I) Conduct Rapid Ecological Assessments

i) Conduct appropriate replicate surveys.

ii) Document biomass, biodiversity impacts relative to appropriate control or reference sites.

iii) Identify ecological functions.

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J) Follow Set Procedures for Safeguarding All Data, Photos and Evidence Collected.

K) Analyze Data.

i) Use Results to Establish Rates of Recovery.

ii) Quantify the Loss on Various Levels.

iii) Determine Mitigation & Restoration Options/Values.

L) Create an Investigation Report.

M) Use Results to Support Mitigation, Restoration, Mediation, and Prosecution.

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THE VARIOUS SECTIONS OF THIS TOOLKIT PROVIDE STEP-BY-STEP GUIDANCE ON EACH OF THESE PHASES IN DETAIL

The General Coral Reef CSI Process

The Land-Based Police CSI Process

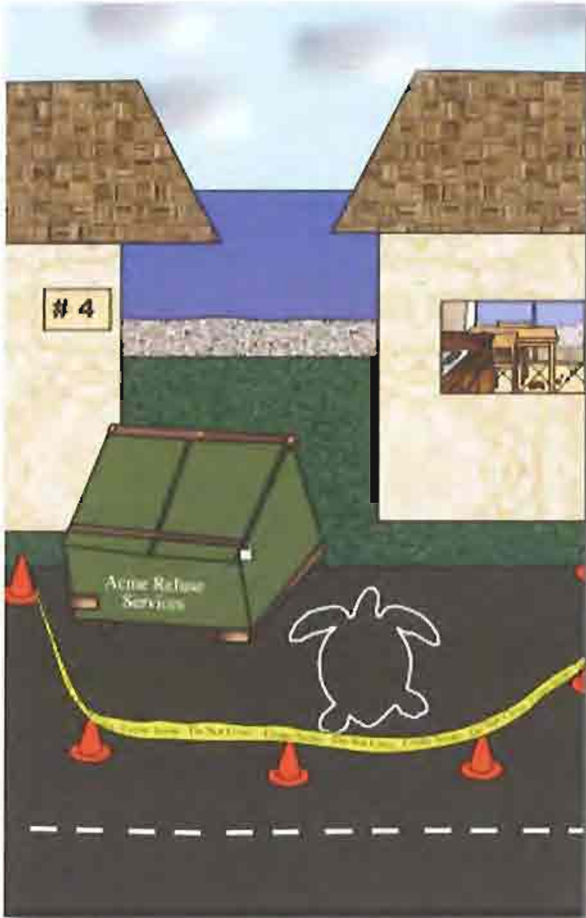
There are set procedures for investigating major crimes:

- Respond to a report of an injured or dead individual.
- Determine the extent of the victim's injuries.
- Set and secure a scene perimeter.
- Search for evidence related to the crime.
- Document and collect evidence at the scene and at a hospital or autopsy.
- Analyze the collected evidence.
- Use results to link suspect, victim and the crime scene.

We've proposed a similar set of procedures for use with marine natural resource injuries that involve investigations underwater:

Translation To A Coral Reef CSI Process

1. **Respond to a report of a damaged coral reef.**
2. **Observe and document the specific areas and types of damage.**
3. **Determine the possible sources of damage.**
4. **Collect evidence necessary to link the possible sources of damage to the reef.**
5. **Analyze the collected evidence.**
6. **Use evidence analysis to link specific sources to specific areas or types of damage.**



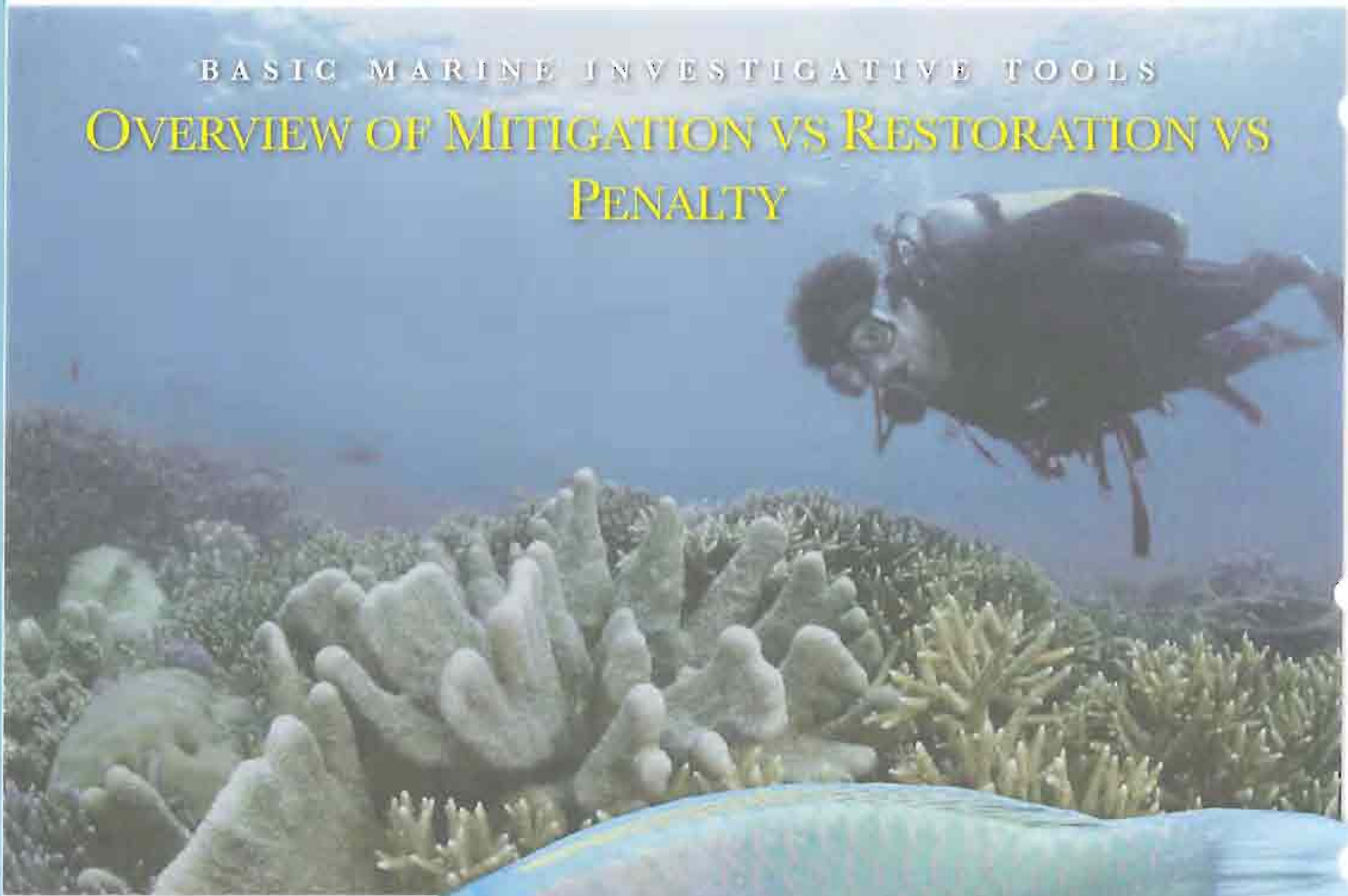
Why Do We Need To Do Coral Reef CSI?

For any given injury event, we recognize the following issues that tend to support the need for conducting Coral Reef CSI:

- There are many possible sources of coral reef damage.
- Need to identify the specific damage sources.
- Need to determine the specific damage impacts.
- Need to reduce or stop damage/impacts.
- Reluctance of sources to admit responsibility.
- Difficulty of assessing degree of responsibility.

BASIC MARINE INVESTIGATIVE TOOLS

OVERVIEW OF MITIGATION VS RESTORATION VS PENALTY



THE END-USE OF INVESTIGATIVE ANALYSIS

After all the analysis and evaluation of data, photos and evidence, decisions will need to be made regarding whether the injury damage will be repaired, the resources restored to their pre-impact status, whether the damage will be mitigated through other efforts either on-site or off-site, and/or whether penalty will be sought against the RP. The answers to these questions will be dependent in part upon the rules and laws associated within any jurisdiction, the resources and political will of the NRT agencies involved, and the strength of the results of the NRT's field investigation (when combined with other investigative agency reports on the incident or the RP).

It should be noted that none of these alternatives are mutually-exclusive; in fact, it is common to have some combination of emergency restoration, compensatory mitigation, primary restoration and penalty sought in many coral reef resource injury cases.

EMERGENCY RESTORATION

This almost always occurs prior to formal proceedings against an RP and represents actions usually taken immediately after in injury event and response activities to prevent additional damage from occurring. An example of emergency restoration might be the removal of rubble from a damaged area to prevent wave action from causing additional damage. Emergency restoration activities are often paid for by the RP to prevent them from being liable for greater costs arising from continuing or additional damage to natural resources caused by the results of the original injury event.

Mitigation

The idea of compensatory mitigation is based on the idea that for many damaged areas, the damaged resource cannot be fully restored and therefore might be credited by preventing or repairing damage elsewhere or by enhancing habitat elsewhere.

When evaluating possible mitigation projects, keep in mind the following:

- The relationship (nexus) of the proposed compensatory mitigation project to the injured resource or impact site.
- Projects should not replace an existing function of another RP or government agency.

Some examples of compensatory mitigation projects that have been used in coral reef areas include:

- Marine Debris Clean-up
- Creation of Marine Protected Areas
- Removal of Abandoned Vessels
- Improvement of Aids to Navigation
- Nursery of Coral Reef Resources
- Alien Species Control

Primary Restoration

Common restoration activities include (Jaap 2000):

- Structural reconstruction of damaged coral reef substrates. When possible, large coral formations are reattached to their original location. If this is not possible, coral formations are replaced with artificial structures having a similar structure. Wherever possible, emphasis should be on the restoration of the original three-dimensional structure of the reef. Cement, limestone boulders, and a combination of the two have been used for this purpose. Steel reinforcements have been applied for strengthening fractured reef structures.
- Transplantation of reef resources.

A recent application of Habitat Equivalency Analysis (HEA) in damage assessment (Banks et al. 1998) generated a claim of $2.4 million against the United States government for injury to a coral reef caused by the grounding of the submarine USS Memphis off southeastern Florida. A detailed assessment of damages was conducted by the use of transects and aerial photographs. The grounding completely destroyed an area of 1,205 m2 (all stony corals were killed). Impacts of the grounding on the abundance/m2, live coral cover and species richness of stony corals were studied by comparing the values in the injured site with adjacent sites, since no previous data for these parameters were available. A conservative figure for reef recovery of 35 years was used, and only the area that was completely destroyed was included in the model. It was estimated that in addition to restoring the area that was destroyed, the restoration project would have to create 37 m2 of new reef (with artificial reefs) to compensate for interim losses. The costs of assessment, removal of loose rubble, substrate stabilization, transplantation of corals, construction and deployment of artificial reefs, and implementation of a 20-year monitoring program were the base of the $2.4 million (USD) legal claim (J Wielgus, 2004).

The following table shows legal cases resulting from vessel groundings in the Florida Keys in which damages to coral reefs were based on the U. S. Marine Protection, Research, and Sanctuaries Act (MPRSA). Total coral reef destruction refers to the death of all coral colonies in an area; partial destruction refers to the occurrence of colony deaths and damages (J Wielgus, 2004).

Vessel Case (Year)	Vessel Length (M)	Reported Range of Damage	Amount Recovered from RP ($USD)
Wellwood (1984)	122	Biological & structural injury.	$5,654,228
Mini Laurel (1986)	65	Biological & structural injury.	$30,000
Alec Maitland (1989)	47	Total destruction of 680.5 m².	$1,450,000

Vessel Case (Year)	Vessel Length (M)	Reported Range of Damage	Amount Recovered from RP ($USD)
Elpis	143	Total destruction of 2604.7 m^2.	$2,275,000
Jacquelyn L (1991)	54	Total destruction of 123.1 m^2.	$251,554
Miss Beholden (1993)	45	Partial destruction of 1025.6 m^2.	$1,873,741
Columbus Iselin (1994)	52	Total destruction of 345 m^2.	$3,760,488
Petty Cache (1994)	15	Total destruction of 17.25 m^2.	$25,000
Houston (1997)	187	2333 m^2 of crushed coral reef substrate; over 3000 broken pieces of coral.	$5,738,000
Golden Lady (1997)	22	Total destruction of 42 m^2; additional sanctuary resources injured.	$54,716

While many of the above restoration recoveries were negotiated with the RP or through the court system; a well-designed restoration program would base its claim on all costs associated with:

- Damage Assessment costs
- Damage Control costs
- Primary Damage Restoration costs
- Secondary Damage Restoration costs
- Interim Losses costs
- Monitoring Program costs
- Administrative costs

Finally, when evaluating a range of possible restoration projects, focus should be on :

- Costs of the alternative actions. This must be a consideration for achieving economic efficiency.
- The likelihood of success.
- The extent to which the implementation of the alternative avoids causing additional damages to natural resources.
- The extent to which the alternative may benefit more than one natural resource or resource services.

(Modified after NOAA, 1997).

Penalty

In most regions, penalties associated with marine natural resources are based on a per specimen basis, often with a sliding scale based on species type or whether the violation occurred within a marine protected area. While this works for many coral reef organisms, corals do not easily classify by such a system - what constitutes a specimen? Under such circumstances, jurisdictions might consider enacting legislation, rules or authorities to seek penalties based on area of damage (for example, per m^2).

Penalties can be either civil or criminal in nature. Civil (or administrative) penalties are those which are usually handled through a government authority where the administrative officer hears evidence from both sides and renders a decision. Civil penalties usually involve fines, confiscation of equipment or catch, or loss of permit or license. Criminal penalties can involve all of the above along with imprisonment. In most cases, criminal cases have a stronger burden of proof associated with them then civil cases.

REFERENCES

Banks K, Dodge RE, Fisher L, Stout D, & Jaap W (1998). Florida Coral Reef Damage from a Nuclear Submarine Grounding and Proposed Restoration. *Journal of Coastal Research Special Issue*, 26: 64-71.

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BASIC MARINE INVESTIGATIVE TOOLS

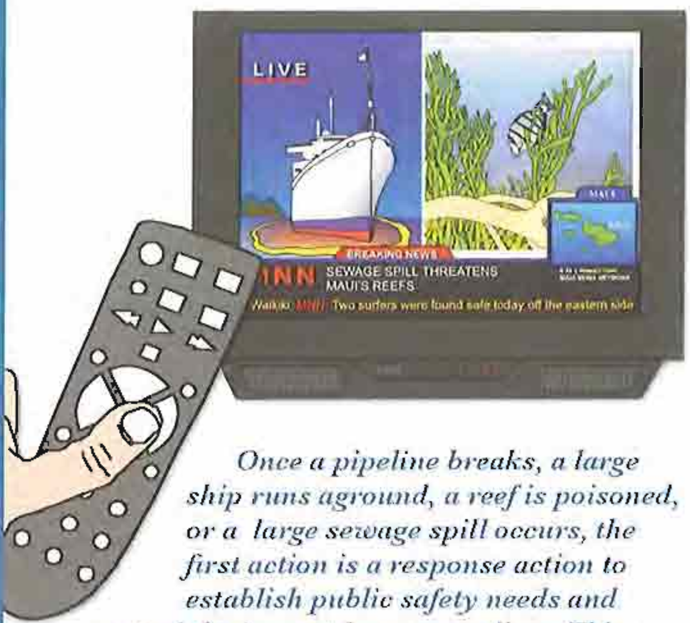
B

Basic Marine Investigative Tools

International resource managers, enforcement officers and researchers training as a Coral Reef CSI Team off Cozumel, Mexico.

Module I: The Marine In-Water Investigative Process In-Depth (Sections)

Conducting A Site Reconnaissance



Once a pipeline breaks, a large ship runs aground, a reef is poisoned, or a large sewage spill occurs, the first action is a response action to establish public safety needs and control the impact from spreading. This will be followed by a salvage or clean-up response. For these to occur safely and effectively, many jurisdictions deploy rapid reconnaissance teams to feed information back to their incident command centers.

