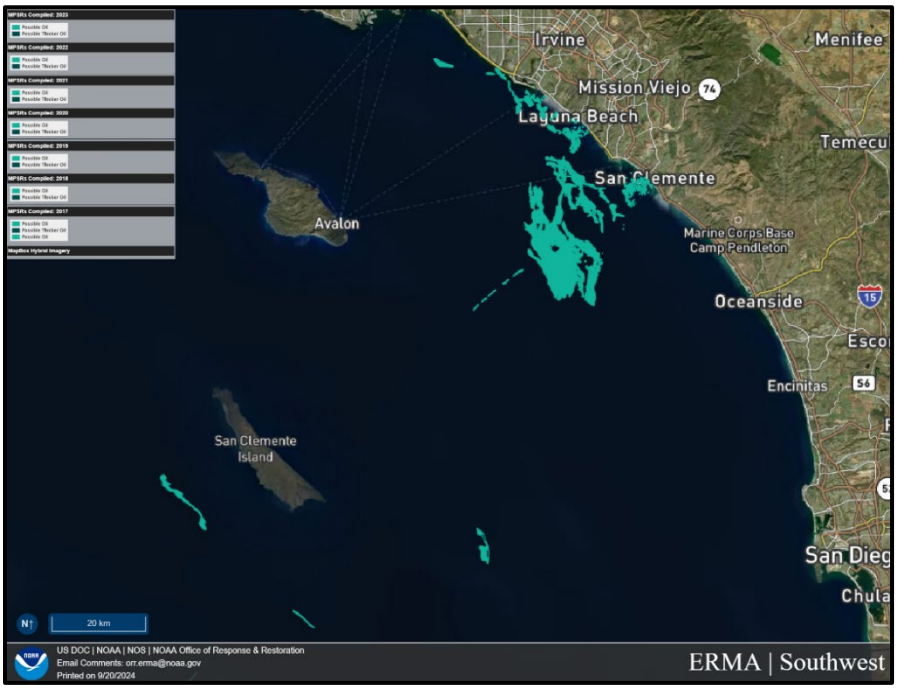
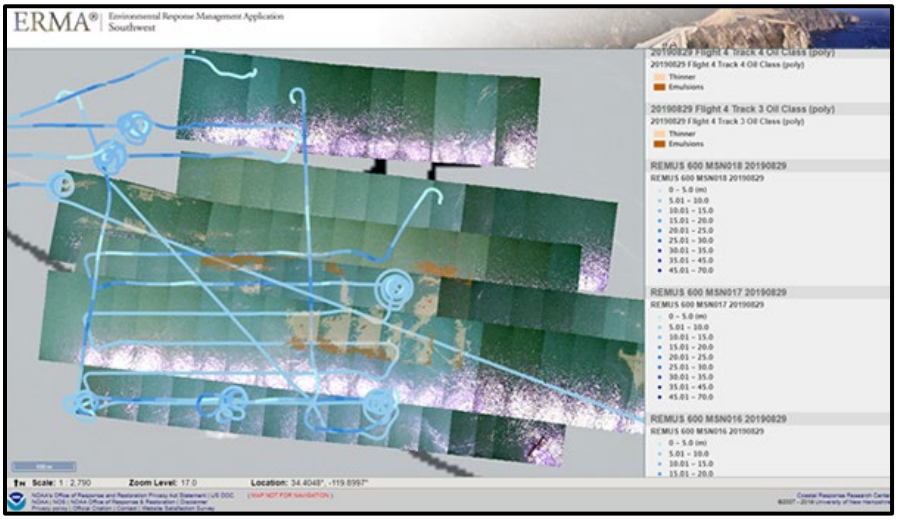
Oil Spill Response Data Management, Storage, and Delivery Guidance





September 2024

Oil Spill Response Data Management, Storage, and Delivery Guidance

A Guide to inform the user of best practices for managing data collections from a small Uncrewed Aircraft System (sUAS) or other remote platform during an oil spill or natural disaster response and/or damage assessment.

