nautical miles long and 100 nautical miles wide. There are only two landing strips in the Northwestern Hawaiian Islands, one at French Frigate Shoals and one at Midway Island. The runway at French Frigate Shoals is only 3,100 feet long and composed of crushed coral. Aviation fuel is consistently available only at Midway and at the time of this document, the future of the runway at Midway is uncertain. The requirements for aircraft support of the Papahānaumokuākea Marine National Monument are the main driver of the Pacific Region requirements. For more detailed, site-specific requirements, see the appendix.

**Table 6. Pacific Islands Region Mission Parameters**

	Altitude (MSL)	Velocity (Kts)	Range (NM)	Duration (HRS)	Minimum Length of Runway for Operations (FT)	Scientific Instrumentation Payload (LBS)	Scientific Crew or System Operators
<b>Requirement</b>							
Marine Mammal Surveys	1,000	120 - 250	2500	10	5,000	1,000	2-4
Vessel Traffic / Human Use	1,000	120 - 250	2500	10	5,000	1,000	2-4
Remote Sensing	4,000 - 25,000	140 - 250	2500	10	5,000	1,500	2-4
Enforcement	1,000 – 5,000	140 - 250	2500	10	5,000	1,000	2-4
Emergency Response	1,000 – 5,000	120 - 250	2500	10	5,000	1,500	2-4
Logistical Support	25,000	250	2500	10	3,000*	10,000	20
Marine Debris	1,000	120 - 250	2500	10	5,000	1,000	2-4

\* Runway length for French Frigate Shoals

## UNMANNED AIRCRAFT SYSTEMS

In terms of developing a range of cost and practical requirements for this document, the potential for utilizing Unmanned Aircraft Systems (UAS) to meet specific mission requirements was not fully analyzed. While UAS are continually expanding their capabilities, they are not yet a proven lower-cost alternative to traditional manned platforms for either military or civilian application. UAS platforms are still in the infancy stages with respect to civilian government research projects and access to the national air space (NAS) through the Federal Aviation Administration (FAA). At this point in time costs for the larger systems are generally expected to be higher than for manned aircraft. UAS-based missions are not likely to replace traditional manned aircraft missions in the near future, but will instead complement and enhance them by providing unique datasets. The NMSP, with its multi-mission requirements, offers the perfect “research laboratory” to further refine the capabilities and specific missions applicable to UAS within NOAA. Table 7 provides a look at NMSP missions and the potential for UAS use.

**Table 7. Potential for UAS Support of Sanctuary Requirements**

Requirement	UAV Type*		
	HALE	MALE	LASE
Marine Mammal Surveys	N/A	Although no established alternative method to visual observers has been developed, there are specific situations where a UAS equipped with an airborne survey package could be utilized: <ul style="list-style-type: none"> <li>• Long endurance surveys</li> <li>• Night time surveys with thermal imagery</li> <li>• Focused surveys of known concentrations</li> <li>• Tracking tagged animals</li> </ul>	
Vessel Traffic / Human Use	N/A	Potential for UAS equipped with imaging systems to study and quantify human use patterns especially in remote areas such as NWHI. <ul style="list-style-type: none"> <li>• Night time surveys with thermal imagery</li> <li>• Surveys of marine zoning, traffic lanes</li> </ul>	
Remote Sensing	N/A	Although the costs are potentially higher than manned aircraft, there are specific situations where a remote sensing equipped UAS could be utilized, such as the remote NWHI	
Enforcement	N/A	High potential for UAS equipped with imaging systems to offer access and discrete capabilities especially in remote areas such as NWHI. <ul style="list-style-type: none"> <li>• Night time patrols with thermal imagery</li> <li>• Surveys of marine zoning, fisheries</li> <li>• Radar</li> </ul>	
Emergency Response	N/A	Potential for long endurance observations and command and control of response activities	High potential for quick response observations
Logistical Support	N/A	N/A	N/A

\*HALE – High Altitude-Long Endurance  
 MALE – Medium Altitude-Long Endurance  
 LASE – Low Altitude-Short Endurance

## IV. FORECASTING REQUIREMENTS

### THE FORECASTING PROCESS

Although the NMSP has limited experience with aircraft support, the SAMSAP program at CINMS provides a model that can be extrapolated across each region while taking into consideration the different environments, resources and mandates. In addition, NOAA's Aircraft Operations Center (AOC) has many years of experience providing aircraft support for a variety of missions that are directly applicable to the NMSP. Building a baseline individual site requirement plan utilizing the experiences gained from CINMS and working with the AOC to estimate flight hours, a minimum set of requirements was determined.

A 10-year planning window was selected because it coincides with the time period of three program and NOAA planning processes that affect aircraft requirements. These include: (1) site-specific sanctuary management plans that define management and resource protection priorities for a 5-10 year period, (2) the sanctuary "life cycle" framework that describes the evolution of a given site from designation to adaptive management during a 10-20 year period, and (3) NOAA's Planning, Programming, Budgeting and Execution System (PPBES) that quantifies requirements of all NOAA programs to achieve their mandated responsibilities during a 5-10 year period.

The process was conducted in consultation with sanctuary managers, operation officers, research and education coordinators, the program's strategic planning team and other experienced personnel. For each site, a standard template was used to forecast program requirements for aircraft and to quantify the mission parameters (see appendix for site specific templates). Specific aircraft-type needs grew out of this analysis, including the aircraft configuration and altitude, duration, and range. The raw data were evaluated in light of regional efficiencies, budgeting and manpower realities. In addition, forecasts for sanctuaries similar in size and mission requirements were compared and adjusted to ensure forecasts fell within a reasonable range.

#### Sanctuary Management Plans

Day-to-day operations at each sanctuary are defined by priorities established in its management plan. These plans are derived directly from the provisions of the National Marine Sanctuaries Act (NMSA) and define the 5-10 year priorities needed to fulfill program mandates. Many of the existing sanctuaries and the newly designated national marine monument are in the process of completing their most recent versions, which are developed through an extensive and highly participatory public process. This process results in site-based action strategies for all functions of site management, resource protection, and public access. For example, detailed action plans are often available for enforcement, education and outreach, research and monitoring, and infrastructure maintenance. These spell out specific requirements (including the spatial and temporal characteristics) that can be translated to aircraft usage.

#### Sanctuary "Life Cycle" Evolution

From the time of its designation, each site undergoes a common and predictable maturation, termed its "life cycle." This evolution is defined by six phases that occur over a 10-20 year period, namely: (1) pre-designation and designation, (2) start-up and early operations, (3) transition – first management plan review, (4) mature operations, (5) recalibration – second management plan review, and (6) adaptive management. Each phase describes the capacities and capabilities expected of the sanctuary to carry out all elements of site management and infrastructure. While the order of phases is consistent across all sanctuaries, the rate

at which sites progress through each phase and the level of resources required will differ according to site complexity (e.g., site size, remoteness, ecosystem type), as well as the type and extent of human uses within the sanctuary.

Predictably, the responsibilities and, therefore, the resource requirements for less complex sites in early phases of their life cycles are less than those for more complex sites in more mature phases. Accordingly, the requirement for aircraft support varies considerably across sites and increases with site maturity. The aerial requirements for a sanctuary to support the program's core missions such as research and monitoring, education and outreach, enforcement, and emergency response are described below and illustrated in Figure 4. Figure 5 depicts changing aircraft requirements based on program evolution.

**Phase 1 (Pre-designation and designation).** Sites are evaluated for addition to the NMS System. Extensive public involvement is used to determine what sanctuary resources and qualities are potentially at risk and how threats could best be addressed. The utilization of aircraft in this phase is relatively uncommon, as needs have not been clearly assessed and management priorities have yet to be established.

**Phase 2 (Start-up and early operations).** Priorities at this stage include: 1) filling resource information gaps; 2) addressing routine management functions (such as inter-agency cooperation); 3) developing initial scientific and educational programs; 4) laying the groundwork for long-term programs and 5) gathering data to support the first management plan review (Phase 3). Aircraft may be acquired to support initial field research, limited monitoring, some enforcement and, perhaps, education or trips to the sanctuary for local stakeholders.

**Phase 3 (Transition and first management plan review).** An important milestone for a site, the first management plan review marks the transition from initial "vision" to more concrete management objectives. Assisted by public input, sites seek to identify emerging issues, create measures of effectiveness for management interventions and develop specific management objectives and long-term programs. Aircraft are used in this phase primarily to collect information on the status of site resources.