The Reconnaissance Team's primary role is NOT to investigate cause and effect, but to gather input to plan the response that will secure and clean-up the injury, while insuring the safety of all involved. Their observations and analysis is usually directed to an incident command center where it is used to assist in the deployment of assets and resources for the response, and for modifying the SOP under which all elements are operating. Usually the reconnaissance team assesses the injury site and adjacent areas without directly entering the water or the injury, working from the shoreline, on boats, or from the air.

A reconnaissance team should be made up of representatives of the various **Natural Resource Trustees (NRTs)**, public safety officials, hazardous materials specialists (Hazmat), enforcement officials, and a representative of the **Responsible Party (RP)**, if available. Once again, the primary function of the reconnaissance survey is to identify immediate public safety issues and to gather information to be used to direct the response efforts; that said, it should also be recognized that the quality of the information gathered at this early stage will determine its usefulness in the investigation that will follow later. The desire for high quality information must be balanced against both a on-site safety concern and necessary requirement for speed and a timely transfer of information to the decision-makers directing the response efforts.


US Dept of Labor (www.osha.gov)

Preparing To Go In The Field

Unlike the follow-on investigative team, the reconnaissance team enters the periphery of the impact area with little to no knowledge of the hazards on-site. As such it is important that all members of this team be proficient in basic Hazmat procedures associated with the type of impacts they are assessing. Gear should include appropriate protective clothing and minimal equipment (GPS, Camera, measuring tape, notebook, oranges) if walking over large coastal areas. Note that additional security and public safety personnel may be necessary to secure the area, keep the public or other users from interfering with the response/investigation, protect others from exposure/harm, and minimize adjacent user actions from contributing to the impact or interfering with the response efforts.

Security perimeters that are established may remain intact for the follow-on investigative activities, or may be reduced or eliminated depending upon need, resources and types of injury.

Coastal Access

STOP Care must be taken when accessing portions of a coastline (or marine waters in areas that practice private marine tenure) to address issues of required permission and/or permits.

Arrival at an Impact Scene

The first official resource trustee representative on a potential coral reef impact scene should attempt to garner resources in order to secure the impact scene. Outside of immediate safety of any and all people in the area, and minimizing any additional damage to protected or rare natural resources, it is critical to preserve the impact scene with minimal contamination and disturbance of the physical evidence. The initial response to an incident should be expeditious and methodical. While the NRT representative(s) assesses the scene to assist in response planning and implementation, they also need to treat the incident and surroundings as a potential natural resource crime scene until the arrival of a Coral Reef CSI Team.

If the incident was originally reported by the RP or if the RP is providing background information regarding the incident, care should be taken regarding the information as historically RPs have tended to under-report damage, size of a spill, risk, etc.

Conducting Reconnaissance Through Segments

As the reconnaissance needs to be conducted quickly, segmentation of the impacted and adjacent areas (especially along coastlines) is often the most effective and time-efficient way to gather the information needed. Segments should be of a defined distance and encompass a known set of habitat and subhabitat types.

Often the fastest way to determine distance is to pace off an area and apply a average pace distance to the

Evaluating Beach Impacts


US EPA (www.epa.gov)

Beaches by definition are fluid environments whereby the substrate is often changing and impacts can frequently go subsurface, with no observable impact in the surface layers. Reconnaissance teams often will dig series of trenches perpendicular to the shore to try and determine subsurface penetration. Impacts along the beach should be marked with pole flags or other evidence markers, photographed, measured and evaluated. Evaluations of beach impact should be done as close to low tide as possible in order to see exposure effects.

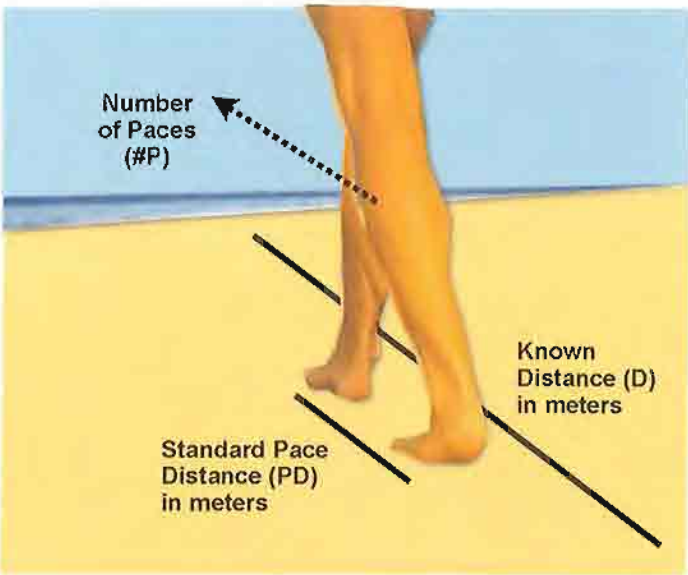

NOAA

Key Terms

- ***Reconnaissance Survey***
- ***Natural Resource Trustee (NRT)***
- ***Responsible Party (RP)***
- ***Pace Distance***
- ***Drift Cards***
- ***Risk Management***
- ***Response Threshold***
- ***Habitat Vulnerability Index***

number of paces. Over long distances (greater than 50 m) the error will be minor. To quickly determine your average pace distance, pace at a standard rate along the beach substrate for a known (measured) distance; divide the number of paces by the number of known meters to determine the number of paces per meter. Note that your pace distance will change depending upon changes in the substrate, grade, and topography that you are walking on.

Pace Distance (PD) = D/#P



Quick Quiz: What's wrong with this picture if it represents a real reconnaissance survey?

Once you have determined your average pace distance, count the number of paces (Total #P) along select peripheral sides of your segment (or other areas to be measured) and multiply by your average pace distance to determine the length to be measured.

Length Distance (LD) = Total #P x PD

Hazmat

STOP

It is critical that all team members be familiar with the Hazmat concerns associated with the injury type or the area to be investigated.

Conducting Coastal Assessments

Dave Gulko

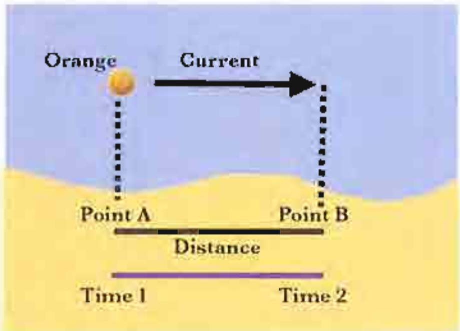
Conducting coastal assessments require field teams to be aware of multiple hazards at the same time that they are evaluating existing impacts and risks to resources. Wave actions, pre-existing broken glass and metal, upland pollution, coastal users, feral animals, private property, rusty metal, sharp rocks & bivalves, human refuse and animal wastes all can be found on the shore that you need to walk, in addition to hazards posed by the injury event itself. Proper footwear (no barefeet, slippers or sandals), sun-protection (hats, sunglasses,etc.) and backpacks should be used.

Dave Gulko

When you encounter unknown impacts along the shore - take care to not directly touch the impacted surfaces or take samples unless you're properly trained and equipped - instead mark the site with flags (see photo of a fish kill and use of flags - *right*) , stakes, flagging tape, etc. and document the impact in regards to location, photos and size and/or numbers.

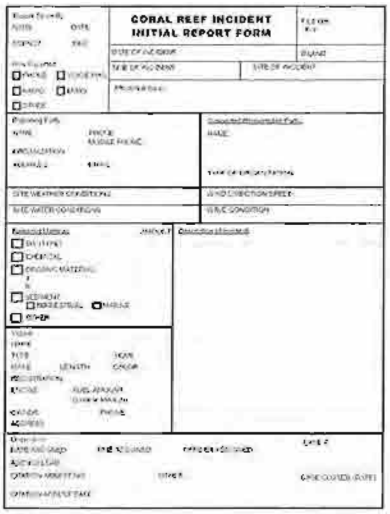
Drift cards such as this (*left*) are made of light wood and biodegrade over time. They are often brightly colored and will wash ashore where their location will help determine the current patterns in the area (*below*).

It's often helpful to gauge the direction and speed of the current at a site in order to have some idea of where debris, pollution or an oil spill might proceed over time; this will help direct both prevention and clean-up efforts. Sometimes agencies will use brightly colored, biodegradable drift cards (*right*) which are numbered and have contact information so that anyone who finds it washed up on a beach can call in the information. For other areas without such resources, or for events without time for extensive preparation, one can use either intact oranges or coconuts whose husks have been removed leaving the intact shelled nut (which you could paint to make it more visible). Both of these organic products are biodegradable and have a density in seawater similar to that of thick oil (such as might be spilled in a large ship grounding). Surface drift currents can be determined (*below right*) by finding two fixed points (Points A & B) along the shoreline and measuring the distance between them in meters. Then tossing the orange (or coconut) straight out from Point A into the water and using a wristwatch to time how long it takes to reach Point B. The ocean current speed (S) is equal to the distance (d) divided by the time (t) : $S = d/t$.



What to Take in the Field

The On-scene Coordinator or Team Leader should review any available intelligence regarding the incident, including the original 'Coral Reef Incident Initial Report Form' filled out by the NRTs who were first on the scene (See Appendix - Forms). The Reconnaissance Team should use this information to be made aware of the general parameters of the event, time frame and location issues that are currently known.


CORAL REEF INCIDENT INITIAL REPORT FORM

Reconnaissance teams should consider the following materials to take in the field:

Safety Gear:

- Sunscreen
- Polarized Sunglasses
- Sunwear
- Covered shoes
- Water

Measuring Gear:

- Oranges for current measurement
- Laser Monocular
- Sand grain gauge
- 15 m measuring tape reel
- Meter stick, shovel or trowel

Documentation Gear:

- Digital camera, extra batteries, North arrow, & photo scale card
- Field notebook, forms, pens
- Handheld GPS
- Compass

Sampling Gear

- Protective gloves
- Aluminum foil
- Ziplock™ bags

Communication Gear:

- Handheld radio or cell phone

To assist the Reconnaissance team, a comprehensive Surface/Shore Reconnaissance data organization form is available (see Appendix - Forms).

SURFACE/SHORE RECONNAISSANCE FORM

GENERAL INFO

SURVEY BY: ☐ FOOT ☐ OVERLOOK ☐ BOAT ☐ AIR

REGION: ____

FILE NO:

CASE TITLE:

DATE (dd/mm/yyyy):

ISLAND:

TIME START(24 hr format):
TIME STOP (24 hr format):

FORM FILLED OUT BY:

LOCATION

EVENT LOCATION:

SEGMENT: TOTAL LENGTH: ____ m LENGTH SURVEYED: ____ m DIFFERENTIAL GPS: yes / no

START GPS: LAT: ____ degrees ____ minutes LONG: ____ degrees ____ minutes

END GPS: LAT: ____ degrees ____ minutes LONG: ____ degrees ____ minutes

TEAM / CONDITIONS

SURVEY TEAM:

	Name	Agency	Phone Number
1.			
2.			
3.			
4.			
5.			
6.			

CONDITIONS:
TIDE HEIGHT: L / M / H H / M / L
WEATHER: Sun / Clouds / Rain / Windy
Wind Speed/Direction:
SURFACE CURRENT:
DIRECTION: ____
SPEED: ____ m / minute

SHORELINE TYPES

SHORELINE TYPE: Select only ONE Primary (P) and ANY Secondary (S) types present

ROCKY CLIFF	ROCKY SHORE	ROCKY PINNACLES	ROCKY TIDEPOOL
SEA GRASS	FINE-MEDIUM GRAIN SAND BEACH	WAVE-CUT PLATFORMS	EXPOSED TIDAL FLATS
MANGROVES	COARSE GRAIN SAND BEACH	MIXED SAND BEACH	SHELTERED TIDAL FLATS
WETLANDS	GRAVEL BEACH	BOULDER BEACH	EXPOSED MAN-MADE
REEF	ISLET	OTHER: ____	SHELTERED MAN-MADE

OPERATIONAL ISSUES

DESCRIPTION OF IMPACT
LOCATION: SUPRA / UPPER / MID / LOWER / SUB-

SURFACE IMPACT DISTRIBUTION
☐ <1 %
☐ 1 - 10 %
☐ 11 - 50 %
☐ 51 - 90 %
☐ 91 - 100 %

IMPACT BAND DIMENSIONS
WIDTH: ____ m
LENGTH: ____ m

SUBSTRATE PENETRATION
☐ <1 cm
☐ 1 - 10 cm
☐ >10 cm

☐ MARINE DEBRIS
☐ SHORE DEBRIS
☐ OILED DEBRIS

TYPE: ____
AMOUNT: ____

OBSERVABLE RESOURCES AT RISK:

LOGISTICAL ISSUES

☐ POSSIBLE SHORE STAGING AREA
☐ POSSIBLE DECONTAMINATION AREA
☐ ON-SITE USER GROUPS:

COLLATERAL IMPACTS FROM RESPONSE

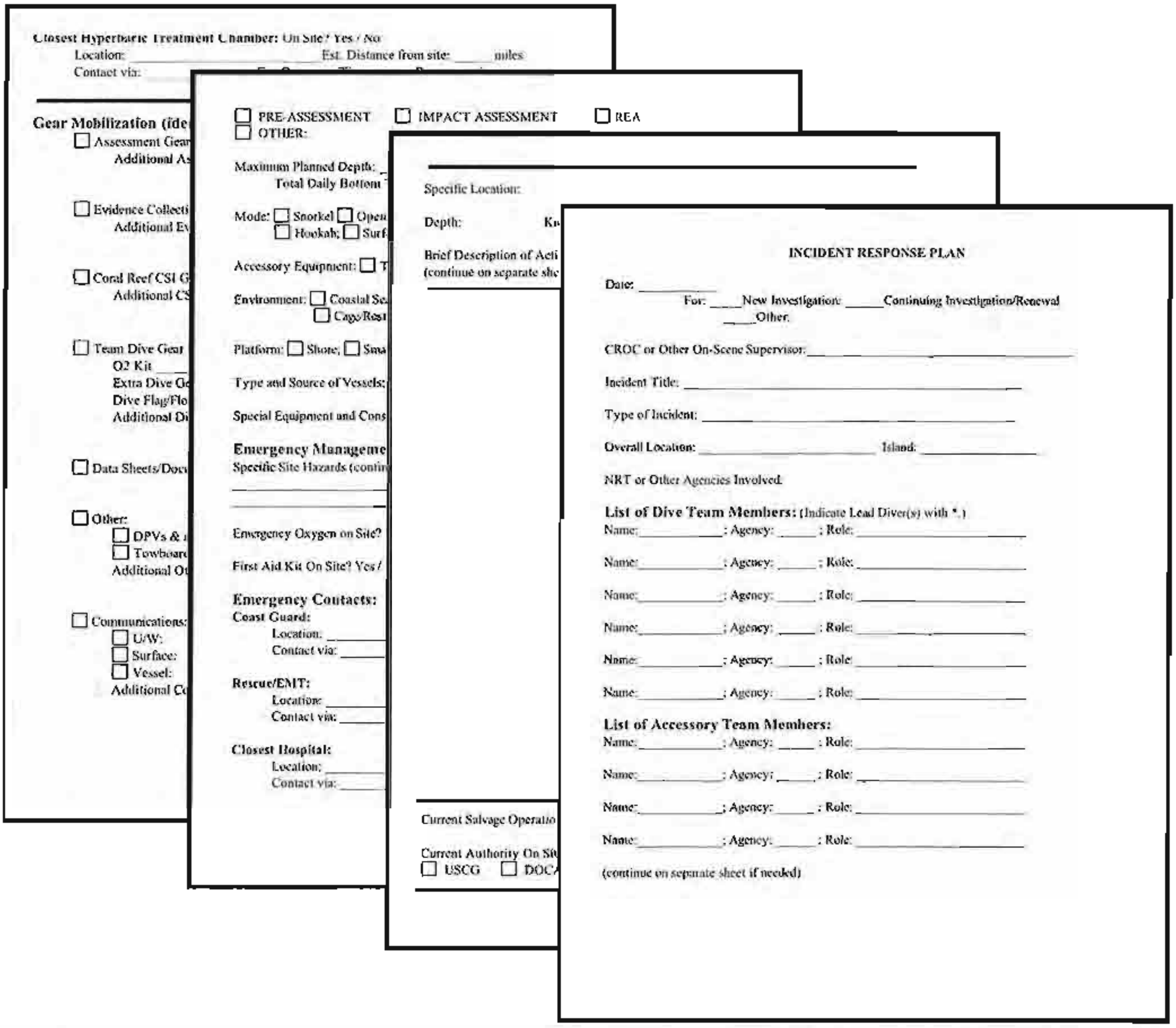
COASTAL FEATURES:
☐ INTAKE PIPES: ____
☐ OUTFALLS: ____
☐ DRAINAGE: ____
☐ SEAWALLS: ____
☐ PIERS: ____
☐ MPAs, REFUGES: ____
☐ OTHER: ____

SCENE SKETCH ☐ PHOTOS ☐ VIDEO ☐ OTHER ☐

dg 2/07

Risk Management

Sighting of users within the immediate injury area raises aspects of the ineffectiveness of security perimeters for the incident, but also raises the concern of humans serving as vectors for expanding the injury beyond the original boundaries through their activities and movement. Activities of humans within, and adjacent to, the impact area should be documented and evaluated, and the results should be reported to the incident command center.