U.S. DEPARTMENT OF COMMERCE • National Oceanic and Atmospheric Administration • National Ocean Service • Office of Response and Restoration • Emergency Response Division

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(lower image – ERMA® Image) UAS mosaics and AUV tracks. NOAA, Office of Response and Restoration (OR&R); https://response.restoration.noaa.gov/unmanned-systems-technology-emergency-response-and-damage-assessment

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Introduction

The purpose of this document is to inform the user of best practices for managing data collections from a small Uncrewed Aircraft System (sUAS) or other remote platform during an oil spill or natural disaster response and/or damage assessment. It will cover a generalized list of data management best practices for ensuring documentation and data lineage for data collected in support of response and damage assessment missions in the nearshore and open-water environments typical of marine environmental response. The intended user is a United States Coast Guard (USCG) or National Oceanic and Atmospheric Administration (NOAA) spill responder or damage assessor that is collecting or directing the collection of response imagery for the purpose of decision-making recommendations for incident response or Natural Resource Damage Assessment (NRDA) case development.

While this document is generally platform agnostic, it will inform the user how to conform to a variety of data management system requirements that both NOAA and the USCG will encounter in pursuit of their mission assignments. The workflows outlined in this document are not intended to rely on NOAA data management systems or tied to specific remote sensing platforms or sensors; these workflows are focused on the data management of the imagery and products derived from any platform and sensor combination. However, NOAA's data management is tied to the Data Integration Visualization Exploration and Reporting (DIVER) data warehouse and the Environmental Response Management Application (ERMA®) Common Operational Picture (COP) for visualization and spatial analysis, and these systems will be used as part of the workflow examples. It provides situational awareness to NOAA and USCG responders.

This document supplements but does not replace various standard operating procedures (SOPs) and protocols already in place such as the USCG Short-Range Unmanned Aircraft Systems (UAS) Flight Operations Standard Operating Procedures, USCG Office of Aviation Forces (USCG SR-UAS SOP, 2021); the NOAA Uncrewed Aircraft Systems (UAS) Handbook, NOAA UxS Operations Center (NOAA UAS, 2022); and the NOAA Uncrewed Aircraft Systems Operations Policy, Office of Marine and Aviation Operations (OMAO-UAS, 2022). These and other SOP documents are listed in the resources section of this document.

Data Management Best Practices

Data Management Overview

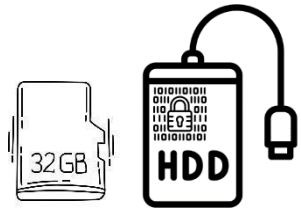
The purpose of this section is to provide recommendations to streamline ingestion of spatial data into an accessible data management system (e.g. NOAA's DIVER data warehouse) and subsequent posting into a Common Operational Picture (e.g. NOAA's ERMA COP) in an operational response timeframe.

Data management is a critical component to mission success and will provide information management and data visualization of flight operations and products to support situational awareness and decision making for USCG, NOAA and all partners. Following the SOPs will enable USCG and NOAA to share and visualize products in an operational timeframe and provide post event documentation for actions taken in near-real-time as well as after action review.

Data collected by USCG (or contractor) pilots need to comply with all UAS-SOP requirements (please note that other Agency requirements may also apply). All raw and processed data must be retained, including Secure Digital Memory Cards (SD Cards) and external drives. All original raw and processed data and associated products must be maintained per Agency/Department guidelines on an approved Agency system or device. This represents the official record of collection, and its long-term disposition is driven by these Agency guidelines for retention and archive.

Upon coordination with and approval from the regional NOAA SSC, an operational copy of the collected data and documentation will be loaded to the NOAA DIVER data warehouse (DIVER) and will be maintained in DIVER and/or ERMA for no more than 6 months after an event unless there are legal constraints or requirements for litigation or law enforcement. Each USCG pilot or support personnel collecting and compiling this information is the principal custodian of the data and is responsible for ensuring data preservation. Each pilot also needs to establish DIVER login credentials prior to traveling for field operations (an ERMA account will also be required to view data in the COP).