Figure 4. Status of Sanctuaries with Respect to Life Cycle Phase

The Sanctuary Life Cycle			Sanctuaries in Phase During FY 2004
Phase	Description	Duration (years)	
1	Pre-Designation and Designation	1 to 3	NW Hawaiian Islands*
2	Start Up and Early Operations	2 to 5	Thunder Bay
3	Transition and First Management Plan Review	1 to 2	Cordell Bank Fagatelle Bay Flower Garden Banks Monitor Monterey Bay Olympic Coast Channel Islands Grays Reef Gulf of the Farallones Stellwagen Bank
4	Mature Operations	3 to 5	HI Islands/Humpback Whale
5	Recalibration and Second Management Plan Review	1	none
6	Adaptive Management	2 to 4	Florida Keys

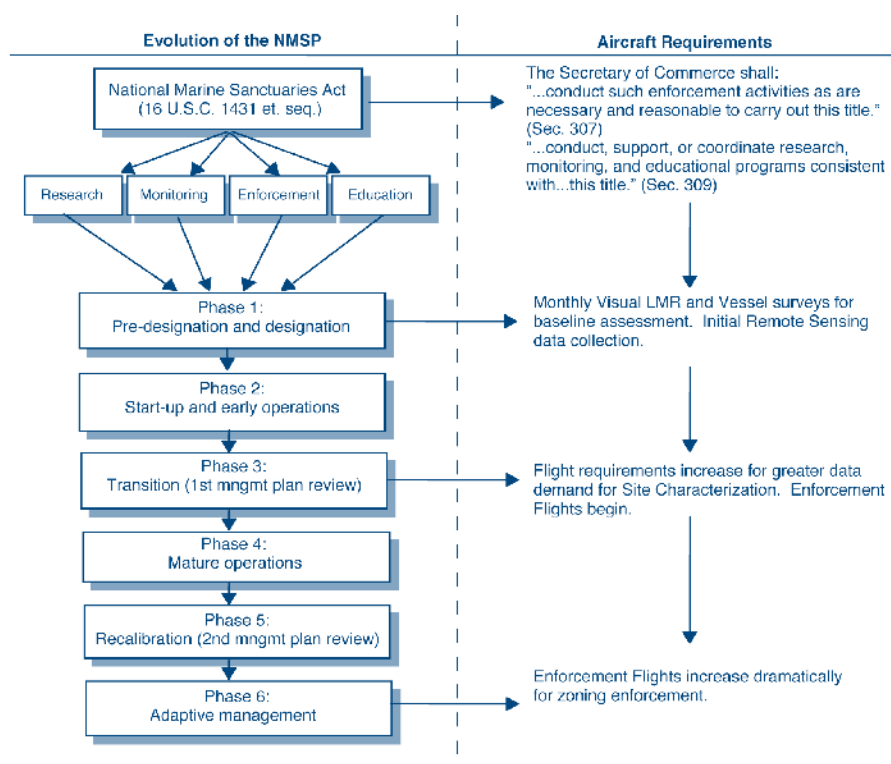
### Phases 4–6 (Mature operations, second management plan review and adaptive management).

As sites mature, aircraft requirements evolve in response to specific, long-term management objectives as identified through the second (and subsequent) management plan review and specific action plans. This will include relatively complex and sophisticated research, monitoring and enforcement activities requiring a substantial presence in order to meet pre-defined measures of effectiveness. At these stages, managers have sufficient resources to “flex” their assets in response to crises, emerging issues, or shifting priorities.

## NOAA’S PPBES PLANNING AND BUDGETING PROCESS

Beginning in 2003, NOAA redefined its planning and budgeting process. The Planning, Programming, Budgeting and Execution System (PPBES) provides a NOAA-wide assessment of program capabilities and requirements to fulfill its mandated responsibilities. The process quantifies these requirements for a sliding five-year period, i.e., in 2005, PPBES focused on resource needs for FY08-FY12. The National Marine Sanctuaries Act (NSMA) provides the legal authorization for the program and explicitly defines “what” and “how” the Program will function to achieve these mandates. As part of this process, the NMSP defined its requirements for all operational and infrastructure components, including the needs for aircraft.

Figure 5. Changing Aircraft Requirements Based on Program Evolution



## V. PROJECTING FLIGHT HOURS

### TRANSLATING MISSION REQUIREMENTS INTO FLIGHT HOURS

Calculating flight hours for each mission type and each sanctuary requires examining a multitude of variables including sanctuary size and shape, transit time, estimated airspeed, trackline spacing, amount of shoreline, required mission frequency, etc. Utilizing historic data from the CINMS SAMSAP program and recent sanctuary remote sensing projects, some fairly accurate estimates can be calculated for each mission in each sanctuary. (For more details, see the worksheets in Appendix A.) In addition, assumptions were made as to required changes in mission frequency depending on the life cycle of each sanctuary.



Aerial photograph of Blue Whale. Photo: NOAA

#### Visual Surveys

To calculate flight hours for the category of visual surveys, it was assumed that living marine resource surveys, vessel traffic surveys, and possibly marine debris flights were performed concurrently during the same multi-mission flight. In addition, once-a-month visual surveys were assumed to be the baseline

for each flight unless unique site needs dictated otherwise. For sites with upcoming management plan reviews, visual survey frequency was increased to twice or three times per month for two to three years prior to the review to meet the increased demand for data.

#### Remote Sensing

For calculating remote sensing flight hours, sites without a coastline were assumed to have no remote sensing needs. Deep water bathymetric LIDAR is not yet commercially available and most other remote sensing data can be collected at appropriate scales from satellites. For all other sites, a five-year cycle was assumed, where data was collected over three field seasons and then again at five-year intervals to allow for change detection and analysis. This cycle was linked to the life cycle of each site to meet increased data demands for management plan reviews. Due to the extreme geographic range of the Papahānaumokuākea Marine National Monument, a continuous need for remote sensing data was assumed.

#### Enforcement

Based on site visits to Hawaiian Islands Humpback Whale NMS, Papahānaumokuākea Marine National Monument and Florida Keys NMS and discussions with enforcement agencies at both sites, a baseline of thirty to fifty enforcement flights per year are assumed with adjustments for site specific regulatory complexity and the existence of marine zoning. Enforcement flights are added or increased after management plan reviews for those sites with potential for future marine zoning regulations.

#### Emergency Response

The necessity and frequency of emergency response flights was estimated by considering the amount of shoreline, type and amount of vessel traffic and visitor use, and interviews with site personnel.



### Education/Outreach

A limited amount of flight hours for each site was estimated as appropriate to support VIP flights, media flights, air shows, etc.

### Logistical Support

Flight hours for logistical support were only applied to the Papahānaumokuākea Marine National Monument for the purpose of ferrying supplies and personnel to the remote island chain.



NOAA Citation working along California coast. Photo: Kip Evans

## THE NATIONAL SUMMARY

By 2009, the program projects a need for more than 2500 aircraft flight hours to meet its mandated requirements. This figure is a significant increase from the current Channel Islands sanctuary program and represents the building of a national aviation program. It reflects the newly appointed Papahānaumokuākea Marine National Monument as well as the increased program requirements at several sites based on revised management plans. Aerial surveys for research and monitoring and remote sensing data collection is expected to comprise about 40% of the flight hours as all sites fully implement “system-wide monitoring” and expand remote sensing technologies and uses. The program also expects to develop aerial patrol and enforcement missions that support enforcement of sanctuary regulations and protection of its resources – the existing enforcement infrastructure cannot support the program’s current requirement, let alone the increased demand as new sanctuaries, marine reserves and protection regulations are realized. In 2009, enforcement requirements represent approximately 40% of the total flight hours, growing to 60% by 2015. Table 8 demonstrates that by 2009, the overall flight hour requirements level off and remain relatively steady as all sites have fully implemented programs and increased data collection needs rotate through sites as management plan reviews dictate.

**Table 8. 2006 thru 2015 Flight Hour Requirements by Region**

Function	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
<b>Northeast Region</b>	<b>42</b>	<b>42</b>	<b>122</b>	<b>72</b>	<b>72</b>	<b>122</b>	<b>122</b>	<b>122</b>	<b>172</b>	<b>122</b>
Research/Monitoring	30	30	110	60	60	30	30	30	80	30
Education/Outreach	12	12	12	12	12	12	12	12	12	12
Enforcement	0	0	0	0	0	80	80	80	80	80
Other	0	0	0	0	0	0	0	0	0	0
<b>Southeast Region</b>	<b>406</b>	<b>401</b>	<b>516</b>	<b>516</b>	<b>540</b>	<b>485</b>	<b>485</b>	<b>521</b>	<b>521</b>	<b>521</b>
Research/Monitoring	99	99	214	214	238	123	123	99	99	99
Education/Outreach	23	18	18	18	18	18	18	18	18	18
Enforcement	208	208	208	208	208	268	268	328	328	328
Other	76	76	76	76	76	76	76	76	76	76
<b>West Coast Region</b>	<b>641</b>	<b>641</b>	<b>681</b>	<b>903</b>	<b>1021</b>	<b>915</b>	<b>1008</b>	<b>995</b>	<b>995</b>	<b>995</b>
Research/Monitoring	318	318	358	580	694	588	366	252	252	252
Education/Outreach	60	60	60	60	64	64	64	64	64	64
Enforcement	162	162	162	162	162	162	467	563	563	563
Other	101	101	101	101	101	101	111	116	116	116
<b>Pacific Region</b>	<b>923</b>	<b>1099</b>	<b>1099</b>	<b>1099</b>	<b>1047</b>	<b>912</b>	<b>912</b>	<b>912</b>	<b>912</b>	<b>942</b>
Research/Monitoring	128	304	304	304	208	208	208	208	208	238
Education/Outreach	47	47	47	47	47	47	47	47	47	47
Enforcement	636	636	636	636	680	545	545	545	545	545
Other	112	112	112	112	112	112	112	112	112	112
<b>Total</b>	<b>2011</b>	<b>2182</b>	<b>2417</b>	<b>2589</b>	<b>2679</b>	<b>2433</b>	<b>2527</b>	<b>2549</b>	<b>2599</b>	<b>2579</b>