INCIDENT RESPONSE PLAN

Date: ________

For: ___New Investigation; _____Continuing Investigation/Renewal

____Other:

CROC or Other On-Scene Supervisor: ________________

Incident Title: ________________

Type of Incident: ________________

Overall Location: ________________ Island: ____________

NRT or Other Agencies Involved.

List of Dive Team Members: (Indicate Lead Diver(s) with *.)

Name:________; Agency: ____; Role: ____________

Name:________; Agency: ____; Role: ____________

Name:________; Agency: ____; Role: ____________

Name:________; Agency: ____; Role: ____________

Name:________; Agency: ____; Role: ____________

Name:________; Agency: ____; Role: ____________

List of Accessory Team Members:

Name:________; Agency: ____; Role: ____________

Name:________; Agency: ____; Role: ____________

Name:________; Agency: ____; Role: ____________

Name:________; Agency: ____; Role: ____________

(continue on separate sheet if needed)

One of the most critical aspects of the Reconnaissance Team's survey is to use the results to help prepare or finalize the Incident Response Plan (see Appendix - Forms) which will be used for setting safety, public control, and injury assessment parameters to control the various aspects of the coordinated response activities.

Aerial Observation

Trained aerial observers offer the ability of quickly documenting the big picture from large scale events or remote areas, and getting that information back to the command center. Observers should have polarized sunglasses, a notebook[1] and pen which can be secured atop their lap or chest during the flight, along with a digital camera with a good telephoto lens with a polarizing filter[2], and a pair of binoculars. If constant direct communication with the

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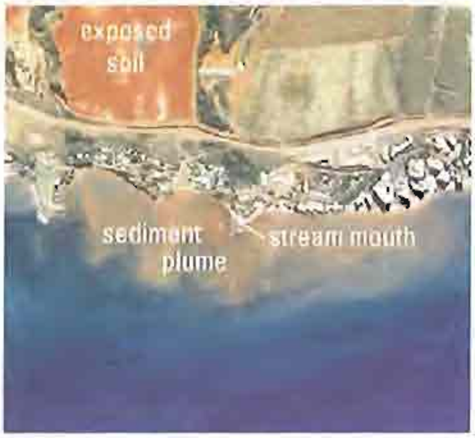
[1] The notebook should have a map/chart (or a copy of one) affixed to it which can be marked upon by the observer. Some folks use a sheet of clear plastic atop the map and a grease pencil.

[2] See Appendix B: Other Tools, Section on Aerial Photography.

pilot is not possible, then the observer should also have a hand-held GPS which can function aboard the aircraft. Some regions are making use of a software program called 'OziExplorer'. OziExplorer allows you to work with maps on your laptop computer that you create from scanned or digital maps - it allows you to track your progress in the plane or helicopter relative to what you're seeing on the water below. Another program produced by the same company called 'OziPhoto' combines the technology of your GPS receiver and your digital camera to automatically keep a mapped record of where the digital photos were taken. Both of these products are available at http://www.oziexplorer.com and http://www.oziphoto.com. OziPhotoTool takes the digital photos from your camera, and tracks that have been downloaded to OziExplorer from your GPS to plot where you were when each photo was taken. As long as the GPS was in the same location as the camera this represents the location of the photo.



USGS

Annotated aerial photo showing a sedimentation event off the island of Molokai in Hawaii. Note the identification of upland features, combined with ability to discern reef features being impacted.


NOAA

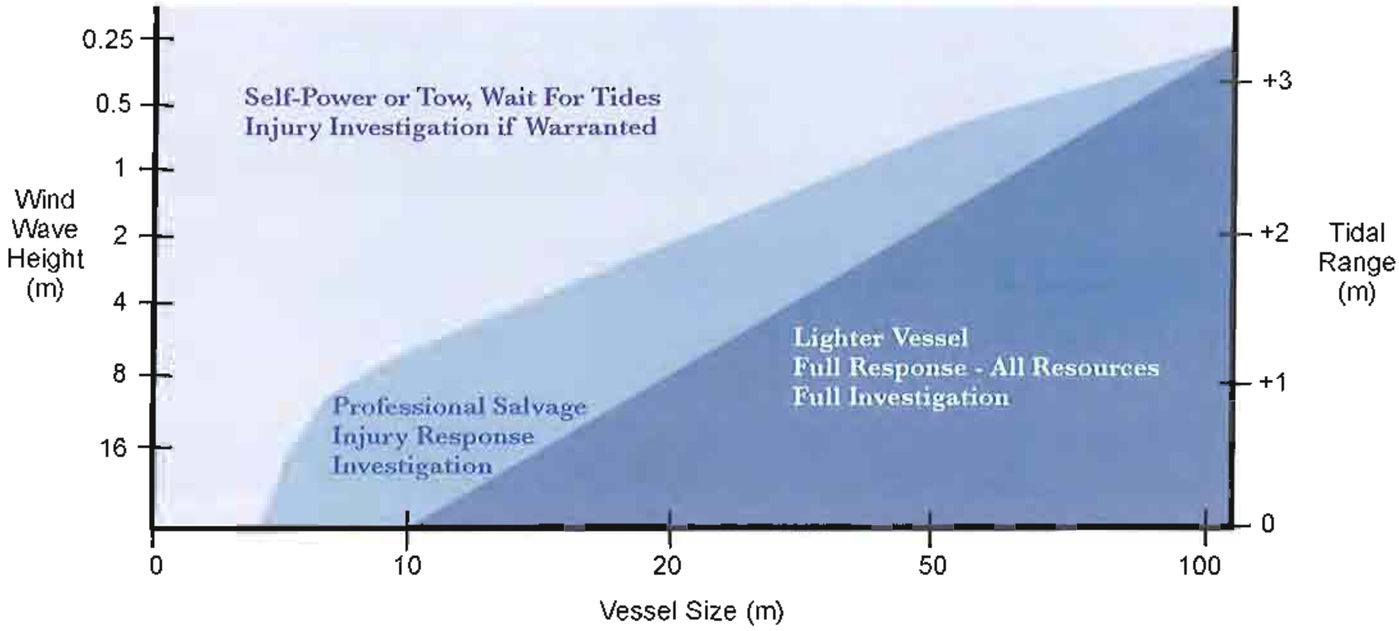
Aerial observers should have excellent eyesight, not get motion sickness easily (as spending long periods in the air looking through binoculars or camera lenses gives some folks motion sickness), and have training in identifying and communicating about surface environmental and impact features in the water and along the coastline.

Vessel-Based Observation

Many of the same tools used on airplanes or helicopters by observers can also be used on board a boat-based operation. The major difference is the field of view changes from downward and wide ranging to horizontal and more restricted. Focus is on surface effects and shallow waters/coastlines. Additional gear required for vessel-based operations includes safety vests that can act as floatation devices, sampling nets or poles, and depth sounders.

Threshold for Response

In any jurisdiction, there will be a minimal threshold from which various levels of response to an injury will occur. For some areas it's size of the vessel, amount of pollutant released, or the protected status of the organism(s) or habitat(s) impacted. Another way of doing this is to create a variable scale based on various conditions specific to the area (see example below); once a combination of parameters is crossed, it triggers a injury response, or an investigation team, or both.



Hypothetical Example of Response Threshold for Vessel Injuries That Are Region- and Agency Specific. Note: parameters may change for your area.

Habitat Vulnerability Index

Each marine habitat has different vulnerabilities to different types of impacts and causal agents based upon substrate type, degree of exposure to waves/currents, the depth, temperature of the water, and type of causal agent. Each region should put together a set of maps or charts that highlight marine areas and habitats that may be ecologically sensitive to human-caused injury events. Annotated charts and maps, if produced and reviewed prior to an event, can assist (along with the reconnaissance surveys) in the deployment of resources and equipment to help minimize the negative environmental impacts of the impact event.

Summary

The Site Reconnaissance Team is an intelligence-gathering operation, designed to gather information for response and investigation planning without (in most cases) entering directly the injured areas. Reconnaissance can be done from the air, a high platform (cliff, building, etc.), boat, or (most frequently) the shoreline. Teams need to be self contained with everything they need to cover large distances independently while still maintaining communication with the Incident Command post.

THE SITE RECONNAISSANCE IS PRIMARILY USED FOR RESPONSE PLANNING; BUT WITH ACCURATE REPORTING COULD ALSO SERVE AS INTELLIGENCE FOR THE INJURY ASSESSMENT TEAM.

REVIEW SHEET

CONDUCTING A RECONNAISSANCE SURVEY

OUTLINE OF ACTIVITIES:

1. Preparation Prior to Reconnaissance	Prepared	Conducted	Documented
a) All team members are trained in field injury reconnaissance (for example oil spill SCAT training) and HAZMAT techniques.			
b) Team leader meets with Incident Commander and NRT representatives regarding the reconnaissance survey.			
c) Platform (vessel, aircraft) and transportation to injury site are arranged.			
d) All team members have appropriate safety, measurement, survey and communication gear for the type of environment and location to be surveyed.			
e) Review any existing intelligence, including the Initial Report form.			

Important Tools, Forms or Other Aids:

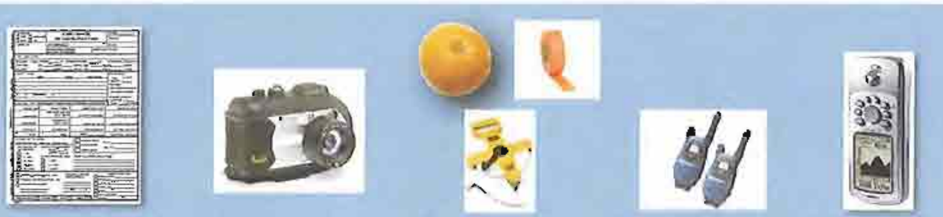
Incident Report Form

Incident Response Plan

2. During Reconnaissance	Prepared	Conducted	Documented
a) Dry run all activities immediately prior to survey.			
b) Calibrate and document all measuring and documentation gear.			
c) Determine pace distance and length of assessment segments.			
d) Determine environmental conditions (including current speeds).			

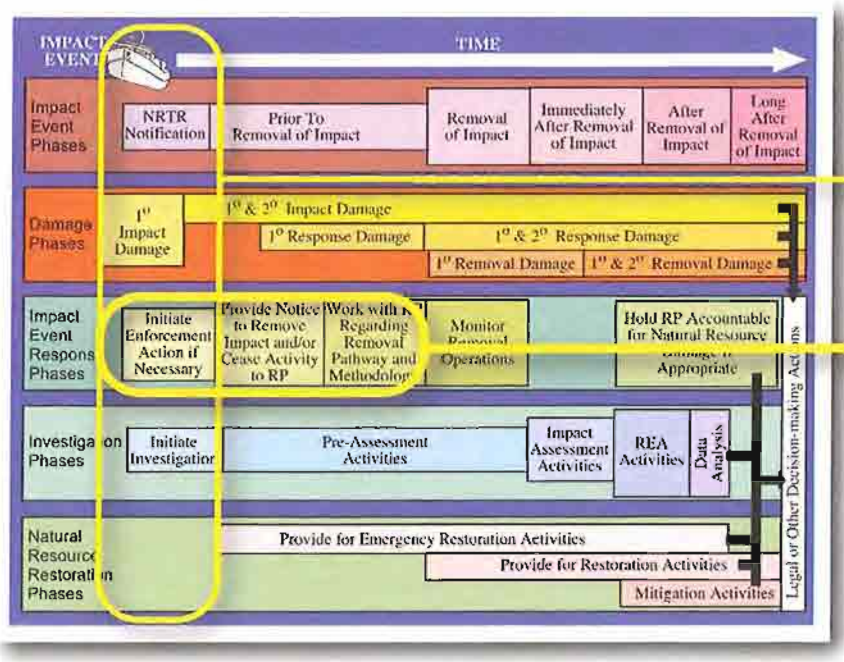
2. During Reconnaissance	Prepared	Conducted	Documented
e) Fill out Reconnaissance Form and report back to Incident Command			

Important Tools, Forms or Other Aids:



Reconnaissance Form Digital Camera Measuring Gear Communications GPS Device

3. Post-Reconnaissance	Prepared	Conducted	Documented
a) Debrief all team members and pass information to the Incident Command.			
b) Help develop and refine the Incident Response Plan.			
c) Provide samples and copies of all photos and data to injury investigators.			



This Module overlaps with these stages during an impact event and the investigation.

This Module represents this point in the timeline.

Conducting A Pre-Assessment & Setting an Impact Event Perimeter

HI Dept. of Health

On arrival at the impact site, surface support personnel set-up an impact event perimeter, if necessary, to delineate the area of focus for the surveys.

Once a marine impact event has been reported and trained response personnel arrive on the scene, one of the first actions is to set an Impact Event Perimeter to visually mark the presumed area of primary impact so that

1. Security and safety personnel can keep the public or other users from interfering with the response/investigation, protect others from exposure/harm, and minimize adjacent user actions from contributing to the impact or interfering with the investigation.
2. Additional response personnel know where to operate.
3. The response and investigative efforts are focused to the areas of greatest impact.

In many cases, setting a marine impact event perimeter and conducting the necessary pre-assessment can be done together in order to save time and make maximum use out of available limited support personnel; exceptions include large vessel groundings and oil spills, chemical spills and large-scale pollution events where the event perimeter will often be set without in-water evaluation due to safety or scale concerns.

D. Gulko

Initial Response & Impact Scene Description

The first official resource trustee representative on a potential coral reef impact scene should attempt to garner resources in order to secure the impact scene. Outside of immediate safety of any and all people in the area, and minimizing any additional damage to protected or rare natural resources, it is critical to preserve the impact scene with minimal contamination and disturbance of the physical evidence. The initial response to an incident should be expeditious and methodical. Upon arrival, the **Natural Resource Trustee (NRT)** representative(s) assesses the scene and treats the incident as a potential natural resource crime scene until the arrival of a Coral Reef CSI Team.

Initially the responding NRT representative should promptly, yet cautiously, approach and enter the

The Initial Responding Natural Resource Trustee Representative(s) Should:

- Note or log dispatch information (e.g. address/location, time, date, type of call, parties involved) on the Coral Reef Incident Initial Report Form.
- Be aware of any persons or vessels leaving the impact scene.
- Approach the impact scene cautiously, scan the entire area to thoroughly assess the scene, and note any possible secondary impact scenes. Be aware of any additional inputs in the vicinity that may be related to the impact or that can expand it.
- Make initial observations (look, listen, smell) to assess the scene and ensure personal safety before proceeding.
- Remain alert and attentive. Assume the impact is ongoing until determined to be otherwise.
- Treat the location as a crime/impact scene until assessed and determined to be otherwise by a recognized field assessment team.

(Modified after 2000 U. S. Dept. of Justice Draft Guidance on Investigating Vessel Groundings)

potential coral reef impact scene, remaining observant of any persons, vessels, events, potential evidence and environmental conditions. It is critical at this stage that the initial responding NRT representative be ultra-observant, noting as much information initially as possible.