Data Storage



Folder Structure Conventions

All original collected imagery and derived products will be organized on a local computer or hard drive that may include Agency or Departmental requirements such as a USCG-Cyber security approved data storage device (hard-drive) or other secure storage. These data and products should be stored in separate folders following the conventions described in the next section.

There should always be a properly defined folder hierarchy for each response or project. The pilot or designated data custodian will create an Incident/Event Parent Folder on an approved

device that will serve as the official organizational structure for all collections related to an incident or event.

This first level folder (Incident/Event parent folder) should include subfolders to catalog each of the image types and derived products that will be expected from the mission. All data for that day should be copied or captured from the platform/sensor used for the project and put in the RAW subfolder (folder 1 in the list below). Additionally, the SD Card itself may need to be retained as the primary, authoritative source of that collection. It is recommended that multiple approved SD Cards are available prior to any collection to ensure that each mission's complete collection is retained.

From the RAW data folder, copies of the Nadir imagery (overhead, looking down) and the Oblique imagery (offset, side-looking) should be copied and placed in separate subfolders as they will have a different workflow (see folders 2 and 3 in the list below). Nadir imagery will be used for mapping and for creating image mosaics of the area of interest. Oblique imagery will be used to provide perspective on the area but is not used for quantification or extent mapping products. Thermal imagery (infrared [IR] heat detection, nadir or oblique) may also be collected to enhance oil detection if RGB visualization is difficult and unclear. Copies of thermal imagery should be placed in a separate subfolder (see folder 5 in the list below) as well as have the TIR suffix as they are generally captured at different resolutions than other sensor data and may have a more complicated workflow.

Folder Structure: ("..\" represents the parent folder for this structure)

1. ..\RAW (all files copied from SD Card)
2. ..\Nadir (copy from RAW)
3. ..\Oblique (any non-nadir, copy from RAW)
4. ..\Metadata (Photo '.jpg' or pdf copy of the UAS Mission log form)
5. ..\Thermal (TIR) (copy from RAW)
6. ..\Videos (Format that allows streaming)
7. ..\Derived_Products (DP) (e.g. classifications, analysis)

All collections must include specific folders for (1) Raw data files, (2) Nadir and/or (3) Oblique imagery, as well as (4) Metadata describing the collection as well as the sensors and platform specifications. Optionally, depending on the sensors and platforms deployed as well as collection methodology, additional folders for thermal imagery, video images, image mosaics, or other derived products may also be necessary.

This folder structure is intended to provide the authoritative, original version of every collection for the Agency collecting imagery. Following this workflow will facilitate the ability to quickly and efficiently create data packages in subsequent steps, described below, and meet the requirements for Agency data collection and retention as well as for management and situational awareness during an event.

Data Content, Collection, Naming, Processing, and Delivery

Overview

These conventions will aid in the time-sensitive management of all data collected under a particular mission assignment or specific project. Completed data packages to be uploaded to the data repository (DIVER) and posted to the COP (ERMA) should include platform tracklines (e.g. aircraft flight tracks), imagery, and classification products as appropriate. These packages should also include full metadata or comprehensive README files with all information required to produce a standard FGDC/ISO metadata record (e.g. NOAA InPort).

Please coordinate any proposed project work with the NOAA SSC and provide this guidance document to partners, contractors, or other interested parties and proscribe the use of the following file naming, file content, and formatting conventions for all files to be considered for posting/transferring to DIVER, ERMA, and/or the AWS S3.

General Naming Conventions

Using standard file naming conventions will greatly enhance and facilitate management of image collections. These naming conventions ensure that key information about a collection is captured and immediately visible, enabling rapid identification of specific activities as well as help packaging the data so that it can be retained as required. The general naming convention including year, month, day, and time enables the file names to be used to sort collected data and create and manage daily image collection packages. All folder and file names should use underscores, not spaces, dashes, or any other character, to split naming description.

The name helps quickly sort and identify what the data are, when it was collected, and who collected it (individual, Agency, or Organization). It also simplifies searching for files within your local system and DIVER File Collection. At the minimum, the name should have a short descriptor type, local date and time, and the collector. The collector can be the established team names, pilot initials, pilot last name, or representative organization. The order of information in the file name should be determined by the need of the mission as long as it includes all the pertinent information. Examples of recommended naming structure and file names are below.