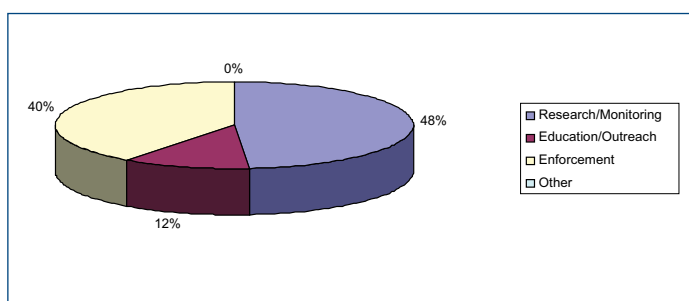


## REGIONAL PRIORITIES

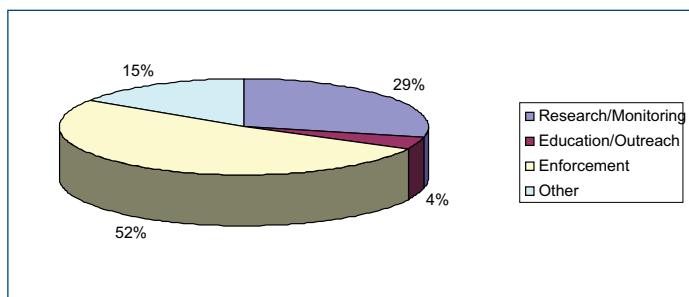
Regional summaries illustrate the increasing importance of aerial enforcement as marine zoning becomes a reality at more sites shown in Figures 6,7,8 and 9. Research and monitoring along with enforcement form the majority of aircraft requirements across all regions. In the Southeast and Pacific Regions, enforcement represents 50 to 60 percent of the requirements with research and monitoring representing the bulk of the remainder. In the Northeast and West Coast Regions, research and monitoring is the priority with growing needs for enforcement.

As the NMSA keeps evolving into a regional office structure, it is envisioned that the aircraft planning and operations will be integrated and optimized at the regional level by the regional office Directors and at the national level by the Aviation Operations Coordinator.

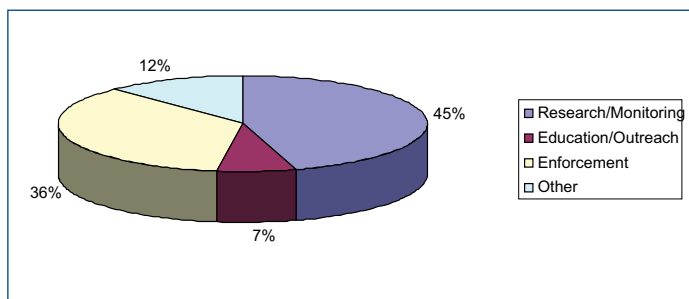
**Figure 6. Northeast, Mid-Atlantic & Great Lakes Regional Priorities**



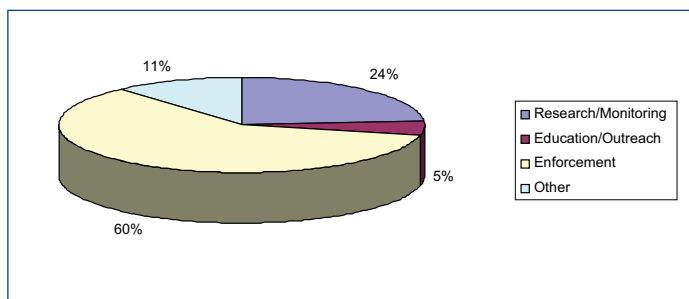
**Figure 7. Southeast, Gulf of Mexico & Caribbean Regional Priorities**



**Figure 8. West Coast Regional Priorities**



**Figure 9. Pacific Islands Regional Priorities**



## VI. FUNDING METHODOLOGY

To generate funding requirements, cost estimates were made for each region. Since the aircraft would not be owned and operated by the NMSP, all operating, maintenance and staffing costs are covered by the applicable hourly rate. Each region's requirements were evaluated to assess the appropriate aircraft type that would meet the majority of needed flight profiles and configuration. Then, using historic flight hour costs provided by AOC, an estimate for each region was developed.

The AOC typically provides cost estimates for potential users broken down into four main categories: an hourly rate, fuel costs, a daily rate, and travel costs as seen in Table 9.

### DEFINITIONS

#### Hourly Rate

AOC utilizes a running five-year average of operating and maintenance costs to determine an hourly rate for each type of aircraft every fiscal year. Program users are charged based on actual aircraft flight time determined by official flight logs. AOC directly pays for all scheduled and unscheduled maintenance and instrumentation costs. Transit times and relocation flights are generally charged to the users; regionally based aircraft would minimize these costs. Maintenance flights and training flights are not charged to the program. Most air charter operations operate in a similar manner.

#### Fuel Costs

AOC provides estimated fuel costs for each type of aircraft based on known fuel burn rates and the current government contract fuel price. Customers are billed for actual fuel costs which may vary slightly from the estimate. Air charter operations will generally include fuel costs in their hourly rates, but would not significantly change the total cost to a user.

#### Daily Rate

To offset administration and overhead costs, AOC charges a flat daily rate for each operational flight day. For the purposes of this document, it is assumed that each aircraft would fly one hundred days per year. Again, most air charter operations also charge a flat or daily rate.

#### Travel Costs

For a typical AOC project, AOC provides and processes the travel orders for the flight crew and then charges the program the actual travel costs. For the purposes of this document, it is assumed that regionally based aircraft would minimize travel costs since the flight crew would be assigned to the aircraft's home base.

Table 9. Cost Estimates by Aircraft Type

Aircraft Type		Light Twin Prop	Medium Turboprop	Large Turboprop
	<b>Characteristics/ Equipment</b>	- Bubble Windows - Belly Port - High Wing	- Bubble Windows - Dual Belly Ports - High Wing	- Bubble Windows - Triple Belly Ports - High Wing - Large Cargo Door
	<b>Speed</b>	120 -250 kts	120 -250 kts	120 -250 kts
	<b>Duration</b>	5 hrs	5 hrs	10 hrs
	<b>Range</b>	500 nmi	1000 nmi	2500 nmi
Operations and Maintenance	<b>Estimated Hourly Operating Cost</b>	<b>\$250/hr</b>	<b>\$450/hr</b>	<b>\$850/hr</b>
	<b>Estimated Hourly Fuel Cost</b>	<b>\$90/hr</b>	<b>\$225/hr</b>	<b>\$400/hr</b>
	<b>Estimated Fixed Daily Cost</b>	<b>\$105/day</b>	<b>\$105/day</b>	<b>\$105/day</b>
	<b>Maintenance Cost</b>	Included in Hourly rate	Included in Hourly rate	Included in Hourly rate
	<b>Aircraft Location</b>	Local FBO	Local FBO	Local FBO
	<b>Administrative Costs</b>	None or minimal	None or minimal	None or minimal
Personnel Requirements	<b>Flight Crew</b>	2	2	2-3
	<b>Mission Crew</b>	2	2-3	2-4
	<b>Maintenance Staff</b>	AOC provided	AOC provided	AOC provided
	<b>Operations Coordinator</b>	Regional Staff	Regional Staff	Regional Staff

## PERSONNEL REQUIREMENTS

For NMSP aircraft missions, staffing responsibilities for the NMSP would be limited to the mission crew responsible for data collection during visual surveys, remote sensing surveys, or enforcement flights. The flight crew, maintenance personnel, and associated aircraft administrative support would all be provided by either AOC or an air charter operation. It is envisioned that the mission crew would be pulled from existing sanctuary site staff, existing partner agencies and organizations, or state and local governments as appropriate. Regional training, coordination of flight schedule, and aircraft sharing among sites would be a collateral responsibility of the Regional Operations Officer. The Aviation Operations Coordinator would be responsible for the national planning, coordination and implementation.

None of these positions would add to the number of FTEs in the program or significantly increase the personnel cost to NMSP, and thus are not included in the funding analysis.

## VII. PROJECTING FUNDING REQUIREMENTS

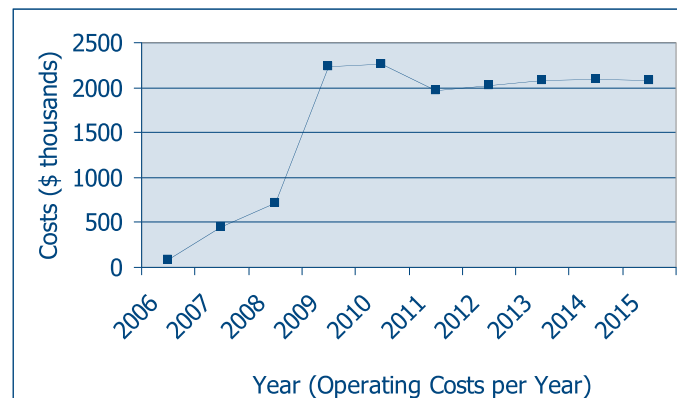
To determine annual funding requirements, a suitable aircraft type was selected from the Cost Estimate table based on regional requirements from Section III. For the Northeast and Southeast Regions, costs figures for a Light Twin Prop were used. For the West Coast Region, the figures for a Medium Turboprop were utilized and finally, for the Pacific Region, the costs for a Large Turboprop were used. Each associated hourly costs were then multiplied by the total flight hours for each region. An estimate was made for the number of flight days based on the mission requirements in Appendix A. Table 10 represents the costs based on an average of the ten year period.