The safety and physical well-being of all individuals, in and around the impact scene, are the initial responding NRT representative's first priority. This initially involves the NRT representative identifying and controlling any dangerous situations or persons to the best of their trained ability. Often this is accomplished through:

- Ensuring that there is no immediate threat to other responders - scan the area for sights, sounds, and smells that may present danger to personnel (e.g. hazardous materials such as gasoline, natural gas).
- Approach the scene in a manner designed to reduce the risk of harm to NRT representatives while maximizing the safety of victims, witnesses, and others in the area. If safely possible, this should also be done in such a way as to minimize any further damage to natural resources of the area.
- Survey the scene for dangerous persons and control the situation if trained and qualified; otherwise, if the situation involves dangerous individuals, contact appropriate enforcement personnel and/or agency prior to entering the scene.
- Notify supervisory personnel and call for assistance/back-up.

After controlling any dangerous situations, the initial responding NRT representative's next responsibility is

Key Terms

- *Primary & Secondary Impact*
- *Natural Resource Trustee (NRT)*
- *Pre-Assessment Survey*
- *Coral Reef On-Scene Coordinator (The CROC)*
- *Impact Event Perimeter*
- *Impact Scene Perimeter*
- *Impact Assessment Exploratory Dive*

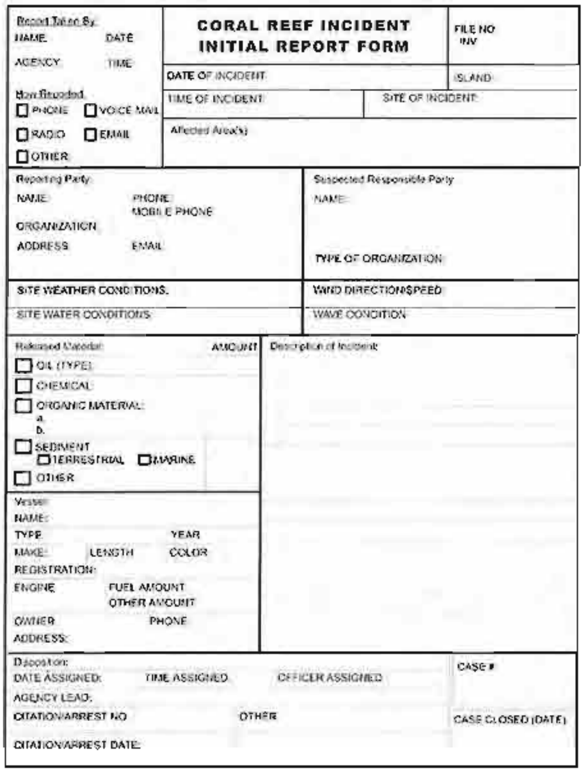
to ensure that medical attention is provided to injured persons while minimizing contamination of the scene. Point out potential physical evidence to medical personnel, instruct them to minimize contact with such evidence, and document movement of persons or items by medical personnel. Finally, document any statements or comments made by victims, suspects or witnesses at the scene. Take photos if possible.

The initial NRT representative(s) shall identify persons and vessels at the natural resources crime or impact scene and control their movement. If the responding NRT representative is NOT an authorized enforcement officer, then he/she should document the person or vessel's actions to the best of their trained ability and get enforcement personnel on-scene as soon as possible. Key to this is the prevention of individuals from altering or destroying physical evidence by restricting their movement, location, and activity while ensuring and maintaining safety at the scene. To the best of the person's trained ability and jurisdiction, he/she should exclude unauthorized and nonessential personnel from the scene.

The initial NRT representative should use the 'Coral Reef Incident Initial Report Form' (*right*) to record initial information for the investigators who will be conducting the full field investigation of the impact scene. Be sure to include a labeled diagram of the scene which includes:

- The approximate visible boundaries of the impact scene.
- Where the specific impact event occurred.
- Potential points and pathways of exit and entry of suspects, witnesses, and impact elements.
- Places where the natural resources/evidence may have been moved.
- Specific sites of concern (danger, fragile or protected resources, human use, etc.).

Upon the arrival on-scene of a trained field investigation team (preferably a multi-agency, multi-disciplinary coral reef CSI team if available and if provided for by the jurisdiction), the NRT representative should turn over control of the impact scene and provide a detailed brief to the investigator(s) in charge; this will have the affect of assisting in controlling the crime/impact scene and helping to establish further investigative responsibilities. Note that the scene briefing is the only opportunity for the next in command to obtain initial aspects of the impact scene prior to subsequent investigation.


Report Taken By:
NAME DATE
AGENCY TIME
How Recorded
☐ PHONE ☐ VOICE MAIL
☐ RADIO ☐ EMAIL
☐ OTHER

CORAL REEF INCIDENT INITIAL REPORT FORM

FILE NO
INV

DATE OF INCIDENT
ISLAND
TIME OF INCIDENT
SITE OF INCIDENT
Affected Area(s)

Reporting Party
NAME PHONE
MOBILE PHONE
ORGANIZATION
ADDRESS EMAIL

Suspected Responsible Party
NAME
TYPE OF ORGANIZATION

SITE WEATHER CONDITIONS.
WIND DIRECTION/SPEED
SITE WATER CONDITIONS
WAVE CONDITION

Released Material AMOUNT
☐ OIL (TYPE)
☐ CHEMICAL
☐ ORGANIC MATERIAL
a.
b.
☐ SEDIMENT
☐ TERRESTRIAL ☐ MARINE
☐ OTHER

Description of Incident

Vessel
NAME:
TYPE YEAR
MAKE LENGTH COLOR
REGISTRATION:
ENGINE FUEL AMOUNT
OTHER AMOUNT
OWNER PHONE
ADDRESS:

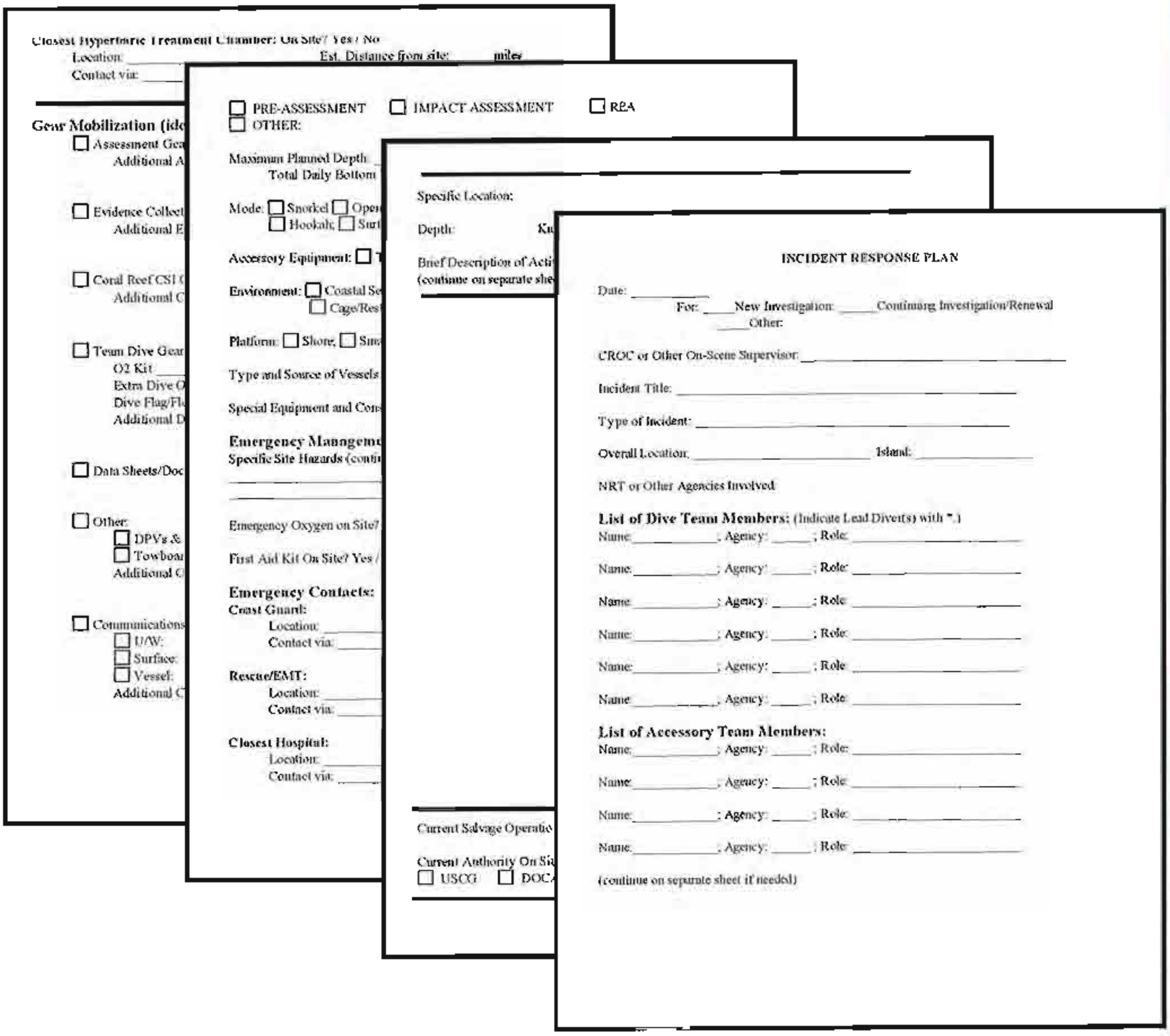
Disposition:
DATE ASSIGNED: TIME ASSIGNED OFFICER ASSIGNED
AGENCY LEAD:
CITATION/ARREST NO OTHER
CITATION/ARREST DATE:
CASE #
CASE CLOSED (DATE)

> **STOP** Note: Coordinated investigative responses often take days to weeks to mount, making the initial report critical due to the ever-changing nature of marine impact scenes.

The NRT representative can also assist the leader of the field investigation team (The CROC, see next section) in planning the in-water investigative phase; this will often entail the creation of a Incident Response Plan in order to help manage the risks associated with the investigation.

The Role of the Coral Reef On-Scene Coordinator (The CROC)

Once a trained field investigation team arrives on-scene, it is critical to document and coordinate the activities of multiple NRT personnel operating within the incident parameters. Often the senior NRT representative on-site oversees all aspects of the in-water investigation and tracks the activities conducted and the evidence collected. This person, called the **Coral Reef On-Scene Coordinator** (or **CROC**) must ensure that necessary documentation and chain-of-custody protocols are followed relative to all information gathered.



To assist the CROC, a comprehensive field data organization form is available (see Appendix A).

D. Gulko

HAWAI'I REGION
On-Scene Lead Agency:
☐ HI DLNR ☐ HI DOH
☐ USCG ☐ POLICE
☐ USFWS ES ☐ MILITARY
☐ NOAA PIRO
☐ Other: ______

CORAL REEF INVESTIGATION FIELD REPORT FORM

FILE NO.
INV.

DATE OF INCIDENT:
ISLAND:
TIME OF INCIDENT:
FIRST REPORTED BY:

CORAL REEF ON-SCENE COORDINATOR (The CROC):
AGENCY: TITLE:
DATE AND TIME ON-SCENE:

CASE TITLE AND REMARKS:

EVENT LOCATION: WHO:
☐ GPS LOCATION:
☐ GPS WAYPOINT: GPS SYSTEM:
☐ 1° EVENT DAMAGE PERIMETER ESTABLISHED ______ m^2
☐ 2° EVENT DAMAGE PERIMETER ESTABLISHED ______ m^2

SITE WEATHER CONDITIONS:
EVENT DEPTH RANGE:
SITE WATER CONDITIONS:
TYPE OF REEF AND ASSOCIATED HABITATS:

FIELD INVESTIGATION COMPONENTS: WHO
☐ EVENT & SCENE PHOTOS
☐ IMPACT PHOTOS
☐ AREA ASSESSMENT
Towboard___ Scooter___
Helicopter___ Dive/Snorkel ___
☐ ENFORCEMENT INVESTIGATION
BIOLOGICAL INVESTIGATION
☐ REA ☐ OTHER ______

EVENT SCENE DIAGRAM WITH LANDMARKS:
COMPASS DIRECTION

SAMPLES COLLECTED AT THE SCENE

TAG NO.:	SAMPLE TYPE	WHO

DETAILS:

01 2/06

OVER -->

INVESTIGATION FIELD REPORT FORM PAGE 2

INVESTIGATORS ON-SCENE:

AGENCY	ASSIGNED ROLE	TIME START	TIME STOP

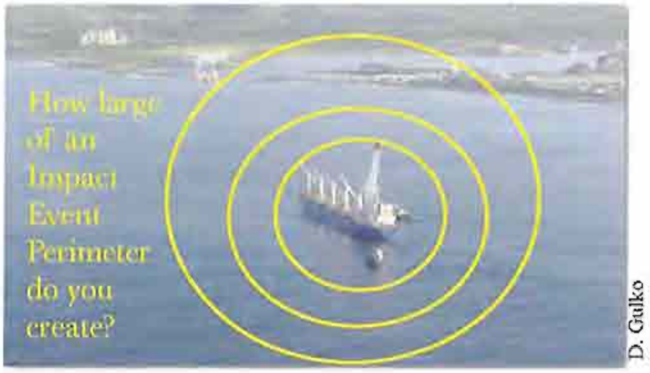
SURVEY INFORMATION:

...ME IN	TIME OUT	DEPTH	MAX DEPTH	SUBHABITATS	PERSONNEL

LAB WORK:
WORK TO BE COMPLETED:

FORM COMPLETED DATE: TIME: SIGNATURE:

01 2/06

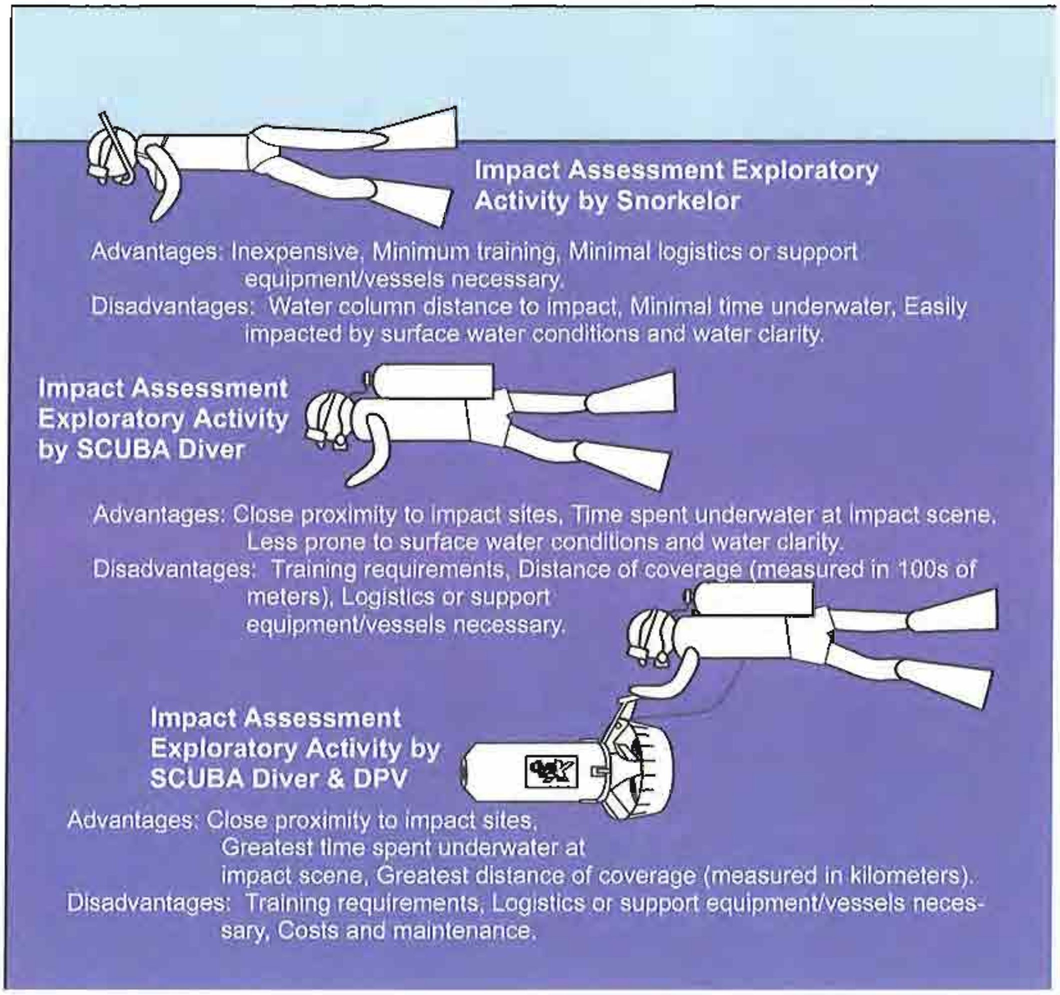


Setting Incident Perimeters

There are two types of boundaries often set around a marine incident location: the Impact Scene Perimeter and the Impact Event Perimeter. These perimeters can be based upon existing knowledge from previous investigations, public reports, or on-site impact investigation; they together serve to delineate the area of focus for the impact assessment and the Rapid Ecological Assessment (REA), and can serve to help prevent additional disturbance by outside parties through education and enforcement activities.