1. **Type**
    - Raw, Nadir, Oblique, Video, Metadata, Derived Products
    - Describes the type of data
2. **Date & Time (YYYYMMDD_HHMM)**
    - YYYYMMDD: Year, month, day
    - HHMM: 24-hr local time
3. **Sensor**
    - RGB, TIR, MSS, LIDAR, etc.
4. **Collector**
    - Team, Pilot, Representative Organization

5. Format **(Optional)**
    - Frames, Mosaic, etc.
6. Mission or Feature Qualifiers **(Optional)**
    - For more complex collections identify any unique features
    - These qualifiers are optional (e.g. Leg, Feature, and Altitude)
    - Note: do not include "( )" or "#" placeholders in file name if not used

    Multiple features, same flight increment with a letter
        - *a = Leg or Feature (e.g. a, b, c…etc.)*

    Multiple Altitudes should be noted
        - *# = Altitude (e.g. 50, 100, 400, etc.)*

File Naming Structure

File Types and Naming Conventions (What is it, Date & Time, and/or Team or Pilot Initials/ LastName or Organization)

Ex. "Nadir_YYYYMMDD_HHMM_UAS01.zip" OR "_MCG.zip" OR "..._Greer.zip"

1. RAW (all files copied from SD Card)
    - jpeg, mov, txt, more… - *Raw_20230724_1330_MCG.zip*
2. Nadir (copy from RAW)
    - jpeg - *Nadir_20230724_1330_UAS01.zip*
    - jpeg - *Nadir_20230724_1330_TIR_UAS01.zip*
3. Oblique (copy from RAW)
    - jpeg - *Oblique_20230724_1330_Team1.zip*
    - jpeg - *Oblique_20230724_1330_TIR_Team1.zip*
4. Videos (Format that allows streaming)
    - mov, mp4, avi, etc. - *Videos_20230724_1330_Greer.zip* or
    - mov, mp4, avi, etc. - *VidOilSlick_20230724_1330_NOAA.mp4*
5. Metadata (Photo '.jpg' or pdf copy of the UAS Mission log form)
    - doc, txt, xlsx, csv - *UASMissionLogForm_20230724_1330_UAS01.doc*
6. Derived_Products (DP) (e.g. mosaics, classifications, analysis)
    - tif, shp, doc, pdf - *DP_20230724_1330_TIR_ OilClass_MCG.pdf*
    - tif, ovr, xml - *DP_20230724_1330_Mosaic_Team1.tif*

Data will be zipped daily by folder type and uploaded to DIVER File Collections at the end of day (or end of operations when daily uploads are not practical) using USCG pilot or contractor login credentials.

Example Image Names:

Ex. "Type_YYYYMMDD_HHMM_sensor_collector_format_a#"
Nadir_20211017_1430_RGB_Team1_frames_a50.tif (can also include MSS or TIR)
Oblique_20211017_1430_TIR_Team1_b100.tif (can also include RGB, or MSS)

- Nadir RGB, MSS, and TIR can be made into composite mosaic images
- Oblique data will not be used for mosaics (frames are assumed)
- Lidar point clouds are not frames or mosaic images
- Data Manager/PI will decide if raw/unprocessed imagery should be included with processed imagery

Example Derived Product Names (Mosaic, Lidar, Classification):

- Mosaics, Lidar, etc.
  - *DP_20211017_1430_RGB_Team1_mosaic_a#.tif (can also include MSS or TIR)*
  - *DP_20211017_1430_LIDAR_Team1_a#.tif (processed Lidar point cloud)*
- Classification/processing result
  - *DP_20211017_1430_SENSORcls_a#.zip*
  - D*P_20211017_1430_RGBcls_*a#*.zip* (*can also include MSS or TIR*)

Example Trackline Names:

GPS_20211017_1430_tk_Team1.zip

- GPS trackline: gpx or other GIS file. Can contain planned path and/or actual flight information.
- GPS tracklines are extremely helpful, however they can be difficult to retrieve from sUAS. A trackline should be collected if possible.