**Table 10. Cost Estimate Based on Regional Requirement**

	<b>West Coast Region</b>	<b>Northeast Region</b>	<b>Southeast Region</b>	<b>Pacific Region</b>
<b>Aircraft Type</b>	Large Turboprop	Light Twin Prop	Light Twin Prop	Large Turboprop
<b>Hourly Costs (including fuel)</b>	\$675/hr	\$340/hr	\$340/hr	\$1250/hr
<b>Average Flight Hours Per Year</b>	800 hrs	100 hrs	500 hrs	1000 hrs
<b>Total Hourly Costs</b>	<b>\$540,000</b>	<b>\$34,000</b>	<b>\$170,000</b>	<b>\$1,250,000</b>
<b>Estimated Days Per Year</b>	150 days	30 days	150 days	150 days
<b>Daily Costs</b>	\$105/day	\$105/day	\$105/day	\$105/day
<b>Total Daily Costs</b>	<b>\$15,750</b>	<b>\$3,150</b>	<b>\$15,750</b>	<b>\$15,750</b>
<b>Total Operating Costs</b>	<b>\$555,750</b>	<b>\$37,150</b>	<b>\$185,750</b>	<b>\$1,265,750</b>

Actual annual operating costs were calculated using the site-specific annual requirements in Appendix A. A phased-in regional-approach was utilized to allow for time to build onto current capacity and to ease the financial requirement. In 2006, only CINMS was calculated to ramp up to meet the full requirements utilizing the existing Seawolf aircraft. In 2007, the requirements for the entire West Coast Region were calculated at the full level replacing the Seawolf with a regionally based medium Turboprop. The Northeast and Southeast regional requirements were added on in 2008, and the Pacific Region was added in 2009. The phased-in annual operating costs are presented in Figure 10.

**Figure 10. Annual Operating Costs**



## VIII. CONCLUSION

This report establishes and presents the procedures for the development and implementation of a ten-year regionally-based aircraft plan for the National Marine Sanctuary Program. To fully meet the requirements of the program, an annual budget of approximately \$2M will be necessary to support an annual flight program of 2500 flight hours. A phased-in approach is recommended with full implementation taking place in 2009. Research, monitoring and enforcement requirements make up over 80% of the total flight hours and the Pacific Islands Region represents over 35% of the total.

Aircraft configuration and mission parameters are presented for each region along with estimated costs of potential platform types. This report does not recommend specific aircraft models to meet the detailed requirements; however, it does identify types of aircraft that may meet the majority of regional needs in order to calculate funding requirements. In addition, the potential for meeting data collection needs with emerging technologies such as UAS was not fully analyzed. Determining the actual budget and the timeline for implementation will depend on a variety of factors including budgetary constraints, AOC aircraft availability, charter aircraft availability, and regional readiness.

For personnel requirements, it is envisioned that the mission crew would be pulled from existing sanctuary site staff, existing partner agencies and organizations, or state and local governments as appropriate. Regional training, coordination of flight schedule, and aircraft sharing among sites would be a collateral responsibility of the Regional Operations Officer. The Aviation Operations Coordinator would be responsible for the national planning, coordination and implementation of this plan.





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## IX. APPENDIX

The appendix contains the raw data tables for each site used in the development of this document. In addition, the assumptions used to arrive at mission requirements and flight hours are included.



Site	NMSP Aircraft Support Requirements Annual Flights Hours										
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
<b>Northeast Region</b>											
TBNMS	6	6	56	6	6	6	6	6	56	6	
SBNMS	36	36	66	66	66	116	116	116	116	116	
MNMS	0	0	0	0	0	0	0	0	0	0	
<b>Northeast Region Totals</b>	<b>42</b>	<b>42</b>	<b>122</b>	<b>72</b>	<b>72</b>	<b>122</b>	<b>122</b>	<b>122</b>	<b>172</b>	<b>122</b>	
<b>Southeast Region</b>											
GRNMS	36	33	60	60	60	93	93	93	93	93	
FKNMS	340	338	426	426	426	338	338	338	338	338	
FGBNMS	30	30	30	30	54	54	54	90	90	90	
<b>Southeast Region Totals</b>	<b>406</b>	<b>401</b>	<b>516</b>	<b>516</b>	<b>540</b>	<b>485</b>	<b>485</b>	<b>521</b>	<b>521</b>	<b>521</b>	
<b>West Coast Region</b>											
OCNMS	85	85	85	85	199	199	199	207	207	207	
CBNMS	27	27	27	51	51	51	72	72	72	72	
GFNMS	40	40	40	110	110	110	123	123	123	123	
MBNMS	139	139	139	267	267	267	320	325	325	325	
CINMS	351	351	391	391	395	289	295	268	268	268	
<b>West Coast Region Totals</b>	<b>641</b>	<b>641</b>	<b>681</b>	<b>903</b>	<b>1021</b>	<b>915</b>	<b>1008</b>	<b>995</b>	<b>995</b>	<b>995</b>	
<b>Pacific Region</b>											
HIHWNMS	186	282	282	282	230	230	230	230	230	260	
NWHINMS	737	817	817	817	817	682	682	682	682	682	
FBNMS	0	0	0	0	0	0	0	0	0	0	
<b>Pacific Region Totals</b>	<b>923</b>	<b>1099</b>	<b>1099</b>	<b>1099</b>	<b>1047</b>	<b>912</b>	<b>912</b>	<b>912</b>	<b>912</b>	<b>942</b>	
<b>NMSP Totals</b>	<b>2011</b>	<b>2182</b>	<b>2417</b>	<b>2589</b>	<b>2679</b>	<b>2433</b>	<b>2527</b>	<b>2549</b>	<b>2599</b>	<b>2579</b>	





Stellwagen Bank NMS  
NE/GL Region

Mission Type	Requirement	Priority	On-Site Duration (hrs)	Transit (hrs)	2006 Requirements				Future Requirements Number of Flights Hours											
					Flights/Month				Phase 4		Phase 5		Phase 6							
					SPR	SUM	FALL	WIN	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015		
<b>Research and Monitoring</b>																				
<b>Visual Surveys</b>																				
LMR Surveys	Distribution and Abundance	M	2	0.5	X	X	X	X												
Vessel Traffic / Human Use	Large Vessel Traffic	M	2	0.5	X	X	X	X												
	Commercial Use	H	2	0.5	X	X	X	X												
	Recreational Use	M	2	0.5	X	X	X	X												
	<b>Visual Surveys Total -1</b>								30	30	60	60	60	30	30	30	30	30	30	30
<b>Remote Sensing</b>																				
Bathymetric LIDAR	Habitat Characterization	N/A																		
Topographic LIDAR	Shoreline/Watershed Analysis	N/A																		
Hyperspectral Imaging	Habitat Characterization	N/A																		
Digital Photography	Change Analysis	N/A																		
	<b>Remote Sensing Total</b>								0	0	0	0	0	0	0	0	0	0	0	0
<b>Enforcement</b>																				
	<b>Research and Monitoring Total</b>								30	30	60	60	60	30	30	30	30	30	30	30
	Zoning Enforcement	H	1.5	0.5																
	<b>Enforcement Total</b>								0	0	0	0	0	0	0	0	0	0	0	0
<b>Emergency Response</b>																				
	Spill Response, Vessel Groundings	N/A																		
	<b>Emergency Response Total</b>								0	0	0	0	0	0	0	0	0	0	0	0
<b>Education / Outreach</b>																				
	Air Shows	N/A																		
	Teacher in the Air	N/A																		
	Sanctuary Documentation	N/A																		
	VIP / Media Overflights	M	1.5	0.5	1	1	1	1	6											
	Student in the Air	N/A																		
	<b>Education / Outreach Total</b>								6	6	6	6	6	6	6	6	6	6	6	6
<b>Logistical Support</b>																				
	Restaffing and resupplying research vessels and stations	N/A																		
	<b>Logistical Support Total</b>								0	0	0	0	0	0	0	0	0	0	0	0
	<b>Site Totals</b>								36	36	66	66	66	116	116	116	116	116	116	116

1 = Visual Survey data of LMR and vessel traffic is assumed to be collected concurrently  
X = Flights per month

Monitor NMS  
NE/GL Region

Mission Type	Requirement	Priority	On-Site Duration (hrs)	Transit (hrs)	2006 Requirements					Future Requirements Number of Flights Hours										
					Number of Flights				Flight Hours Total 2006	Phase 4		Phase 5		Phase 6						
					SPR	SUM	FALL	WIN		2007	2008	2009	2010	2011	2012	2013	2014	2015		
<b>Research and Monitoring</b>	<b>Visual Surveys</b>																			
	LMR Surveys	N/A																		
	Vessel Traffic / Human Use	N/A																		
	Commercial Use	N/A																		
	Recreational Use	N/A																		
	<b>Visual Surveys Total</b>																			
<b>Remote Sensing</b>	<b>Visual Surveys Total</b>																			
	Habitat Characterization	N/A																		
	Shoreline/Watershed Analysis	N/A																		
	Habitat Characterization	N/A																		
	Change Analysis	N/A																		
	<b>Remote Sensing Total</b>																			
	<b>Research and Monitoring Total</b>																			
<b>Enforcement</b>	Zoning Enforcement	N/A																		
	<b>Enforcement Total</b>																			
<b>Emergency Response</b>	Spill Response, Vessel Groundings	N/A																		
	<b>Emergency Response Total</b>																			
<b>Education / Outreach</b>	Air Shows	N/A																		
	Teacher in the Air	N/A																		
	Sanctuary Documentation	N/A																		
	VIP / Media Overflights	N/A																		
	Student in the Air	N/A																		
	<b>Education / Outreach Total</b>																			
<b>Logistical Support</b>	Restaffing and resupplying research vessels and stations	N/A																		
	<b>Logistical Support Total</b>																			
										<b>Site Totals</b>										
										0										