Impact Event Perimeters

The **Impact Event Perimeter** is defined as the immediate area around an existing incident source (examples: a spill zone, the area immediately around a grounded vessel, etc.). The size of the defined perimeter should include all elements currently causing a primary impact along with a small buffer *(as shown right)*. The **primary impact** is the type of damage immediately caused by the impact event (example: the grounding scar caused by a vessel running aground); **secondary impact** may be a variety of forms of immediate and follow-on damage triggered by the initial impact event, the initial impact damage, the response activities, or combinations of any or all of these.



The impact event perimeter is used to coordinate pre-assessment and other investigative activities. It serves a function similar to a crime scene perimeter in regards to providing a boundary for concentrating investigative effort and possibly restricting other human use activities to minimize disturbance or contamination of the impact scene. For some types of events, the event perimeter may serve to protect the greater public from coming in contact with harmful elements involved with the event. Note that the Impact Event Perimeter does **not** represent a measurement of damage, but it should include all damaged areas plus enough of a buffer to be manageable or to make easy identification of the boundaries.

Often an impact event perimeter can be delineated without entering the water and can be fluid (i.e. move with a defined surface feature such as a oil slick or vessel). Often it is measured in terms of a fixed distance around a visible object or substance (example: 20 meters from the leading edge of the spill). If necessary, surface buoys can be deployed to mark the boundary or enforcement personnel can remain on-scene to enforce the boundary during the response.

D. Gulko

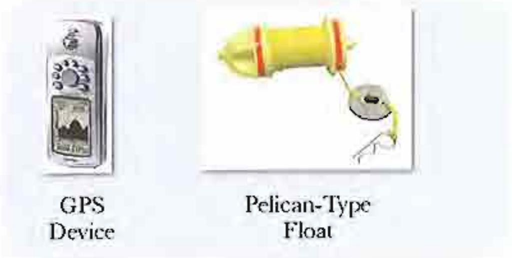
If sub-surface documentation is required, a series of dives may be necessary to determine the extent of both primary and secondary damage paths in order to establish the impact event perimeter. During the fist of these dives, efforts should focus on establishing both an overall event perimeter and a more concise impact scene perimeter delineating the greatest extent of visible damage on all sides (using floats and taking GPS points). Follow-up pre-assessment dives can provide greater details on the area of impact and focus on immediate mitigation needs. Note that biological data taken at this stage is limited to immediate identification of important or fragile natural resources at risk from the existing impact or potential response activities.

IMPACT SCENE PERIMETER

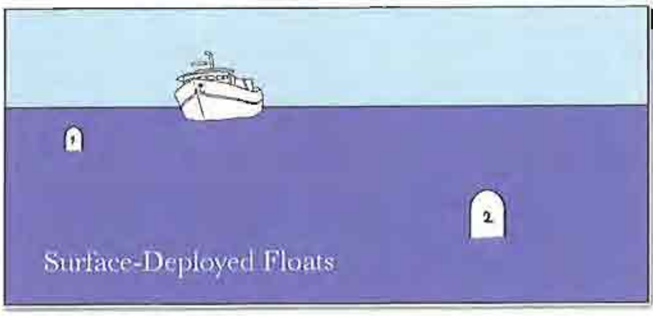
The **Impact Scene Perimeter** consists of all components of an area impacted directly by the immediate incident (i.e. what's occurring within the Impact Event Perimeter). Often it expands beyond the area of the Impact Event Perimeter and includes a variety of types of observable damage and habitat types.

D. Gulko

The impact scene perimeter is also a quick delineation of the impact area from a damage event. It is used to get an initial estimate of damaged area in preparation for a more detailed impact assessment. The basic method involves either swimming over an easily identified impact area and delineating a polygon by way of GPS points for all outside edges of the impacted area. For large or complex impact sites, the use of a search pattern technique to delineate the corners of the polygon will result in an approximate estimate of damaged substrate. Corners may be delineated on subsurface surveys through the use if Pelican-type floats and surface GPS (Note: the team member taking the surface GPS points must wind the float line until it is taut with the anchoring point subsurface in order to minimize horizontal and current error.). Other data taken should include changes in depth, bottom type, habitat and subhabitat composition.



Numbered floats can be surface-deployed, or an **Impact Assessment Exploratory Dive(s)** can be conducted by snorkelor, diver, tow-board, drop camera, or scooter, to establish the impact scene perimeter, identify habitats and subhabitats, and include the area of damage or area to be surveyed.



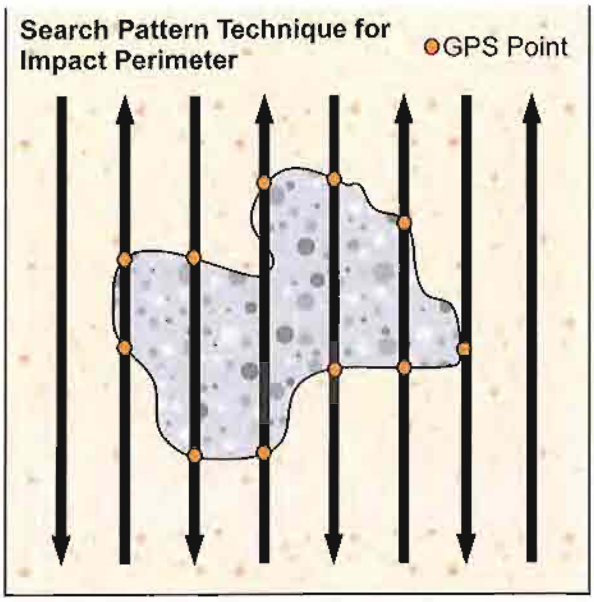
As with much of the Coral Reef CSI gear, floats can be either hand-made from easily available materials (*please see Appendix B, Section 3*) or purchased from a number of suppliers. Key points include that each float should be able to be deployed sub-surface, numbered, and easily retrieved from the surface.

B. Lumsden

As the floats or other markers are deployed, make sure that accurate location information is taken to document the perimeter for later use in follow-on damage assessment and recovery monitoring.

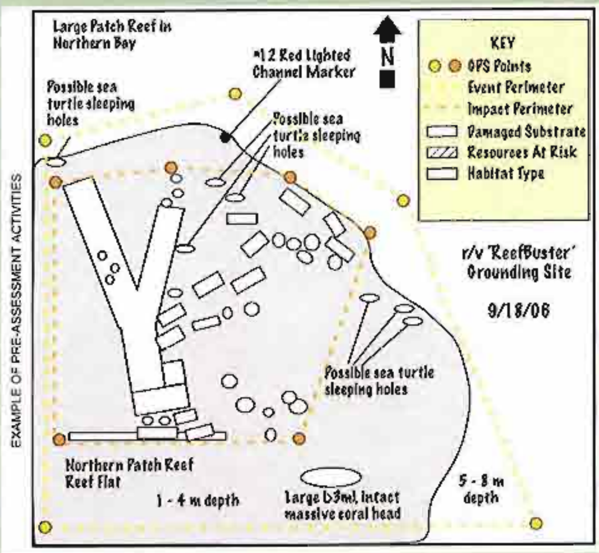
One can use a variety of techniques to delineate an impact area (snorkel, SCUBA, DPV, towboard, drop camera, aerial survey). The method used should be based on the the resources available, the scale of the event and the topography involved. Consideration should be on covering a large area efficiently to visually survey for the extent of impact.

Advantages and disadvantages of different modes of conducting initial impact assessment activities (*below*) such as those used for setting perimeters or defining habitats and subhabitats in the field. Other modes not shown include tow board with a small boat, drop cameras, or relying on pre-existing maps, field data and photos.



The most efficient way of delineating a large area to to determine the impact perimeter is to use a **Search Pattern Technique**, whereby the overall area is searched starting at a point known to be outside of the impact area and moving in a set direction for a defined distance marking each time one meets a impact edge. At the end of the proscribed distance, the team moves perpendicular to the first search transect and repeats in the return direction (*as shown above*).

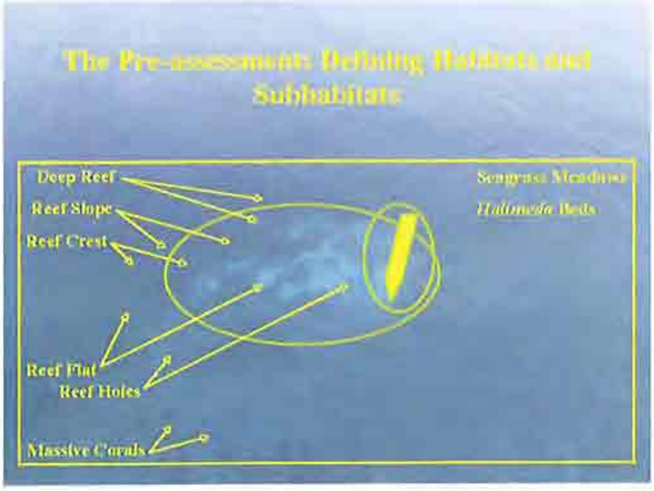
Essential Data Components to be Gathered During a Pre-Assessment



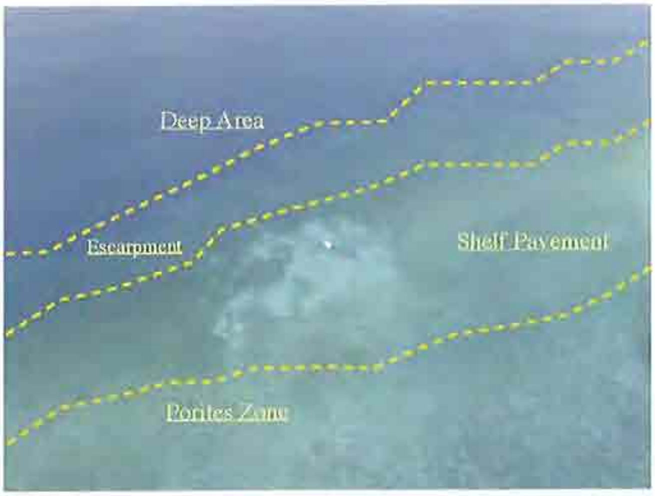
- Impact Event Perimeter (outside all known impacts): Depth, GPS, Habitat & Subhabitat Identification.
- Impact Scene Perimeter (polygon for outside edge of all immediately impacted areas): Depth, GPS, Habitat & Subhabitat Identification, Photos of Subsurface Damage (all forms).
- Immediate Mitigation Efforts or Pathways to Decrease Additional Damage: Depth, GPS, Habitat & Subhabitat Identification, Photos of Actions or Threats to be Mitigated, Photos of Potential Pathways.
- Fragile or Immediately Threatened Resources At-Risk: Depth, GPS, Habitat & Subhabitat Identification, Photos of Resources At-Risk.

Defining Habitats and Subhabitats

An important component of most pre-assessments is the determination of the types of habitats and **subhabitats** (A classification of habitat components into ecological functional groups. Examples include large massive corals within lagoon habitat, seagrass patches within sand habitat, etc.) found both within the impact areas and adjacent to it.



In the photo below you can see the same grounding site that has been classified for habitat types only. Note that the absence of subhabitat information makes it harder to quickly differentiate where follow-on field operations should concentrate.



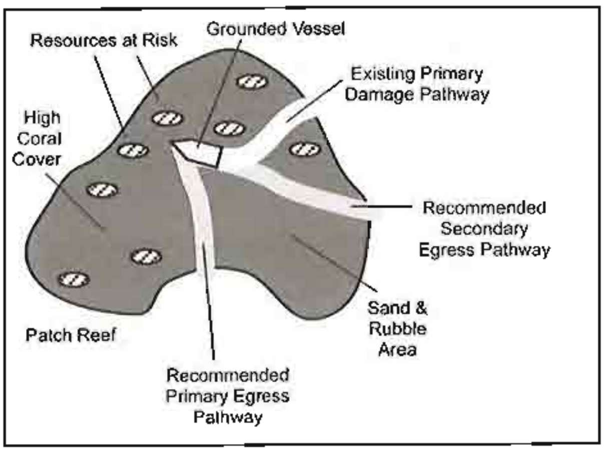
Such classifications play an important role in both immediate mitigation planning and in determining the scale of both the Impact Assessments and Rapid Ecological Assessments (REAs) to follow. As such, pre-assessments often include an initial estimate of area of critical habitats and subhabitats observed; these measurements can often be quickly acquired through the use of a limited number of surface markers and GPS.

PACIFIC ISLAND REEF ZONES	
Island Vertical Wall Shoreline Intertidal Lagoon Back Reef Reef Crest	Fore Reef Bank/Shelf Bank/Shelf Escarpment Unknown
PACIFIC ISLAND REEF HABITATS	
Unconsolidated Sediments (0%-<10% submerged vegetation) Sand Mud Submerged Vegetation Seagrass Continuous Seagrass (90%-100% Cover) Patchy Seagrass (50%-<90% Cover) Patchy Seagrass (10%-<50% Cover) Macroalgae (fleshy and turf) Continuous Macroalgae (90%-100% Cover) Patchy Macroalgae (50%-<90% Cover) Patchy Macroalgae (10%-<50% Cover) Coral Reef and Hardbottom Coral Reef and Colonized Hardbottom Linear Reef Spur and Groove Patch Reef (Individual) Patch Reef (Aggregated) Scattered Coral/Rock in Unconsolidated Sediment	Colonized Pavement Colonized Volcanic Rock Colonized Pavement with Sand Channels Colonized Island Vertical Walls Uncolonized Hardbottom Reef Rubble Uncolonized Pavement Uncolonized Volcanic Rock Uncolonized Pavement with Sand Channels Uncolonized Island Vertical Wall Encrusting/Coralline Algae Continuous Encrusting/ Coralline Algae (90%-100% Cover) Patchy Encrusting/ Coralline Algae (50%-<90% Cover) Patchy Encrusting/ Coralline Algae (10%-<50% Cover) **Other Delineations** Land Mangrove Artificial Dredged Unknown
PACIFIC ISLAND REEF SUBHABITATS (examples)	
Reef Hole Massive Coral Colony Garden Eel Bed *Halimeda* Meadow	Cleaning Station Sea Turtle Sleeping Depression

When deploying a surface marker (*above right*) to either delineate a perimeter edge or to identify a unique subhabitat, it's important that you fully document the reference point to the best of your ability prior to releasing the surface marker.

Delineate Immediate & Necessary Mitigation Actions

A final component of a pre-assessment activity involves delineating immediate actions that can be taken to mitigate additional resource damage from the impact event. For example, in the case of a grounded vessel (*below*), identification of an egress pathway may be different than the initial damage pathway due to nearby resources at risk. This entails identification of significant habitat and subhabitat components by GPS relative to the overall impact polygon and the larger habitat components. Draft emergency mitigation efforts should be described and suggested sites or pathways identified and GPS'd.