Image Resolution Naming Qualifier (Nadir example):

- Image files are assumed to be at full resolution, unless otherwise noted in the name. Imagery may be down-sampled for quicker uploading/reviewing. Naming of files needs to reflect the resolution. Full resolution images do not need to specify "_full".
  - *Nadir_20211017_1430_RGB_.zip*
- Medium- and low-resolution versions of the imagery, (for data transfer efficiency and quick-looks), should have a "_med" and "_low" designation
  - *Nadir_20211017_1430_RGB_med_Team1.zip*
  - *Nadir_20211017_1430a_RGB_low_Team1.zip*

File Package Contents

Zip file within project folder will contain:

- One .zip file/activity (e.g. flight) that contains all collected image type folders for documentation required for future work
- Zip files for complete package per imagery set
- Underscores instead of spaces in .zip name and files within .zip
- Description: less than 75 characters

1. *Raw data*
    a. *Raw_2011017_1430_Team1.zip*
2. *Processed imagery (Nadir example)*
    a. *Nadir_20211017_1430_RGB_Team1.zip*
    b. *Nadir_20211017_1430a_RGB_med_Team1.zip*
    c. *Nadir_20211017_1430a_RGB_low_Team1.zip*
3. *Metadata*
    a. Camera platform (manufacturer, spectral collection characteristics (e.g. RGB and NIR spectral range)
    b. Processing steps taken
    c. File naming conventions used (reference this document)

Image File Format

Format: GeoTIFF (preferred). Can also be Imagine, png/jpg with world file for geographic information.

Spatial Data Projections and Coordinate Systems

Geographic WGS84 (EPSG:4326) or Web Mercator (Auxiliary Sphere) (EPSG:3857).
Projection should be stabilized as early in the processing chain as possible.
Use only one projection across a project activity.

Image and Package File Size Limitations

Images and image mosaics should be compiled so that the file packages do not exceed reasonable upload or download speeds for the project's capacity, particularly when internet conditions are slow or inconsistent. Field data reporting packages containing mosaics (for ERMA) may need to be limited/down-sampled to approximately 2 GB or less based on operational period or other factors.

Images may be split in ArcGIS (data management, split raster) or by reducing image resolution (down-sampling). Full resolution data should always be retained for documentation, law enforcement, and damage assessment requirements. If the activity allows for less than daily delivery, bulk uploads of RAW data to DIVER can be done once high-speed connections are available.

Image Data Storage and Transfer Requirements

This section describes procedures for uploading and managing data in NOAA's DIVER data warehouse. Alternative data management systems may have alternative workflows and requirements however the DIVER system workflow represents best practices that can be applied to similar systems.

Data Upload (DIVER)

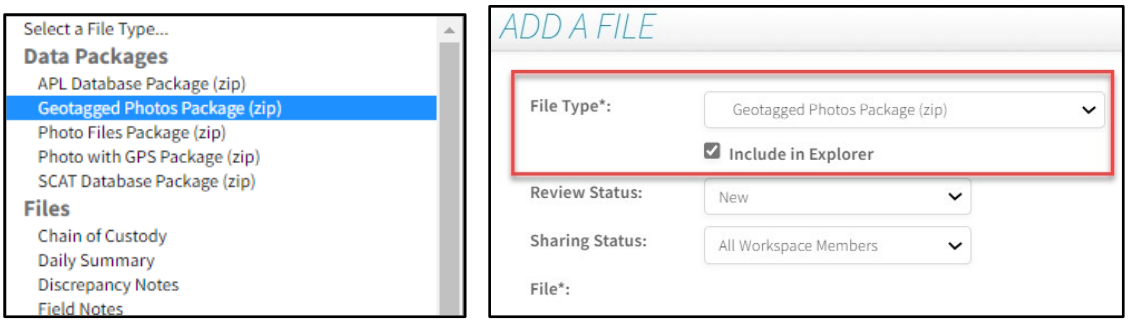
NOAA's DIVER data warehouse provides a variety of data management functions that will simplify image and derived product management and automated processing that will facilitate moving this data into the decision-making process. A NOAA OR&R data manager Point of Contact (POC) will create and provide you with a link to your designated DIVER Response Activity and File collection where you will upload the various data sets that have been collected. All the files you will be uploading are the ones for which you've already established the folder structure and file naming conventions and derived products prior to this section.