Gray's Reef NMS  
NE/GL Region

Mission Type	Requirement	Priority	On-Site Duration (hrs)	Transit (hrs)	2006 Requirements				Future Requirements Number of Flights Hours																	
					Number of Flights				Phase 4		Phase 5		Phase 6													
					SPR	SUM	FALL	WIN	2007	2008	2009	2010	2011	2012	2013	2014	2015									
<b>Research and Monitoring</b> Visual Surveys LMR Surveys Vessel Traffic / Human Use																										
	Distribution and Abundance	M	1	0.5	X	X	XX	XX																		
	Large Vessel Traffic	L																								
	Commercial Use	L																								
	Recreational Use	M	1	0.5	X	X	X	X																		
	<b>Visual Surveys Total - 1</b>																									
<b>Remote Sensing</b> Bathymetric LIDAR Topographic LIDAR Hyperspectral Imaging Digital Photography																										
	Habitat Characterization	N/A																								
	Shoreline/Watershed Analysis	N/A																								
	Habitat Characterization	N/A																								
	Change Analysis	N/A																								
	<b>Remote Sensing Total</b>																									
<b>Enforcement</b>	<b>Research and Monitoring Total</b>																									
	Zoning Enforcement	M	1.5	0.5																						
	<b>Enforcement Total</b>																									
<b>Emergency Response</b>	Spill Response, Vessel Groundings	L																								
	<b>Emergency Response Total</b>																									
	Air Shows	N/A																								
<b>Education / Outreach</b>	Teacher in the Air	N/A																								
	Sanctuary Documentation	N/A																								
	VIP / Media Overflights	M	1	0.5	2	2	2	2																		
	Student in the Air	N/A																								
	<b>Education / Outreach Total</b>																									
<b>Logistical Support</b>	Restaffing and resupplying research vessels and stations	N/A																								
	<b>Logistical Support Total</b>																									
	<b>Site Totals</b>																									

1 = Visual Survey data of LMR and vessel traffic is assumed to be collected concurrently  
X = Flights per month

Florida Keys NMS  
SE/GOM Region

Mission Type	Requirement	Priority	On-Site Duration (hrs)	Transit (hrs)	2006 Requirements							Future Requirements Number of Flights Hours									
					Number of Flights				Flight Hours Total 2006	Phase 6		Phase 5		Phase 6							
					SPR	SUM	FALL	WIN		2007	2008	2009	2010	2011	2012	2013	2014	2015			
<b>Research and Monitoring</b> <b>Visual Surveys</b> LMR Surveys Vessel Traffic / Human Use	Distribution and Abundance	L																			
	Large Vessel Traffic	M	4	0		X	X	X	X												
	Commercial Use	M	4	0		X	X	X	X												
	Recreational Use	M	4	0		X	X	X	X												
	<b>Visual Surveys Total -1</b>									48											
<b>Remote Sensing</b> Bathymetric LIDAR Topographic LIDAR Hyperspectral Imaging Digital Photography	Habitat Characterization	M																			
	Shoreline/Watershed Analysis	M																			
	Habitat Characterization	M																			
	Change Analysis	M																			
	<b>Remote Sensing Total</b>									0											
<b>Enforcement</b>	<b>Research and Monitoring Total</b>									48											
	Zoning Enforcement	H	2	0		2/wk	2/wk	2/wk	2/wk												
	<b>Enforcement Total</b>									208											
<b>Emergency Response</b>	Spill Response, Vessel Groundings	H	2	0		wk	2/mo	wk	2/mo												
	<b>Emergency Response Total</b>									76											
	<b>Education / Outreach</b>																				
<b>Logistical Support</b>	Air Shows	L																			
	Teacher in the Air	L																			
	Sanctuary Documentation	L																			
<b>Logistical Support</b>	VIP / Media Overflights	M	2	0		1	1	1	1	8											
	Student in the Air	L																			
	<b>Education / Outreach Total</b>									8											
<b>Logistical Support</b>	Restaffing and resupplying research vessels and stations	N/A																			
	<b>Logistical Support Total</b>									0											
	<b>Site Totals</b>									340											
											338	426	426	426	338	338	338	338	338	338	338

1 = Visual Survey data of LMR and vessel traffic is assumed to be collected concurrently  
X = Flights per month

Flower Garden Banks NMS  
SE/GOM Region

Mission Type	Requirement	Priority	On-Site Duration (hrs)	Transit (hrs)	2006 Requirements				Future Requirements Number of Flights Hours										
					Number of Flights				Phase 6			Phase 5			Phase 6				
					SPR	SUM	FALL	WIN	2007	2008	2009	2010	2011	2012	2013	2014	2015		
<b>Research and Monitoring</b> <b>Visual Surveys</b> LMR Surveys Vessel Traffic / Human Use																			
	Distribution and Abundance	M	1	1		X	X	X	X										
	Large Vessel Traffic	M	1	1		X	X	X	X										
	Commercial Use	M	1	1		X	X	X	X										
	Recreational Use	M	1	1		X	X	X	X										
<b>Visual Surveys Total -1</b>										24	24	24	24	48	48	24	24	24	24
<b>Remote Sensing</b> Bathymetric LIDAR Topographic LIDAR Hyperspectral Imaging Digital Photography																			
	Habitat Characterization	N/A																	
	Shoreline/Watershed Analysis	N/A																	
	Habitat Characterization	N/A																	
	Change Analysis	N/A																	
<b>Remote Sensing Total</b>										0	0	0	0	0	0	0	0	0	0
<b>Research and Monitoring Total</b>										24	24	24	24	48	48	24	24	24	24
<b>Enforcement</b>	Zoning Enforcement	H	1	1															
	<b>Enforcement Total</b>									0	0	0	0	0	0	0	0	0	0
<b>Emergency Response</b>	Spill Response, Vessel Groundings	L																	
	<b>Emergency Response Total</b>									0	0	0	0	0	0	0	0	0	0
<b>Education / Outreach</b>	Air Shows	L																	
	Teacher in the Air	L																	
	Sanctuary Documentation	L																	
	VIP / Media Overflights	M	1	1	1	1	1	1	0										
	Student in the Air	L																	
<b>Education / Outreach Total</b>										6	6	6	6	6	6	6	6	6	6
<b>Logistical Support</b>	Restaffing and resupplying research vessels and stations	N/A																	
	<b>Logistical Support Total</b>									0	0	0	0	0	0	0	0	0	0
<b>Site Totals</b>										30	30	30	30	54	54	90	90	90	90

1 = Visual Survey data of LMR and vessel traffic is assumed to be collected concurrently  
X = Flights per month

Olympic Coast NMS  
WC Region

Mission Type	Requirement	Priority	On-Site Duration (hrs)	Transit (hrs)	2006 Requirements				Future Requirements Number of Flights Hours										
					Number of Flights				Phase 4		Phase 5		Phase 6						
					SPR	SUM	FALL	WIN	2007	2008	2009	2010	2011	2012	2013	2014	2015		
<b>Research and Monitoring</b> <b>Visual Surveys</b> LMR Surveys Vessel Traffic / Human Use																			
	Distribution and Abundance	M	4	0.5		X	X	X	X										
	Large Vessel Traffic	H	4	0.5		X	X	X	X										
	Commercial Use	M	4	0.5		X	X	X	X										
	Recreational Use	M	4	0.5		X	X	X	X										
	<b>Visual Surveys Total-1</b>									54	54	54	108	108	108	54	54	54	54
<b>Remote Sensing</b> Bathymetric LIDAR Topographic LIDAR Hyperspectral Imaging Digital Photography																			
	Habitat Characterization	M																	
	Shoreline/Watershed Analysis	H																	
	Habitat Characterization	M																	
	Change Analysis	M																	
	<b>Remote Sensing Total</b>									0	0	0	0	60	60	0	0	0	0
	<b>Research and Monitoring Total</b>									54	54	54	168	168	168	54	54	54	54
<b>Enforcement</b>	Zoning Enforcement	H	3	0.5															
	<b>Enforcement Total</b>									0	0	0	0	0	0	0	0	0	0
<b>Emergency Response</b>	Spill Response, Vessel Groundings	H	2	0.5		1	2	2	1										
	<b>Emergency Response Total</b>									15	15	15	15	15	15	15	15	15	15
<b>Education / Outreach</b>	Air Shows	M		1.5			2												
	Teacher in the Air	M	2	0.5				1											
	Sanctuary Documentation	M	2	0.5			1												
	VIP / Media Overflights	M	2	0.5			1	1	1										
	Student in the Air	N/A																	
	<b>Education / Outreach Total</b>									15.5	16	16	16	16	16	16	16	16	16
<b>Logistical Support</b>	Restaffing and resupplying research vessels and stations	N/A																	
	<b>Logistical Support Total</b>									0	0	0	0	0	0	0	0	0	0
	<b>Site Totals</b>									84.5	85	85	199	199	198.5	207	207	207	207

1 = Visual Survey data of LMR and vessel traffic is assumed to be collected concurrently  
X = Flights per month