Final Steps in a Pre-Assessment

As the pre-assessment events in the field reach the final stages, a series of off-site actions will need to be contemplated and decisions made relative to their impacts on the follow-on phases of the field investigation:

- Other non-NRT government or civil agencies should be notified of the impact event and on-going field investigation. Assistance may be sought with various parameters involved with background investigations, controlling human uses in the area, etc.
- Adjacent land owners, primary commercial and recreational organizations/operations which make use of the impacted area, and targeted user groups should be briefed and specific efforts directed to educate them regarding the event and investigation should be undertaken in order to maximize public safety and to minimize interference with the on-going field investigation or contamination of the impact scene.
- The Media (and through them, the general public) may need to be briefed regarding the impact event and the on-going investigation. Often this is best handled through a formal Press Release by the lead NRT agency. Care needs to be taken to ensure that the media involvement and public notification does not release sensitive details or inhibit the field investigation from proceeding (see Introduction Module: Enhancing Notification of an Impact Event Section (Dealing with the Media)).

Summary

After a marine impact event has been reported, first responders will secure the scene and deal with rescue and safety concerns first. An Impact Event Parameter is established immediately around the impacted area. An Impact Scene Parameter encompasses the Impact Event Parameter and the adjacent areas. Habitats and subhabitats both adjacent to, and within, the impact area need to be described, and where possible, delineated. Information from these various components needs to be analyzed and used for immediate mitigation needs and to plan for follow-on assessments.

The Pre-Assessment is the first of three in-water components involved in a marine impact event field investigation

REVIEW SHEET

CONDUCTING A PRE-ASSESSMENT

OUTLINE OF ACTIVITIES:

1. Identify Location/Type of Incident	Prepared	Conducted	Documented
a) Note or log dispatch information. Fill out the Coral Reef Incident Initial Report Form.			
b) Make initial observations (look, listen, smell) to assess the scene and ensure personal safety before proceeding. Record everything, make a surface site diagram.			
c) Brief responding field assessment team and provide forms, visuals and any other materials.			

Important Tools, Forms or Other Aids:


Incident Report Form


Initial Site Diagram


CROC Form

2. Delineate Perimeter/Security	Prepared	Conducted	Documented
a) Set the Impact Event Perimeter: May need to include adjacent habitats and subhabitats.			
b) Set the Impact Scene Perimeter			
c) Identify Adjacent and Impacted Habitats and Subhabitats			
d) Delineate Immediate Actions that can be taken to mitigate additional resource damage from the impact event			

Important Tools, Forms or Other Aids:


Incident Report Form


Search Pattern Technique


Pelican-Type Float

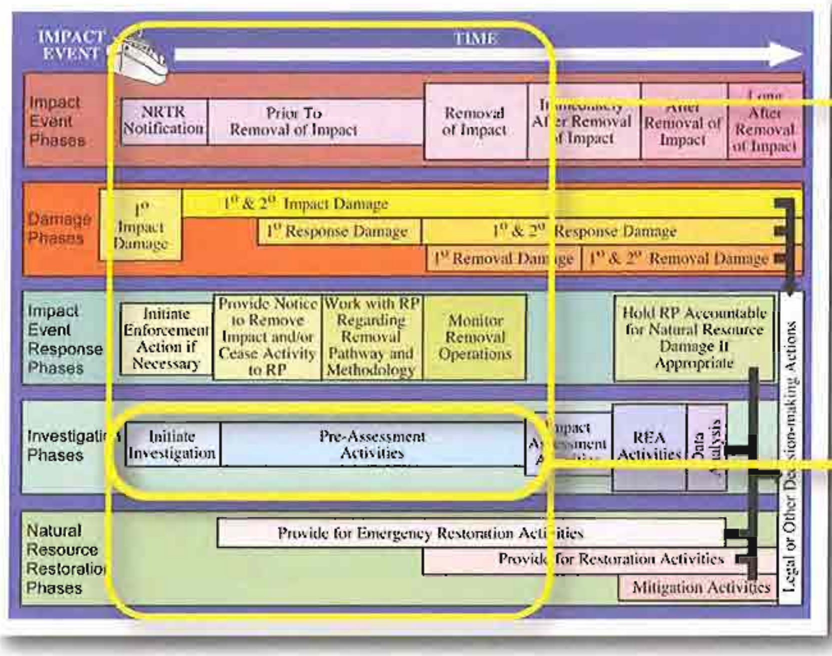

GPS Device

3. Notify Users/Other Agencies	Prepared	Conducted	Documented
a) Notify other non-NRT government or civil agencies, as appropriate.			
b) Brief adjacent land owners, commercial users, user group organizations directly adjacent to, or primary users of, the impact site.			
c) Issue press release if necessary or appropriate.			

Important Tools, Forms or Other Aids:

Incident Report Form

CROC Form



This Module overlaps with these stages during an impact event and the investigation.

This Module represents this point in the timeline.

Conducting an Impact Assessment

D. Gulko, HI DLNR

Collection of physical evidence, photographs of damage, and data on an impact event are extremely time-sensitive procedures in the marine environment due to currents, tides, safety issues, biological & chemical interactions, and the three-dimensional nature of marine habitats and the water column.

STOP **NEVER Move or Alter the Positioning of An Evidentiary Item Until It Has Been Documented and Photographed.**

D. Gulko

Make close visual examinations of the item and the area immediately around it from multiple perspectives.

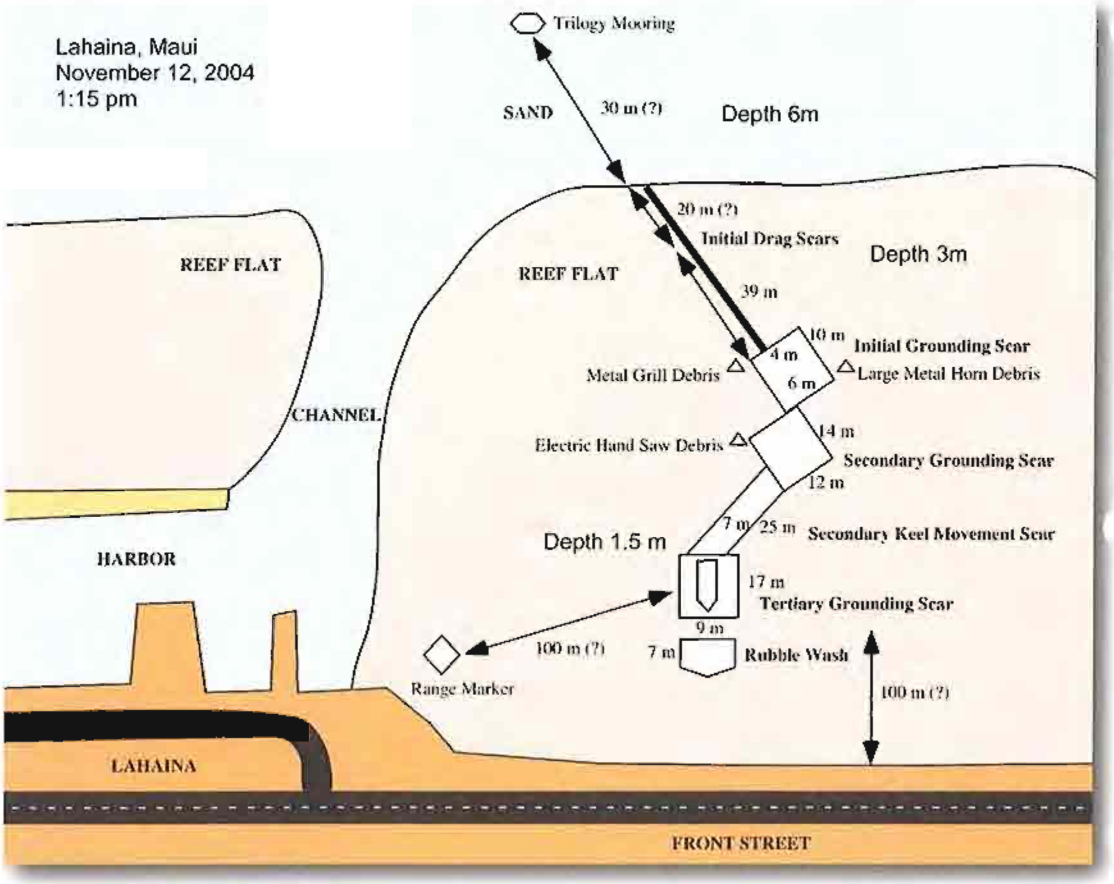
Searching & Examining an Impact Scene

The fluid nature of marine environments highlights the critical nature of underwater impact scene examinations and the need to search in a careful and methodical manner. After reviewing the initial incident parameters and learning about any changes that might have been made to the scene from either natural or human parameters, start the examination by working your way into the impact scene perimeter, using great care to avoid disturbing or destroying any evidence as you do. Carefully observe the bottom habitat or substrate surrounding the primary impact site. Look for items of evidential value, such as disturbed or dying organisms, physical marks, etc. Remember to also look up and out as all marine impact scenes are three-dimensional.

Another technique to assist in locating evidence is to shine a flashlight on the substrate at an oblique angle, as even in daytime, many man-made objects will reflect differently then natural substances on the bottom. Look at all loose items as they are located. Are there any freshly broken corals or drag marks through the sediments? Is there anything on the ocean floor that may be diminished or destroyed by the next tidal change or prevailing currents?

Damage Pathway Diagrams

EXAMPLE OF A DAMAGE PATHWAY DIAGRAM



A **Damage Pathway** shows a route through which injury occurred at an impact site. In some instances, multiple damage pathways will be present at an impact site, requiring careful measurement and description. Items found underwater should be measured, photo-documented, and their precise location mapped prior to collection as evidence.

Distances to stationary and permanent features should also be noted. Diagrams should include date and time (allows tidal information to be calculated) and depths should be listed for all major zonal changes. Diagrams should differentiate progressional elements where possible.

Damage pathway diagrams should be carefully labeled and efforts made to differentiate between habitat and map features versus the impact damage being described.

NOTE: All data forms shown in this section are available as templates in Appendix A.

Components of a Good Underwater Impact Scene Diagram

Impact scene diagrams provide a large overlook that describes the relational components of an investigative site. They provide an overview that links physical evidence collection, photography, scene narratives and rapid ecological assessments.

Depending upon the complexity of the impact scene, the number of habitats and subhabitats impacted and

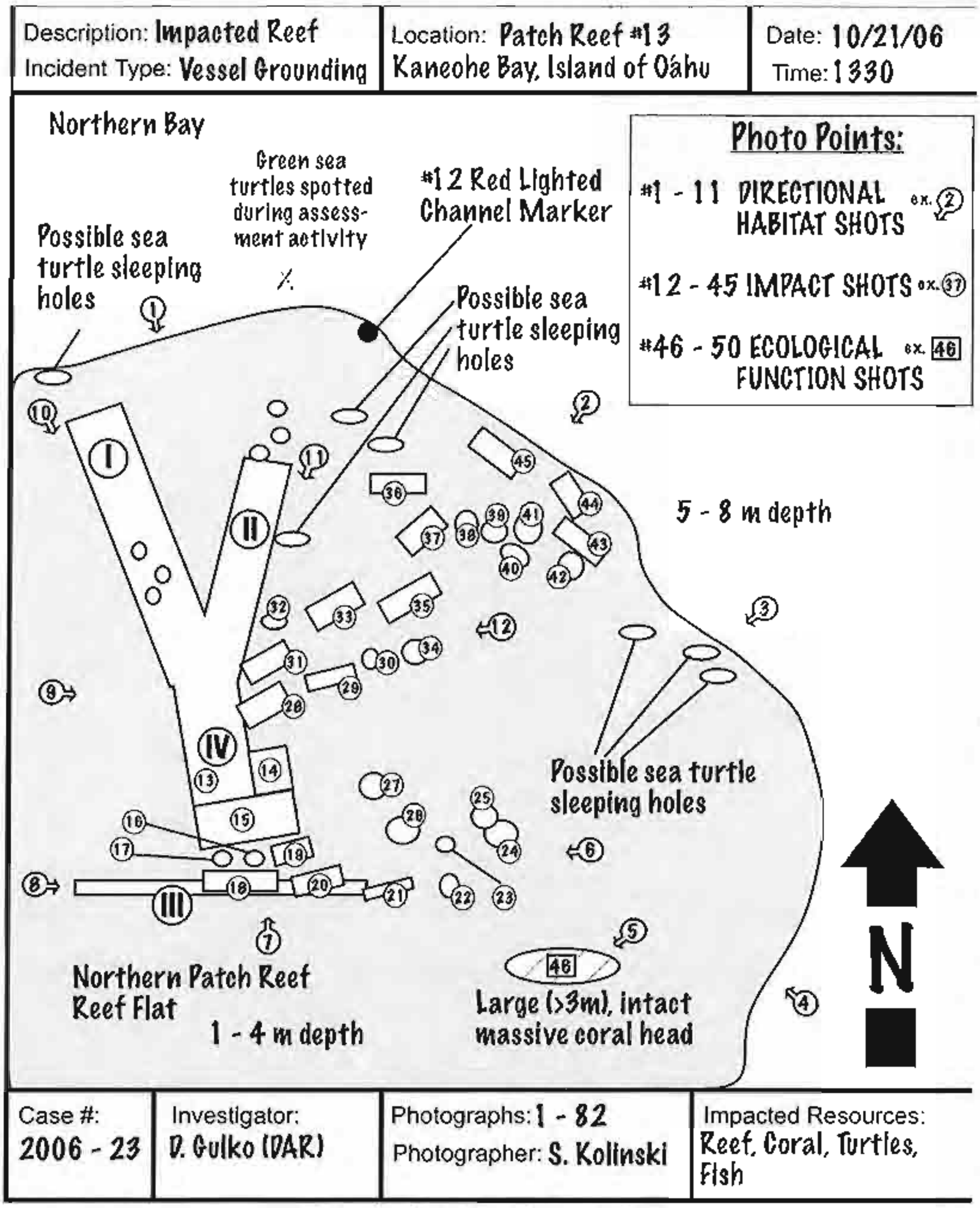
Key Terms

- *Damage Pathway*
- *Impact Scene Diagram*
- *Impact Sample*
- *Standard or Reference Sample*
- *Control or Blank Sample*
- *Elimination Sample*
- *Emergency Restoration*

the area of impact, multiple scene diagrams may be necessary.

The impact scene diagram should include the following informational components:

- Location Information.
- Date & Time of the Diagram.
- Incident Reference Information.
- Diagram Author.
- Accessory Contributors (ex. Photographers, etc.).
- Description of Identified Incident.
- Description of Identified Impacts.



Example of an impact scene diagram

The impact scene diagram should include the following drawing components:

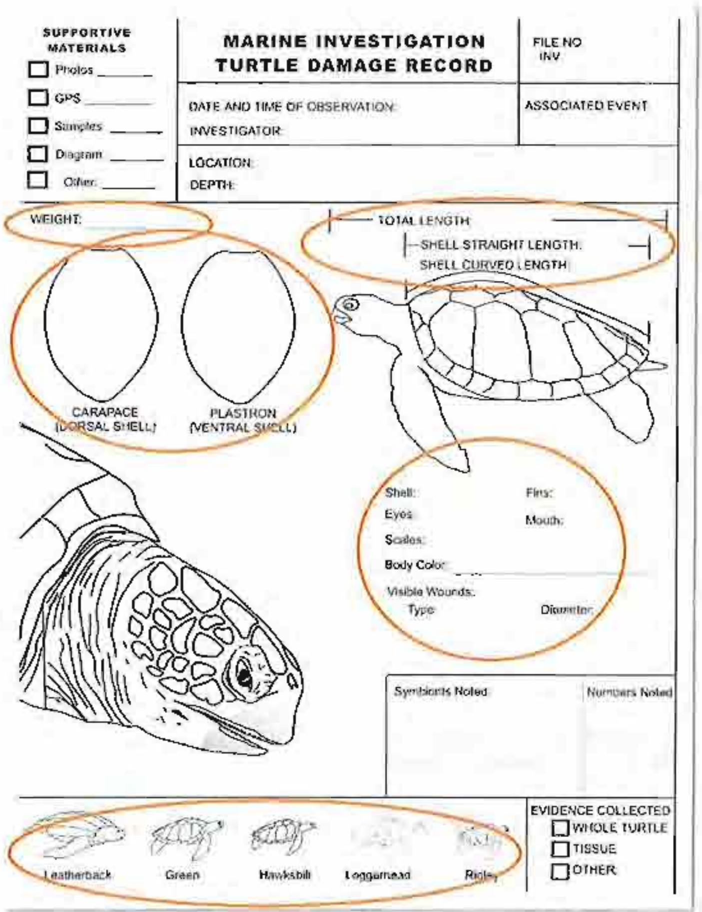
- Drawing/ Labeling of major geomorphological features.
- Descriptions of major depth changes.
- Descriptions and diagrams of major identifiable physical impacts and damage pathways.
- Descriptions and diagrams of major ecological features.
- Compass Directional Arrow.
- Approximate locations of protected wildlife or natural features.
- Locations of major photographs taken.
- Where possible, an approximate scale of the diagram.