Example URL: https://portal.diver.orr.noaa.gov/group/[IncidentName]/filecollection/[xxxx]

File Types:

- Data Packages: "Geotagged Photos Package (.zip)" will be for the zipped photos to display "Red Kites" in ERMA and only include Nadir, Obliques and Thermal imagery.
- Files: "Original Image Files (.zip)" will be for the files in the RAW folder zipped.
- Files: "Other Document" will be for all the videos zipped or any other documents not listed in the dropdown.
- Files: "Field Notes" will be for any metadata files. Can be uploaded individually, e.g. MissionLog, Oil Observation form.
- Files: "GIS Files (.zip)" will be for any mosaic images or static map products generated as well as any other associated GIS files.

In the DIVER **Add A File** Section select the Data Package type as "***Geotagged Photos Package (zip)***" and select the "***Include in Explorer***" (see below) check box so DIVER will automatically process your file to an ERMA-ready package.



Keep the Review Status and Sharing Status at the default values (New and All workspace members respectively). Drag and drop, or manually select the file(s) and click “Upload File.” Once the uploads are complete, email your NOAA OR&R data management POC for ERMA COP ingest.

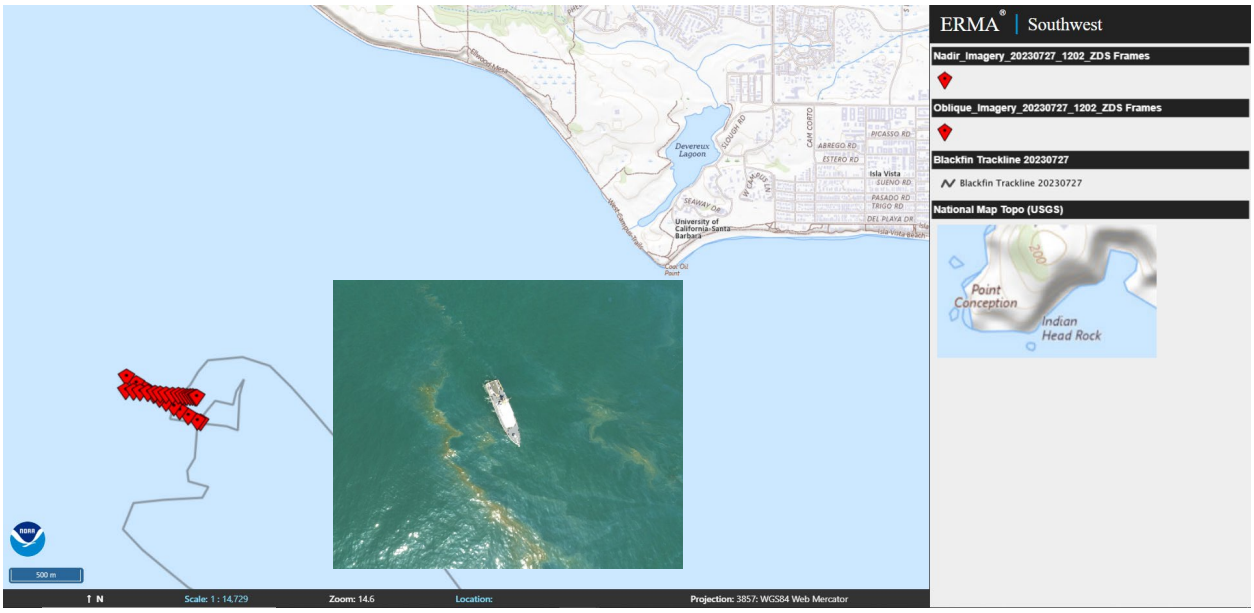
DIVER Photo Management

Within the DIVER system, there is a tool that can help manage photos. The data collectors and data managers can add additional information such as water markings, descriptions, notes, and keywords to photos providing a better understanding of what that photo contains and identifying important individual photos for response users and for the COP. All this information can be searchable, making it much easier to identify and share photos.