Cordell Bank NMS  
WC Region

Mission Type	Requirement	Priority	On-Site Duration (hrs)	Transit (hrs)	2006 Requirements				Future Requirements Number of Flights Hours														
					Number of Flights				Phase 4		Phase 5		Phase 6										
					SPR	SUM	FALL	WIN	2007	2008	2009	2010	2011	2012	2013	2014	2015						
<b>Research and Monitoring</b> Visual Surveys LMR Surveys Vessel Traffic / Human Use																							
	Distribution and Abundance	M	1.5	0.5	X	X	X	X															
	Large Vessel Traffic	M	1.5	0.5	X	X	X	X															
	Commercial Use	M	1.5	0.5	X	X	X	X															
	Recreational Use	M	1.5	0.5	X	X	X	X															
	<b>Visual Surveys Total-1</b>									24	24	24	48	48						24	24	24	24
<b>Remote Sensing</b> Bathymetric LIDAR Topographic LIDAR Hyperspectral Imaging Digital Photography	Habitat Characterization	L																					
	Shoreline/Watershed Analysis	L																					
	Habitat Characterization	L																					
	Change Analysis	L																					
		<b>Remote Sensing Total</b>									0	0	0	0	0						0	0	0
	<b>Research and Monitoring Total</b>									24	24	24	48	48						24	24	24	24
<b>Enforcement</b>	Zoning Enforcement	H	1	0.5																			
	<b>Enforcement Total</b>									0	0	0	0	0						0	0	0	0
<b>Emergency Response</b>	Spill Response, Vessel Groundings	L																					
	<b>Emergency Response Total</b>									0	0	0	0	0						0	0	0	0
	Air Shows	N/A																					
<b>Education / Outreach</b>	Teacher in the Air	N/A																					
	Sanctuary Documentation	N/A																					
	VIP / Media Overflights	M	1	0.5		1	1																
	Student in the Air	N/A																					
		<b>Education / Outreach Total</b>									3	3	3	3	3					3	3	3	3
<b>Logistical Support</b>	Restaffing and resupplying research vessels and	N/A																					
	<b>Logistical Support Total</b>									0	0	0	0	0					0	0	0	0	0
		<b>Site Totals</b>									27	27	27	51	51					27	27	27	72

1 = Visual Survey data of LMR and vessel traffic is assumed to be collected concurrently  
X = Flights per month







Hawaiian Islands Humpback  
Whale NMS  
PI Region

Mission Type	Requirement	Priority	On-Site Duration (hrs)	Transit (hrs)	2006 Requirements					Future Requirements Number of Flights Hours										
					Number of Flights				Flight Hours Total 2006	Phase 4		Phase 5		Phase 6						
					SPR	SUM	FALL	WIN		2007	2008	2009	2010	2011	2012	2013	2014	2015		
<b>Research and Monitoring</b>																				
<b>Visual Surveys</b>																				
LMR Surveys	Distribution and Abundance	H	14	2.5					*											
Vessel Traffic / Human Use	Large Vessel Traffic	M	14	2.5		**	**	**	**											
	Commercial Use	M	14	2.5		**	**	**	**											
	Recreational Use	M	14	2.5		**	**	**	**											
	Marine Debris	M	14	2.5		**	**	**	**											
	<b>Visual Surveys Total-1</b>									66	132	132	66	66	66	66	66	66	66	66
<b>Remote Sensing</b>																				
Bathymetric LIDAR	Habitat Characterization	M																		
Topographic LIDAR	Shoreline/Watershed Analysis	M																		
Hyperspectral Imaging	Habitat Characterization	M																		
Digital Photography	Change Analysis	M																		
	<b>Remote Sensing Total</b>									0	30	30	0	0	0	0	0	0	0	30
	<b>Research and Monitoring Total</b>									66	162	162	66	66	66	66	66	66	66	96
<b>Enforcement</b>	Vessel Interaction Enforcement	H	3	1					2/wk	96										
	<b>Enforcement Total</b>									96	96	96	140	140	140	140	140	140	140	140
<b>Emergency Response</b>	Entanglements, etc.	H	3	1					4	16										
	<b>Emergency Response Total</b>									16	16	16	16	16	16	16	16	16	16	16
	Air Shows	N/A																		
	Teacher in the Air	N/A																		
	Sanctuary Documentation	H	1.5	0.5					2	4										
	VIP / Media Overflights	H	1.5	0.5					2	4										
	Student in the Air	N/A																		
	<b>Education / Outreach Total</b>									8	8	8	8	8	8	8	8	8	8	8
	Restaffing and resupplying research vessels and stations	N/A																		
<b>Logistical Support</b>										0	0	0	0	0	0	0	0	0	0	0
	<b>Logistical Support Total</b>									0	0	0	0	0	0	0	0	0	0	0
	<b>Site Totals</b>									186	282	282	230	230	230	230	230	230	230	260

1 = Visual Survey data of LMR and vessel traffic is assumed to be collected concurrently  
 \* = Annual  
 \*\* = Quarterly

Papahānaumokuākea National  
Marine Monument  
PI Region

Mission Type	Requirement	Priority	On-Site Duration (hrs)	Transit (hrs)	2006 Requirements							Future Requirements Number of Flights Hours								
					Number of Flights				Flight Hours Total 2006	Phase 2		Phase 3		Phase 4						
					SPR	SUM	FALL	WIN		2007	2008	2009	2010	2011	2012	2013	2014	2015		
<b>Research and Monitoring</b> <b>Visual Surveys</b> LMR Surveys Vessel Traffic / Human Use	Distribution and Abundance	M	14	1.5	qtrly	qtrly	qtrly	qtrly	qtrly											
	Large Vessel Traffic	M	14	1.5	qtrly	qtrly	qtrly	qtrly	qtrly											
	Commercial Use	H	14	1.5	qtrly	qtrly	qtrly	qtrly	qtrly											
	Recreational Use	H	14	1.5	qtrly	qtrly	qtrly	qtrly	qtrly											
	Marine Debris	H	14	1.5	qtrly	qtrly	qtrly	qtrly	qtrly											
	<b>Visual Surveys Total-1</b>										62	62	62	62	62	62	62	62	62	62
	<b>Remote Sensing</b> Bathymetric LIDAR Topographic LIDAR Hyperspectral Imaging Digital Photography	Habitat Characterization	H																	
	Shoreline/Watershed Analysis	H																		
	Habitat Characterization	H																		
	Change Analysis	H																		
	<b>Remote Sensing Total</b>									0	80	80	80	80	80	80	80	80	80	80
	<b>Research and Monitoring Total</b>									62	142	142	142	142	142	142	142	142	142	142
<b>Enforcement</b>	Zoning Enforcement	H	12	1.5	wk	wk	wk	2/mo												
	<b>Enforcement Total</b>									540	540	540	540	540	540	540	540	540	540	540
<b>Emergency Response</b>	Spill Response, Vessel Groundings	H	5	3	1	1	1	1		24										
	<b>Emergency Response Total</b>									24	24	24	24	24	24	24	24	24	24	24
<b>Education / Outreach</b>	Air Shows	N/A																		
	Teacher in the Air	M	4	1.5	1					5.5										
	Sanctuary Documentation	M	4	1.5	1	1	1	1		11										
	VIP / Media Overflights	M	4	1.5	1	1	1	1	1	22										
	Student in the Air	N/A																		
	<b>Education / Outreach Total</b>									38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5
<b>Logistical Support</b>	Restaffing and resupplying research vessels and stations	M		12	2	2	2	2		72										
	<b>Logistical Support Total</b>									72	72	72	72	72	72	72	72	72	72	72
										<b>Site Totals</b>	736.5	817	817	817	817	817	817	817	817	817

1 = Visual Survey data of LMR and vessel traffic is assumed to be collected concurrently



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## X. AIRCRAFT REQUIREMENTS BY SANCTUARY

The following one page site-specific summaries are not representative of a specific year, rather a summarized snapshot of potential projects during forecast years. For specific site requirements for any given year, please refer to the full worksheets. The data in these summaries is not meant to represent the entire spectrum of potential airborne missions for any given site. It is solely based on site visits, interviews and program experience.

## Thunder Bay National Marine Sanctuary Airborne Requirements

Mission Type							
	Visual Surveys	Remote Sensing	Enforcement	Emergency Response	Education-Outreach	Logistical Support	
<b>Flights</b>	Spring	5	N/A	N/A	1	N/A	
	Summer	0	N/A	N/A	1	N/A	
	Fall	5	N/A	N/A	1	N/A	
	Winter	0	N/A	N/A	0	N/A	
	<b>Total</b>	10				3	
<b>Mission Parameters</b>	Altitude	4,000 - 12,000 ft			2,000 ft		
	Speed	120 - 200 kts			150 kts		
	Duration	4.5 hrs			1.5 hrs		
	Range	500 nmi			500 nmi		
	Aircraft Configuration	<ul style="list-style-type: none"> <li>• L1/L2 GPS antennae</li> <li>• Down-looking ports</li> <li>• Instrument rack</li> <li>• Scientific power</li> </ul>			<ul style="list-style-type: none"> <li>• Bubble windows</li> <li>• Camera window</li> </ul>		
	Instrumentation	<ul style="list-style-type: none"> <li>• Bathy LIDAR</li> <li>• Topo LIDAR</li> <li>• Digital Camera</li> <li>• Magnetometer</li> </ul>					

- The data in this chart is not meant to represent the entire spectrum of potential airborne missions for any given site. It is solely based on site visits, interviews, and program experience.

- This chart is not representative of a specific year, rather a snapshot of potential projects during forecast years. For specific requirements for any given year, please refer to the appendix.