The impact scene diagram needs to be produced prior to any evidence collection and is best accomplished by the senior in-water investigator on-site and/or the CROC.

Documenting Damage to Marine Life

As with other types of marine damage, make close visual examinations of the organism and the area immediately around it. Photo-document the organism in place from a variety of angles and the surrounding area. Take close-up shots of anything unusual on the organism. Are there any obvious wounds? Can you determine the cause of death and the instrument or method used? Take careful notes of the external appearance of the body and the surrounding area. Make detailed notes. Describe the location and appearance of wounds, bruises, etc.

In general, diagrams should be used to show any unusual markings or damage, and to assist in written descriptions. Use the organism damage forms in Appendix A for sea turtles, fish or coral colonies. Note the following when filling out these forms:



Sea Turtle Damage Form

Weight: Note turtle's weight in either kg or lbs. If estimated, place a "(?)" after listed weight.

Length: Note turtle's total length from snout to tip of tail, note shell length. If estimated, place a "(?)" after listed length.

Shell: Note lacerations or other damage, unusual marks.

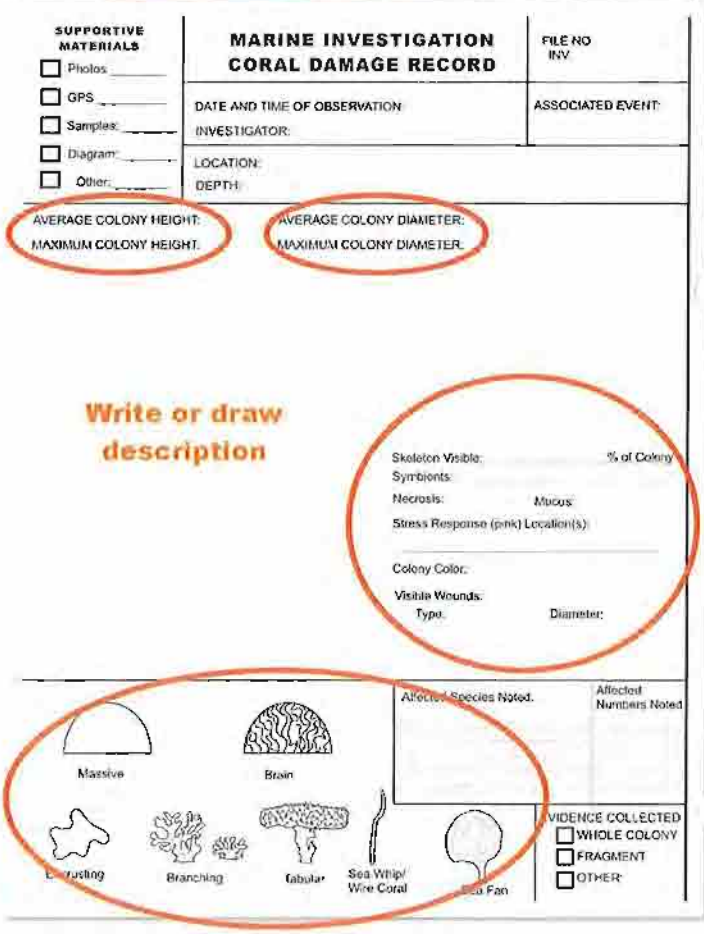
Flippers, Eyes: Note tumors (Fibropapilloma), damage, unusual marks.

Body Color: Note discoloration.

Scales: Note discoloration, lost scales, tumors.

Visible Wounds: Note specific locations, freshness, and amount/size of wounds.

Sea Turtle Species: Circle the species being documented.



Coral Damage Form

Height: Note colony height from base to tallest vertical point. Average across all big colonies. If estimated, place a "(?)" after listed diameter

Diameter: Note colony diameter across widest points. Average across all big colonies. If estimated, place a

"(?)" after listed diameter.

Skeleton: Note if coral skeleton (without tissue) is visible, and the % of the colony in that state.

Symbionts: Note the number & type of organisms living atop/within the coral colony.

Necrosis: Note dying or dead tissue. Note % of colony in this state.

Mucus: Note mucus layers if present. Note color and presence of other materials within the mucus.

Stress Response: Note locations and amount of pink stress response in coral tissue.

Colony Color: Note colony coloration (especially relative to adjacent colonies of the same species). Note degree of paleness or whiteness relative to other colonies.

Basic Colony Forms: Circle the colony form most similar to the corals being described.

Fish Damage Form

Weight: List weight in either kg or lbs. If estimated, place a "(?)" after listed weight.

Total Length: List total length in cm or inches, from the tip of the snout to the tip of the tail; a second measurement can be from the snout to the beginning of the caudal peduncle (tail). If estimated, place a "(?)" after listed length.

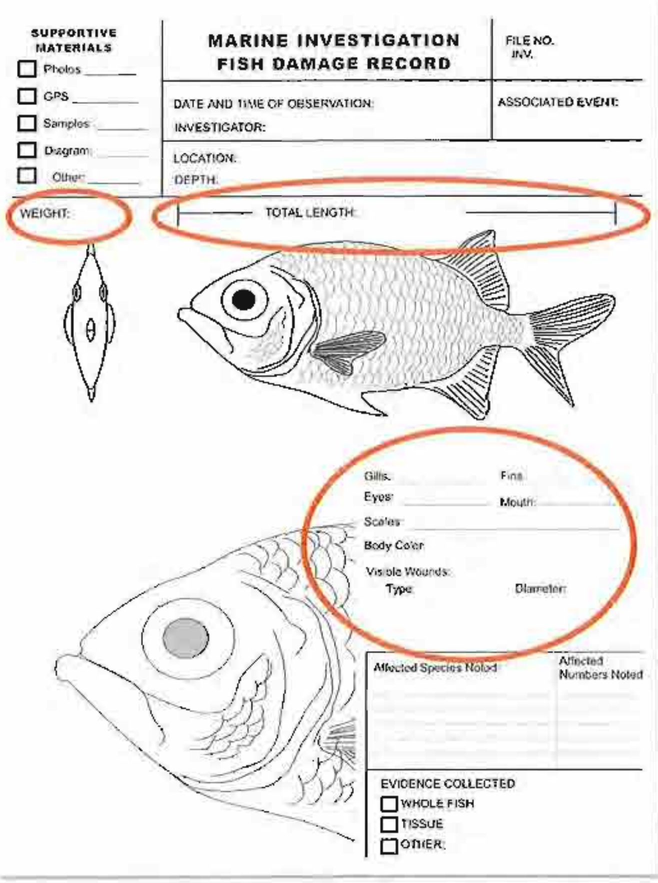
Gills: Note damage, color of gills, intactness, unusual odors, parasites, etc.

Fins: Note damage, unusual coloration, intactness.

Eyes: Note damage, clarity, firmness.

Mouth: Note damage, discharge, unusual contents.

STOP Note that once the organism is removed from the water its appearance and form may change radically - requiring detailed notes and photos to be taken underwater, prior to collection.



Body color: Note body coloration (especially sexual or juvenile coloration), discoloration, unusual coloration, paleness, slime discharge, loss of scales.

Visible Wounds: Note in detail all external wounds.

K. Foster, USFWS

Other Marine Animals:

Follow guideline listed for other marine animals. Algae, seagrasses and seaweeds may require special training relative to sampling and preservation.

Documenting Substrate Damage

For physical scars in the substrate, describe the marks, their lengths and width, and especially the condition of the impacted substrate. Do scratches or breakage indicate the direction and/or timeline of the event? Note all marks and breakage on the substrate; diagram and photograph them. There could also be trace evidence in the marks and breakage; look closely for paint chips or metal scrapes (See 'Examples of Underwater Impact Evidence').

Underwater Evidence Identification Markers

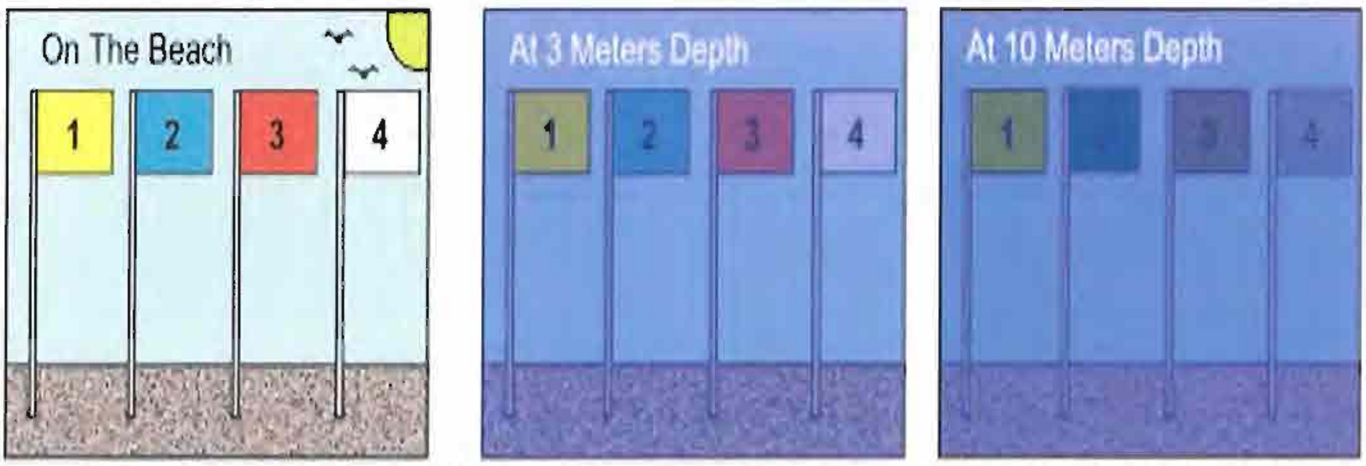
On land, evidence is often marked during a crime scene documentation with a variety of cones, tapes, paper, flags, etc. The primary role of such markers is to identify objects that would otherwise not be apparent in evidence photos taken at the scene. Objects such as alphanumeric flags or cones can be used to identify specific objects referenced in a scene report or on a scene diagram.

Underwater, various properties of water itself, along with currents, surge, and depth, all lend towards different or modified markers needing to be used. As one descends with depth, certain colors effectively disappear, resulting in difficulty seeing the marker. Depending upon the material used, bright yellow will photograph well at shallow depth under even sub-optimal conditions.

The need to affix identification markers due to the three-dimensional nature of water and the fluid environment leans most investigators towards either heavily-weighted markers or those designed to be attached in some way to the substrate or object.

The use of weighted markers vs flagging tape, poleflags, or lasers

While terrestrial investigators might be inclined to take numbered cones and add weights to them to use underwater, the limitations on traveling and working underwater along with the physical three-dimensional nature of underwater habitats makes this strategy questionable. Divers are extremely limited in their ability to carry bulky items such as evidence cones along with the other necessary equipment for both safety and investigation. Flagging tape and short poleflags (such as those commonly used in forestry applications) can be easily carried within a small mesh bag or a buoyancy compensator pocket. An inexpensive underwater laser (see www.divetrident,com) can be attached to a underwater camera or held and pointed at an object as a picture is taken. Care needs to be taken when using even a weak



Note: Bright yellow objects photographs best at shallower depths without a flash. Try to use yellow markers where possible.

Use of an underwater laser to mark a feature for the photograph

Use of yellow flagging tape to mark a feature for the photograph

laser underwater as the beam will disorient and frighten many organisms if shined in their eyes; likewise, even a weak laser can damage another diver's vision.

The above photograph of an anchor found within a no boating area of a no-take MPA, was investigated by a pair of investigators in Hawai'i. There was strong current in the area and the divers could not spend a lot of time at the scene. The photos that were taken did not easily identify the features of the scene that would be used to determine further action. In this case, the growth of medium sized branching corals atop a portion of the anchor suggests that it had been on-site and relatively stable for over a year. Marking of the coral for both photographs (as has been done digitally above) would have made this very obvious for later analysis and decision-making. Other uses of evidence markers underwater might be to show the evidence to pathways of suspects, a trail of damage pathways, the pathways of secondary damage, and items obscured in the surface covering. Underwater markers can be displayed on manmade objects, geological objects, and relatively sessile biological organisms.

The Underwater Time Constraint Paradigm

On land, investigators would first photograph the entire scene, mark every piece of potential evidence and photograph each from a variety of angles, map the entire scene, and then collect and preserve all the evidence at the scene. Underwater, the strong time constraints imposed upon divers by limited air sources and decompression concerns serves to limit time spent at an impact scene. Repetitive dives on the same impact scene carry problems associated with variations in individual investigators documenting the same scene or in the fluid environment of the impact scene (especially during the period when it is unsupervised). The result is a strong need for a condensed scene evaluation/documentation and evidence collection process. Often this entails each diver being independent in his/her ability to document and collect evidence. The decision to use an evidence marker should therefore be based on its ability to serve as a successful tool that will reveal, simplify, organize and identify the numerous items of evidence found at an impact scene in a manner that is extremely time efficient, non-destructive, and responsive to the variable constraints of the underwater environment.

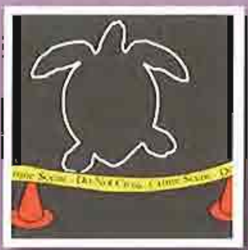
Underwater, an investigator will first photograph the scene from every angle in its original state, then use one or more of the following markers which would be put in place. A series of photographs will then need to be taken from each prospective to thoroughly document the scene with the evidence identification markers in place. Communications with other team members can be very important at this stage; if someone is assigned to do an impact scene diagram, it will be important to have communicated the critical scene photos so that they are captured correctly relative to the other scene diagram components. It's also important that all of the items labeled on the sketch are labeled correctly with the same assigned markings as in the photographs being taken. The same applies to co-worker(s) assigned to collect items of evidence. As you can see this is a teamwork concept. Each individual has to be informed to keep the information correct and consistent. One of the biggest problems is trying to communicate all of this underwater given the time constraints involved and the physical difficulties of conducting such communication. As such, one often has to first photograph the scene and place markers; followed by a short surface interval and team debriefing in order to get the team orientated for the follow-up documentation dive where a series of photographs will be taken from each prospective to thoroughly document the scene with the evidence identification markers in place.

Examples of Underwater Markers: Flagging Tape, Underwater Laser Pointer, Flagging Poles.

Which evidence marking system to use?

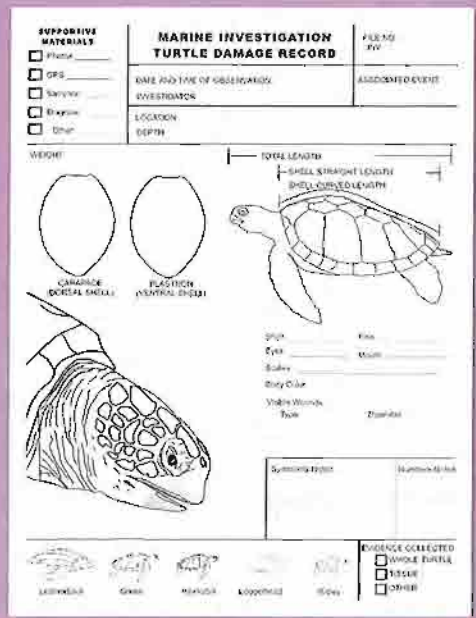
The choice of which type of marker is used should be based first on the need to adapt to meet the environmental trends that are occurring in the field, second to meet the resource protection needs of the site, and third based upon the tools available to the investigator. Investigators should keep in mind the need to minimize the number of underwater markers given difficulties in accessing the impact scene and ability to control changes at the scene from both natural and man-made effects during the investigative period. While it may be common to be able to document hundreds of impact points and items of evidence at a large vessel grounding site, manpower and time constraints in a fluid environment dictate a prioritization in regards to the use of markers underwater.