Data Management and Derived Products

Image collections are packaged and uploaded for specific use in DIVER and ERMA. Following the steps above for moving the data into NOAA applications will enable the creation of specific derived products useful for situational awareness and near-real-time decision making. The two principle derived mapping products for this Job Aid are “Red Kite Mapping” and “Image Mosaic Mapping”. Red Kite maps are semi-automated products created in DIVER that can be posted in ERMA in less than 1 hour from upload. Image mosaic maps require additional pre-processing in custom or commercial software prior to posting in ERMA. The posting time of image mosaic maps is driven by this pre-processing and subsequent ingestion in ERMA.

Figure 1: Red Kite Mapping.



The “Red Kites” represent the location where a photo (Nadir or Oblique) is taken and contains a link to a thumbnail and full resolution image. “Red Kite” maps can be generated in near-real-time providing rapid situational awareness.

Figure 2: Image Mosaic Mapping.

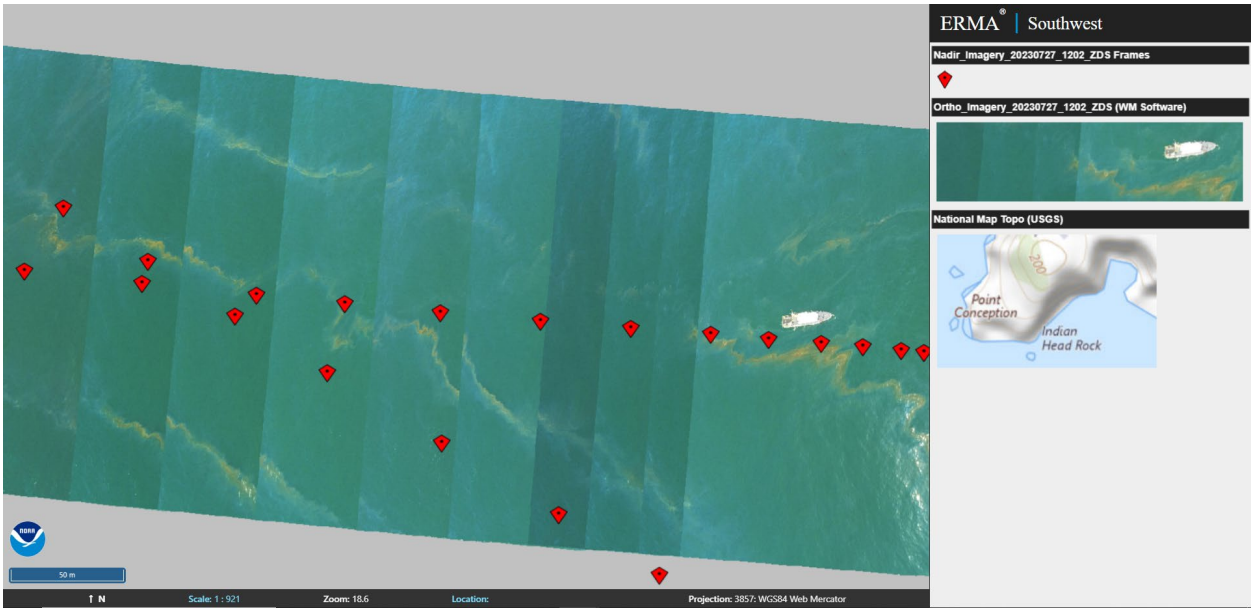


Image mosaics are a set of individual frames, collected following standardized flight patterns that allow the individual images to be stitched together to create a larger image map for visualization. In the example above, the images collected (and linked to the “Red Kites”) have been stitched together into a comprehensive “picture” of the features of interest.

The data and derived product data management described in this Job Aid represent critical components of the capture, process, and delivery workflow that will support situational awareness and decision-making support required for effective operations. Each step in the described workflow is important in moving data from the field and into decision-makers’ hands in near-real-time.