## Stellwagen Bank National Marine Sanctuary Airborne Requirements

		Mission Type					
		Visual Surveys	Remote Sensing	Enforcement	Emergency Response	Education- Outreach	Logistical Support
<b>Flights</b>	Spring	3	N/A	10	N/A	1	N/A
	Summer	3	N/A	12	N/A	1	N/A
	Fall	3	N/A	12	N/A	1	N/A
	Winter	4	N/A	6	N/A	0	N/A
	Total	12		40		3	
<b>Mission Parameters</b>	Altitude	1,000 ft		1,000 ft		2,000 ft	
	Speed	150 kts		150 kts		150 kts	
	Duration	2.5 hrs		2 hrs		2 hrs	
	Range	500 nmi		500 nmi		500 nmi	
	Aircraft Configuration	<ul style="list-style-type: none"> <li>• Bubble windows</li> <li>• Camera window</li> </ul>		<ul style="list-style-type: none"> <li>• Bubble windows</li> <li>• Camera window</li> </ul>		<ul style="list-style-type: none"> <li>• Bubble windows</li> <li>• Camera window</li> </ul>	
	Instrumentation						

- The data in this chart is not meant to represent the entire spectrum of potential airborne missions for any given site. It is solely based on site visits, interviews, and program experience.  
 - This chart is not representative of a specific year, rather a snapshot of potential projects during forecast years. For specific requirements for any given year, please refer to the appendix.



## Monitor National Marine Sanctuary Airborne Requirements

		Mission Type					
		Visual Surveys	Remote Sensing	Enforcement	Emergency Response	Education-Outreach	Logistical Support
<b>Flights</b>	Spring	N/A	N/A	N/A	N/A	N/A	N/A
	Summer	N/A	N/A	N/A	N/A	N/A	N/A
	Fall	N/A	N/A	N/A	N/A	N/A	N/A
	Winter	N/A	N/A	N/A	N/A	N/A	N/A
	Total						
<b>Mission Parameters</b>	Altitude						
	Speed						
	Duration						
	Range						
	Aircraft Configuration						
	Instrumentation						

- The data in this chart is not meant to represent the entire spectrum of potential airborne missions for any given site. It is solely based on site visits, interviews, and program experience.  
 - This chart is not representative of a specific year, rather a snapshot of potential projects during forecast years. For specific requirements for any given year, please refer to the appendix.

## Gray's Reef National Marine Sanctuary Airborne Requirements

		Mission Type						
		Visual Surveys	Remote Sensing	Enforcement	Emergency Response	Education-Outreach	Logistical Support	
<b>Flights</b>	Spring	3	N/A	8	N/A	2	N/A	
	Summer	3	N/A	10	N/A	2	N/A	
	Fall	6	N/A	8	N/A	2	N/A	
	Winter	6	N/A	4	N/A	0	N/A	
	<b>Total</b>	<b>18</b>		<b>30</b>		<b>6</b>		
<b>Mission Parameters</b>	Altitude	1,000 ft		1,000 ft		2,000 ft		
	Speed	150 kts		150 kts		150 kts		
	Duration	1.5 hrs		2 hrs		1.5 hrs		
	Range	500 nmi		500 nmi		500 nmi		
	Aircraft Configuration	<ul style="list-style-type: none"> <li>• Bubble windows</li> <li>• Camera window</li> </ul>		<ul style="list-style-type: none"> <li>• Bubble windows</li> <li>• Camera window</li> </ul>		<ul style="list-style-type: none"> <li>• Bubble windows</li> <li>• Camera window</li> </ul>		
<b>Instrumentation</b>								

- The data in this chart is not meant to represent the entire spectrum of potential airborne missions for any given site. It is solely based on site visits, interviews, and program experience.

- This chart is not representative of a specific year, rather a snapshot of potential projects during forecast years. For specific requirements for any given year, please refer to the appendix.

## Florida Keys National Marine Sanctuary Airborne Requirements

Mission Type							
	Visual Surveys	Remote Sensing	Enforcement	Emergency Response	Education- Outreach	Logistical Support	
Flights	Spring	0	24	12	1	N/A	
	Summer	0	24	6	1	N/A	
	Fall	10	24	12	1	N/A	
	Winter	0	24	6	1	N/A	
	Total	10	96	36	4		
Mission Parameters	Altitude	4,000 - 12,000 ft	2,000 ft	2,000 ft	2,000 ft		
	Speed	120 - 200 kts	150 kts	150 kts	150 kts		
	Duration	4 hrs	2 hrs	2 hrs	2 hrs		
	Range	750 nmi	750 nmi	750 nmi	750 nmi		
	Aircraft Configuration	<ul style="list-style-type: none"> <li>• Bubble windows</li> <li>• Camera window</li> </ul>	<ul style="list-style-type: none"> <li>• L1/L2 GPS antennae</li> <li>• Down-looking ports</li> <li>• Instrument rack</li> <li>• Scientific power</li> </ul>	<ul style="list-style-type: none"> <li>• Bubble windows</li> <li>• Camera window</li> </ul>	<ul style="list-style-type: none"> <li>• Bubble windows</li> <li>• Camera window</li> </ul>		
	Instrumentation		<ul style="list-style-type: none"> <li>• Bathy LIDAR</li> <li>• Topo LIDAR</li> <li>• Digital Camera</li> </ul>				

- The data in this chart is not meant to represent the entire spectrum of potential airborne missions for any given site. It is solely based on site visits, interviews, and program experience.

- This chart is not representative of a specific year, rather a snapshot of potential projects during forecast years. For specific requirements for any given year, please refer to the appendix.

## Flower Garden Banks National Marine Sanctuary Airborne Requirements

		Mission Type						
		Visual Surveys	Remote Sensing	Enforcement	Emergency Response	Education-Outreach	Logistical Support	
<b>Flights</b>	Spring	3	N/A	6	N/A	1	N/A	
	Summer	3	N/A	10	N/A	1	N/A	
	Fall	3	N/A	6	N/A	1	N/A	
	Winter	3	N/A	4	N/A	0	N/A	
	<b>Total</b>	<b>12</b>		<b>30</b>		<b>3</b>		
<b>Mission Parameters</b>	Altitude	1,000 ft		1,000 ft		2,000 ft		
	Speed	150 kts		150 kts		150 kts		
	Duration	2 hrs		2 hrs		2 hrs		
	Range	500 nmi		500 nmi		500 nmi		
	Aircraft Configuration	<ul style="list-style-type: none"> <li>• Bubble windows</li> <li>• Camera window</li> </ul>		<ul style="list-style-type: none"> <li>• Bubble windows</li> <li>• Camera window</li> </ul>		<ul style="list-style-type: none"> <li>• Bubble windows</li> <li>• Camera window</li> </ul>		
<b>Instrumentation</b>								

- The data in this chart is not meant to represent the entire spectrum of potential airborne missions for any given site. It is solely based on site visits, interviews, and program experience.

- This chart is not representative of a specific year, rather a snapshot of potential projects during forecast years. For specific requirements for any given year, please refer to the appendix.

## Olympic Coast National Marine Sanctuary Airborne Requirements

Mission Type							
	Visual Surveys	Remote Sensing	Enforcement	Emergency Response	Education- Outreach	Logistical Support	
<b>Flights</b>	Spring	3	0	8	1	1	N/A
	Summer	3	4	10	2	4	N/A
	Fall	3	10	12	2	2	N/A
	Winter	3	0	4	1	0	N/A
	<b>Total</b>	12	14	34	6	7	
<b>Mission Parameters</b>	Altitude	1,000 ft	4,000 - 12,000 ft	1,000 ft	1,000 ft	2,000 ft	
	Speed	150 kts	120 - 200 kts	150 kts	150 kts	150 kts	
	Duration	4.5 hrs	4.5 hrs	3.5 hrs	2.5 hrs	2.5 hrs	
	Range	1000 nmi	1000 nmi	1000 nmi	1000 nmi	1000 nmi	
	Aircraft Configuration	<ul style="list-style-type: none"> <li>• Bubble windows</li> <li>• Camera window</li> </ul>	<ul style="list-style-type: none"> <li>• L1/L2 GPS antennae</li> <li>• Down-looking ports</li> <li>• Instrument rack</li> <li>• Scientific power</li> </ul>	<ul style="list-style-type: none"> <li>• Bubble windows</li> <li>• Camera window</li> </ul>	<ul style="list-style-type: none"> <li>• Bubble windows</li> <li>• Camera window</li> </ul>	<ul style="list-style-type: none"> <li>• Bubble windows</li> <li>• Camera window</li> </ul>	
	Instrumentation		<ul style="list-style-type: none"> <li>• Bathymetry LIDAR</li> <li>• Topo LIDAR</li> <li>• Digital Camera</li> </ul>				

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## Gulf of the Farallones National Marine Sanctuary Airborne Requirements

Mission Type							
	Visual Surveys	Remote Sensing	Enforcement	Emergency Response	Education-Outreach	Logistical Support	
<b>Flights</b>	Spring	3	0	10	0	N/A	
	Summer	3	5	12	0	N/A	
	Fall	3	5	12	1	N/A	
	Winter	3	0	6	0	N/A	
	<b>Total</b>	12	10	40	1	3	
<b>Mission Parameters</b>	Altitude	1,000 ft	4,000 - 12,000 ft	1,000 ft	1,000 ft	2,000 ft	
	Speed	150 kts	120 - 200 kts	150 kts	150 kts	150 kts	
	Duration	2.5 hrs	4 hrs	2 hrs	3 hrs	2 hrs	
	Range	500 nmi	500 nmi	500 nmi	500 nmi	500 nmi	
	Aircraft Configuration	<ul style="list-style-type: none"> <li>• Bubble windows</li> <li>• Camera window</li> </ul>	<ul style="list-style-type: none"> <li>• L1/L2 GPS antennae</li> <li>• Down-looking ports</li> <li>• Instrument rack</li> <li>• Scientific power</li> </ul>	<ul style="list-style-type: none"> <li>• Bubble windows</li> <li>• Camera window</li> </ul>	<ul style="list-style-type: none"> <li>• Bubble windows</li> <li>• Camera window</li> </ul>	<ul style="list-style-type: none"> <li>• Bubble windows</li> <li>• Camera window</li> </ul>	
	Instrumentation		<ul style="list-style-type: none"> <li>• Bathy LIDAR</li> <li>• Topo LIDAR</li> <li>• Digital Camera</li> </ul>				

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## Cordell Bank National Marine Sanctuary Airborne Requirements

Mission Type							
	Visual Surveys	Remote Sensing	Enforcement	Emergency Response	Education-Outreach	Logistical Support	
<b>Flights</b>	Spring	3	N/A	6	N/A	0	N/A
	Summer	3	N/A	10	N/A	1	N/A
	Fall	3	N/A	10	N/A	1	N/A
	Winter	3	N/A	4	N/A	0	N/A
	<b>Total</b>	<b>12</b>		<b>30</b>		<b>2</b>	
<b>Mission Parameters</b>	Altitude	1,000 ft		1,000 ft		2,000 ft	
	Speed	150 kts		150 kts		150 kts	
	Duration	2 hrs		1.5 hrs		1.5 hrs	
	Range	500 nmi		500 nmi		500 nmi	
	Aircraft Configuration	<ul style="list-style-type: none"> <li>• Bubble windows</li> <li>• Camera window</li> </ul>		<ul style="list-style-type: none"> <li>• Bubble windows</li> <li>• Camera window</li> </ul>		<ul style="list-style-type: none"> <li>• Bubble windows</li> <li>• Camera window</li> </ul>	
	Instrumentation						

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## Monterey Bay National Marine Sanctuary Airborne Requirements

		Mission Type						
		Visual Surveys	Remote Sensing	Enforcement	Emergency Response	Education-Outreach	Logistical Support	
<b>Flights</b>	Spring	3	0	10	3	1	N/A	
	Summer	3	3	10	3	4	N/A	
	Fall	3	10	12	3	3	N/A	
	Winter	3	0	8	2	1	N/A	
	<b>Total</b>	<b>12</b>	<b>14</b>	<b>40</b>	<b>11</b>	<b>9</b>		
<b>Mission Parameters</b>		Altitude	1,000 ft	4,000 - 12,000 ft	1,000 ft	1,000 ft	2,000 ft	
		Speed	150 kts	120 - 200 kts	150 kts	150 kts	150 kts	
		Duration	6.5 hrs	4 hrs	4.5 hrs	4 hrs	2 hrs	
		Range	1000 nmi	1000 nmi	1000 nmi	1000 nmi	1000 nmi	
		Aircraft Configuration	<ul style="list-style-type: none"> <li>• Bubble windows</li> <li>• Camera window</li> </ul>	<ul style="list-style-type: none"> <li>• L1/L2 GPS antennae</li> <li>• Down-looking ports</li> <li>• Instrument rack</li> <li>• Scientific power</li> </ul>	<ul style="list-style-type: none"> <li>• Bubble windows</li> <li>• Camera window</li> </ul>	<ul style="list-style-type: none"> <li>• Bubble windows</li> <li>• Camera window</li> </ul>	<ul style="list-style-type: none"> <li>• Bubble windows</li> <li>• Camera window</li> </ul>	
		Instrumentation		<ul style="list-style-type: none"> <li>• Bathy LIDAR</li> <li>• Topo LIDAR</li> <li>• Digital Camera</li> </ul>				

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## Channel Islands National Marine Sanctuary Airborne Requirements

		Mission Type						
		Visual Surveys	Remote Sensing	Enforcement	Emergency Response	Education- Outreach	Logistical Support	
<b>Flights</b>	Spring	6	0	6	3	1	N/A	
	Summer	6	0	12	3	5	N/A	
	Fall	6	10	12	3	3	N/A	
	Winter	6	0	5	2	1	N/A	
	<b>Total</b>	<b>24</b>	<b>10</b>	<b>35</b>	<b>11</b>	<b>10</b>		
		<b>Altitude</b>	4,000 - 12,000 ft	1,000 ft	1,000 ft	2,000 ft		
		<b>Speed</b>	120 - 200 kts	150 kts	150 kts	150 kts		
		<b>Duration</b>	4 hrs	4.5 hrs	3.5 hrs	2 hrs		
		<b>Range</b>	750 nmi	750 nmi	750 nmi	750 nmi		
		<b>Aircraft Configuration</b>	<ul style="list-style-type: none"> <li>• Bubble windows</li> <li>• Camera window</li> </ul>	<ul style="list-style-type: none"> <li>• Bubble windows</li> <li>• Camera window</li> </ul>	<ul style="list-style-type: none"> <li>• Bubble windows</li> <li>• Camera window</li> </ul>	<ul style="list-style-type: none"> <li>• Bubble windows</li> <li>• Camera window</li> </ul>		
		<b>Instrumentation</b>	<ul style="list-style-type: none"> <li>• Bathy LIDAR</li> <li>• Topo LIDAR</li> <li>• Digital Camera</li> </ul>					

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## Hawaiian Islands Humpback Whale National Marine Sanctuary Airborne Requirements

Mission Type							
	Visual Surveys	Remote Sensing	Enforcement	Emergency Response	Education-Outreach	Logistical Support	
<b>Flights</b>	Spring	8	0	0	0	N/A	
	Summer	8	0	0	0	N/A	
	Fall	8	8	0	0	N/A	
	Winter	8	0	24	4	N/A	
	<b>Total</b>	<b>32</b>	<b>8</b>	<b>24</b>	<b>4</b>	<b>4</b>	
<b>Mission Parameters</b>	Altitude	1,000 ft	4,000 - 12,000 ft	1,000 ft	1,000 ft	2,000 ft	
	Speed	150 kts	120 - 200 kts	150 kts	150 kts	150 kts	
	Duration	4 hrs	4 hrs	4 hrs	4 hrs	2 hrs	
	Range	750 nmi	750 nmi	750 nmi	750 nmi	500 nmi	
	Aircraft Configuration	<ul style="list-style-type: none"> <li>• Bubble windows</li> <li>• Camera window</li> </ul>	<ul style="list-style-type: none"> <li>• L1/L2 GPS antennae</li> <li>• Down-looking ports</li> <li>• Instrument rack</li> <li>• Scientific power</li> </ul>	<ul style="list-style-type: none"> <li>• Bubble windows</li> <li>• Camera window</li> </ul>	<ul style="list-style-type: none"> <li>• Bubble windows</li> <li>• Camera window</li> </ul>	<ul style="list-style-type: none"> <li>• Bubble windows</li> <li>• Camera window</li> </ul>	
	Instrumentation		<ul style="list-style-type: none"> <li>• Bathymetry LIDAR</li> <li>• Topo LIDAR</li> <li>• Digital Camera</li> </ul>				

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## Papahānaumokuākea Marine National Monument

### Airborne Requirements

		Mission Type						
		Visual Surveys	Remote Sensing	Enforcement	Emergency Response	Education-Outreach	Logistical Support	
<b>Flights</b>	Spring	1	0	12	1	1	2	
	Summer	1	0	12	1	3	2	
	Fall	1	10	12	1	2	2	
	Winter	1	0	6	0	1	0	
	<b>Total</b>	<b>4</b>	<b>10</b>	<b>42</b>	<b>3</b>	<b>6</b>	<b>6</b>	
<b>Mission Parameters</b>								
Altitude		1,000 ft	4,000 - 12,000 ft	1,000 ft	1,000 ft	2,000 ft	25,000 ft	
Speed		150 kts	120 - 200 kts	150 kts	150 kts	150 kts	250 kts	
Duration		15.5 hrs	8 hrs	13 hrs	8 hrs	6 hrs	12 hrs	
Range		2500 nmi	2500 nmi	2500 nmi	2500 nmi	2500 nmi	2500 nmi	
Aircraft Configuration		<ul style="list-style-type: none"> <li>• Bubble windows</li> <li>• Camera window</li> </ul>	<ul style="list-style-type: none"> <li>• L1/L2 GPS antennae</li> <li>• Down-looking ports</li> <li>• Instrument rack</li> <li>• Scientific power</li> </ul>	<ul style="list-style-type: none"> <li>• Bubble windows</li> <li>• Camera window</li> </ul>	<ul style="list-style-type: none"> <li>• Bubble windows</li> <li>• Camera window</li> </ul>	<ul style="list-style-type: none"> <li>• Bubble windows</li> <li>• Camera window</li> </ul>	<ul style="list-style-type: none"> <li>• Cargo door</li> </ul>	
Instrumentation			<ul style="list-style-type: none"> <li>• Bathymetry LIDAR</li> <li>• Topographic LIDAR</li> <li>• Digital Camera</li> </ul>					

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## Airborne Requirements

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		Mission Type						
		Visual Surveys	Remote Sensing	Enforcement	Emergency Response	Education-Outreach	Logistical Support	
Flights	Spring	N/A	N/A	N/A	N/A	N/A	N/A	
	Summer	N/A	N/A	N/A	N/A	N/A	N/A	
	Fall	N/A	N/A	N/A	N/A	N/A	N/A	
	Winter	N/A	N/A	N/A	N/A	N/A	N/A	
	Total							
Mission Parameters	Altitude							
	Speed							
	Duration							
	Range							
	Aircraft Configuration							
	Instrumentation							

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