Resources

Data Management Resources

DIVER

- DIVER Homepage: https://www.diver.orr.noaa.gov/
- DIVER Help: https://www.diver.orr.noaa.gov/web/guest/help
- DIVER Portal: https://portal.diver.orr.noaa.gov/ (Workspaces)

ERMA®

- ERMA Home Page (All Regions): https://response.restoration.noaa.gov/resources/maps-and-spatial-data/environmental-response-management-application-erma
- ERMA Help: https://erma.noaa.gov/ermaHelp

NOAA OR&R Job Aids

- Uncrewed Aircraft Systems Hurricane Response Job Aid
- Uncrewed Aircraft Systems Oil Spill Response Job Aid
- Open Water Oil Identification Job Aid for Aerial Observation

UAS Operations

U.S. Coast Guard (USCG) Short-Range Unmanned Aircraft Systems (UAS) Flight Operations Standard Operating Procedures, USCG Office of Aviation Forces (USCG SR-UAS SOP, 2021). https://homeport.uscg.mil/Lists/Content/Attachments/71056/Short-range%20UAS%20USCG%20SOP.pdf

NOAA Uncrewed Aircraft Systems (UAS) Handbook, NOAA UxS Operations Center. https://www.omao.noaa.gov/sites/default/files/documents/NOAA%20UAS%20Handbook.pdf

NOAA Uncrewed Aircraft Systems Operations Policy, Office of Marine and Aviation Operations (OMAO-UAS, 2022) *(internal NOAA access only)*. https://www.omao.noaa.gov/uncrewed-systems

14 Code of Federal Regulations (CFR) Part 107. https://www.ecfr.gov/current/title-14/chapter-I/subchapter-F/part-107

Uncrewed Aircraft Systems Oil Spill Response Job Aid, NOAA, 2021. https://response.restoration.noaa.gov/jobaid/UAS-oilspill

Uncrewed Aircraft Systems Hurricane Response Job Aid, NOAA, 2021. https://response.restoration.noaa.gov/jobaid/UAS-hurricane

Maritime Environmental Response Oil Mission Guidelines, WaterMapping LLC, NOAA OR&R, USCG, 2023. Available at the University of New Hampshire (UNH) Coastal Response Research Center (CRRC) https://crrc.unh.edu/

Appendix

ERMA COP Image Processing Requirements

This appendix is provided for completeness; however, these processing steps are beyond the scope of this Job Aid. These steps involve more complex image processing and are most often managed by the commercial off-the-shelf (COTS) sUAS software used for processing and are not required for most USCG applications.

As noted above, it is highly recommended that imagery and image products use standard projections (e.g. geographic (4326), web Mercator (3857), etc.) as early in the processing as possible. Assigning a standard geographic projection and datum will improve the quality and usability of image collections and any derived products. The ERMA COP standard includes geographic and web Mercator, greatly simplifying the ingest of data in a response timeline.

It is also important to understand how image processing is going to impact the ability to import data quickly and efficiently. Some desktop GIS systems will not embed processing detail into the image files as is required by ERMA for proper display. For example, ERMA cannot honor on-the-fly ArcGIS Image color enhancement (i.e. color stretching) parameters, so the image must be exported from ArcGIS with the image stretch parameters 'burned' into the final image.

ArcGIS Image Processing/Preparation:

When preparing to export RGB imagery for ERMA (all steps happen at once):

- Review image in ArcGIS without any stretch to determine if the delivered image looks good as-is; if needed, apply appropriate hardwired stretch (e.g. percent clip)
- Export from ArcGIS (retain source projection, do not project into new system)
- Specify 8-bit tiff with a no data value of 0 (may need to be modified)
    - Data values should never include 0
- Rendering settings
    - Use Render
    - Force RGB
- Output format is tiff with LZW compression
- Ensure pyramid/overviews are created with the final tiff
- Once complete, remove the ArcGIS display stretch (set stretch to none) to review for successful stretch and no-data values
- Zip the image and component files together for import directly into ERMA

A quick check in an image viewer such as Windows built-in viewer, IrfanView, or Xnview should show an image that looks like it was seen in ArcGIS with no additional stretch required.