CORAL REEF CSI TIPS...



Prior to entry, the team's photographer should photograph site information off of a dive slate to establish the start of a photo series for that dive. Additionally, the photographer should get a 360 degrees series of shots above water and then again initially on the ocean bottom once the team arrives at the impact site. Photographer should also periodically photograph his/her depth gauge and dive computer underwater in order to assist in establishing the time into the dive and depth series for the assessment. Immediately upon surfacing at the end of the dive, the photographer should photograph each team member's data sheets along with those of the CROC and any other important info on the surface (including any samples taken or evidence gathered).

The surface support team will keep a log of all GPS waypoints, depths, team diving data, and surface observations related to the investigation, including human uses encountered while on-site. The surface support team will also record (through use of a laser monocular or similar device) the distances to various surface marine and coastal features, which will be included in the site diagram to be produced later.



Care must be exercised to not use too many markers in a single photo of a scene or to use multiple types of numbered markers repetitively as this introduces confusion into the documentation process. This is especially true for documentation of the "primary" impact event scene where one should not (if possible) repeat the sequence of identification markers that have been placed and assigned to sites of impact or items of evidence. That said, it may be acceptable at a "secondary" impact scene to have the repeated sequence during a supplemental or follow up to the original investigation where the time and the location would become the sequence indicators. Note that underwater, given the constraint issues mentioned earlier, it often is necessary to cluster or group impact or evidence items that occur in different areas of the scene allowing the investigator to reasonably divide and label areas through use of small sectors or grids. Individual items could then be identified as belonging to a certain sector or grid.

Examples of Underwater Impact Evidence

The following represents a small (though by no means exhaustive) collection of the range of different types of underwater impact evidence one might encounter on a coral reef.

Primary Investigation Photos:

1. **Incoming Keel Scar.** Note the freshness as indicated by the bright white reef substrate where little, if any, colonization by filamentous algae or other organisms has occurred.

2. **Propeller Scar**. Note the freshness as indicated by the bright white reef substrate where little, if any, colonization by filamentous algae or other organisms has occurred. Also note the striations caused by the shearing action of the propeller.

3. **Fractured Reef Substrate**. Note the various colorations of the internal substrate (due to bioeroders, oxidation and geological processes), but the ensuing lack colonization by filamentous algae, calcareous algae or other epibenthic organisms which would indicate a longer existence of the material being in this state on the bottom.

4. **Bottom Paint.** In close proximity to freshly damaged substrate. Also note that the bottom paint is on top of colonized hard substrate.

5. **Smashed Coral Colonies.** Note the freshness as indicated by the bright white skeleton relative to live coral (brown to tan color) on the fractured pieces.

6. **Fractured Reef Substrate.** Note the freshness as indicated by the bright white reef substrate where little, if any, colonization by filamentous algae or other organisms has occurred. Variation in rubble piece sizes suggest that a large abrupt force impacted this reef in a short period of time. Lack of smoothing (weathering) on the pieces further attest to the recentness of the event.

7. **Presence of Endangered or Protected Species.** While not an underwater shot, note the proximity of a protected monk seal to the impact site – which raises a variety of additional potential impact concerns.

8. **Large Ship Anchor Scar**. Scar is unidirectional and relatively linear, suggesting that the ship was under power or being towed with the anchor deployed.

9. **Anchor Bounce**. Note both live and dead coral, intact and smashed colonies. Unidirectional effect suggests that a boat's anchor came loose and the vessel moved shoreward, bouncing its anchor along the bottom.

10. **Presence of Loose Man-made Objects**. Need to look at pieces to discern if discarded refuse, or if represent actual pieces lost or broken off during an impact event.

11. **Re-Suspension of Soft Sediment or Sewage Plume**. Gentle disturbance of bottom sediments (using dive fin) can reveal underlying material that otherwise would be disguised by deposited surface sands.

12. **Fish Kill**. Evidence of fish kills (whether chemical, disease, starvation or other cause) tends to be first noticed when they wash ashore with tidal changes.

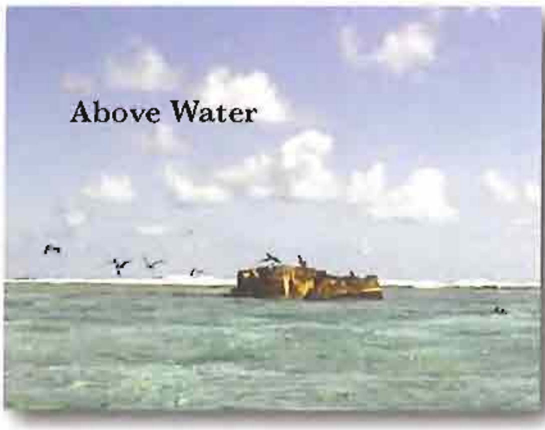
Delayed Investigation Photos:

D. Gulko, HI DLNR

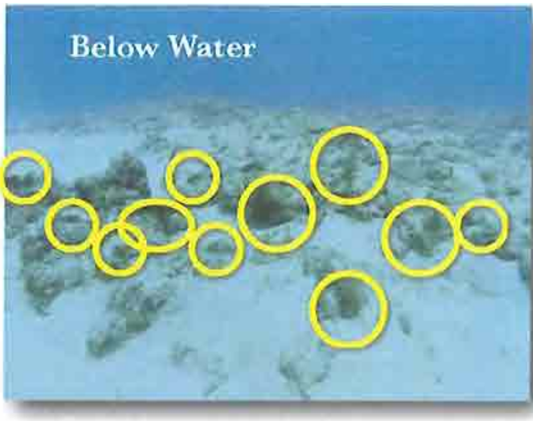
13. **Delayed Coral**. Partial loss of a coral colony may show some recovery over time. This is often expressed by new tissue growth or lightened color of the colony representing recovery of zooxanthellae populations.

HI DLNR

14. **Delayed Massive**. Fractured or over-turned massive colonies may show partial recovery overtime or partial re-cementing onto the substrate by either crustose coralline algae or re-growth of coral tissue.



HI DLNR



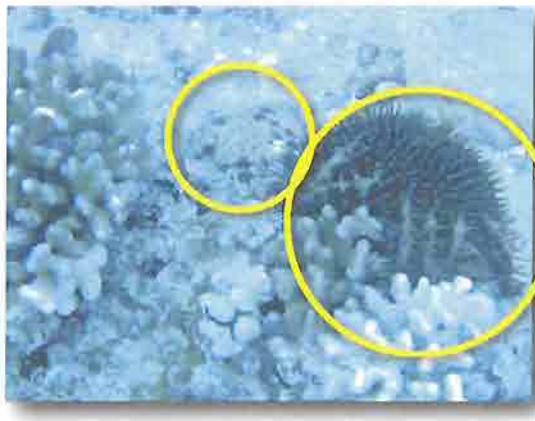
D. Gulko, HI DLNR

15. **Cyanobacteria Bloom** (Lyngbya). In remote areas, cyanobacteria may use remnant metal from an impact event (such as an abandoned vessel wreckage) as a substrate to enhance colonization and population size.

Secondary Impact Photos:

D. Gulko, HI DLNR

16. **Invasive Species Inundation**. Over time, invasive species, such as certain seaweeds, may colonize and monopolize the impacted substrate, causing cascade events or phase shifts in the habitat.



D. Gulko, HI DLNR

17. **Facilitated Coral Predation Events**. The impact event causes large numbers of damaged organisms (in this case, corals) to release chemicals which serve to attract and concentrate coral predators (such as the Crown-of-Thorns seastar and Cushion seastar pictured above feeding on live coral rubble).

D. Gulko, HI DLNR

18. **Facilitated Calcareous Coralline Algae Predation Events**. The impact event causes large numbers of injured organisms (in this case, coralline algae) to release chemicals which serve to attract and concentrate predators (such as the long-spined urchins pictured above feeding on live coralline algae rubble).

False Leads Photos:

D. Gulko, HI DLNR

19. **Fish Bites**. Certain large butterflyfish and parrotfish can leave relatively large bite marks in live coral colonies that can be mistaken for human-caused impact damage.

D. Gulko, HI DLNR

20. **Symbiotic Parasites**. Some coral colonies may have parasites which express themselves visually on the colony surface. Pictured here is a massive Porites colony infested with a parasitic trematode that uses the coral colony as an intermediate host prior to infecting its final host, a coral-feeding butterflyfish. Often these parasites are a normal part of the fabric of reef life.

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21. **Crown-of-Thorns Predation**. Crown-of-Thorns seastars (and some of their relatives) prey exclusively on certain coral species, often digesting away entire colonies and leaving behind bright white skeletons that can look like coral bleaching or human impact events. Careful inspection often reveals selective predation (i.e. intact corals of the same species or different species adjacent to the impacted one) or the presence of the predator in close proximity to the affected coral colony.

22. **Sea Turtle Resting Holes**. A number of sea turtle species will actively rest on coral reefs, often using their flippers to break coral colonies to create a more comfortable sleeping spot.

Underwater Evidence Collection at the Impact Scene

Prioritize the collection of evidence to prevent loss, destruction, or contamination; taking into account the ever-changing nature and dangers associated with the underwater impact scene. Continually assess environmental and other factors that may affect the evidence or the ability to process the impact scene.

To accomplish this, the team member(s) should:

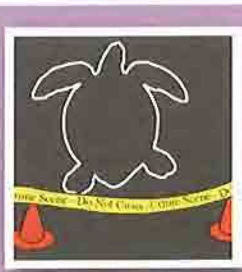
- Conduct a careful and methodical evaluation considering all physical and biological evidence possibilities.
- Focus first on the easily accessible areas in open view and proceed to cryptic, distant and semi-enclosed underwater locations.
- Select a systematic search pattern for evidence collection based on the size and location of the primary and secondary impact scene(s).
- Select a progression of processing/collection methods so that the initial techniques do not compromise subsequent processing/collections methods.
- Concentrate on the most transient evidence and work to the least transient forms of physical and/or biological evidence.

Prior to Collection of Evidence from an Underwater Impact Scene the Responding Natural Resource Trustee Representative(s) Should:

- Pre-assign team members to be individually responsible for underwater photography, scene sketch, physical measurements (including measurements from evidence items to permanent underwater features), and evidence collection and documentation.
- The investigator(s) in charge shall require all personnel to follow procedures to ensure scene safety and evidence integrity.
- Wherever possible, divers should clean/sanitize their gear/tools/equipment and personal protective equipment between dives/impact scenes where evidence collections may occur.
- Describing the underwater scene as it appears prior to physical evidence collection. Record transient evidence (smells, sounds, sights) and conditions (temperature, current, tide, etc.).
- Photos should include the impact scene (from various perspectives, including overall, medium and close-up coverage); the evidence to be collected with and without measurement scale and/or evidence identifiers; identifiable damage pathways; un-impacted reference habitat and species; victims, suspects, witnesses, users and vessels; additional perspectives (e.g. surface/aerial photographs, area under impact once the impact is removed.
- Sketches and measurements should include: immediate area of the impact scene, noting case identifiers and indicating north on the sketch; relative location of items of evidence prior to movement; large coral heads, reef holes or other subhabitats; distance to adjacent subhabitats or other submerged landmarks.

(Modified after 2000 U. S. Dept. of Justice Draft Guidance on Investigating Vessel Groundings)

D. Gulko, HI DLNR



CORAL REEF CSI TIPS...

Prior to collection of anything off the substrate (man-made or natural), make sure you have legal authority to collect it.

Collection of Man-Made Objects Underwater

Prior to movement or collection of a piece of evidence underwater, document the collection of evidence by recording its location (including depth), at the scene, date of collection, and who collected it. Pre- and Post-collection photos of the habitat scene should be taken.


MARINE INVESTIGATION CHAIN OF CUSTODY RECORD

Documentation can occur underwater on a Chain-of-Custody form (*left*) printed on waterproof paper and maintained with other data sheets by the investigative diver. The diver that fills out the Chain-of-Custody form should maintain custody of the evidence collected (and described on the form) until surfacing with the collected material. For more on Chain-of-Custody, see Module II, Section 6.

Once documentation is complete, collect each item identified as evidence and place into separate

Often eels and other hazardous marine life will take-up residence in large pieces of debris or rubble piles created by impact events. Care should be taken when handling such items that have been in place on the ocean bottom for a couple days or more.

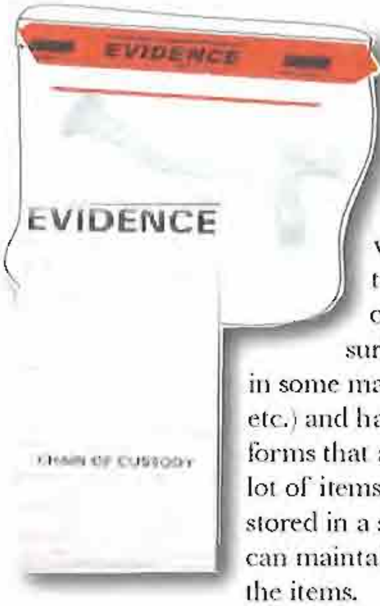
Pre-Evidence Collection Photo

Post-Evidence Collection Photo

D. Gulko, HI DLNR

containers, bags, etc. that can be identified relative to the samples taken. For example, objects could be placed into separate pre-numbered sealable plastic bags (Ziplock™), containing the date and collector's name. In some cases, collected evidence of large size may need to be placed into mesh bags or hand-carried to the surface.

At the surface, all evidence bags should be photographed along with the waterproof chain-of-



custody form. If evidence needs to be transferred to another container or bag, document this both photographically and in writing. The final transport bags for collected evidence (after surfacing) should be sealed in some manner (evidence tape, etc.) and have chain-of-custody forms that accompany each item or lot of items. Evidence should be stored in a secure location which can maintain chain-of-custody for the items.

Care should be taken to have investigators wear gloves if possible when collecting evidence underwater. Underwater impact sites are often extremely hazardous relative to risks to exposed skin. If wearing dive gloves worn previously on other investigations, divers should cover their gloved hands with disposable examination gloves.

Attempts should not be made to clean-up items while in the field. Such activities should only be done by appropriate personnel, following standardized procedures in a proper facility. Seizure or securing of suspected personal property associated with an impact event should only be done by authorized personnel and agencies.

Collection of Impacted & Reference Natural Resources Underwater

Biological and geological sampling underwater is often needed in an impact investigation. It often breaks down into the following three types:

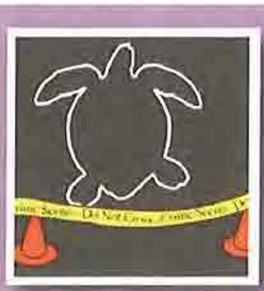
1) An **Impact Sample** is material from an impact event site which is suspected of having been damaged, killed, or modified by the event itself.

2) A **Standard/Reference Sample** is material of a variable/documented source which, when compared with evidence of an unknown source, shows an association or linkage between a responsible party, impact scene, and/or affected natural resource (e.g. a paint fragment taken from a substrate location suspected as the point of impact for a vessel grounding for comparison with a paint scraping recovered from the suspect vessel's hull.

3) A **Control/Blank Sample** is material of a known source that presumably was uncontaminated during the commission of the underwater impact event (e.g. a sample to be used in laboratory testing to ensure that the surface on which the sample is to be deposited does not interfere with testing.

In general, most impact events will require both impact samples and reference samples to be taken independently. Many coral reef impact sites will not have been monitored extensively prior to an impact event and therefore one may have to collect proper control samples from an appropriate control site to establish what may have been lost at the impacted site.

Under some circumstances it may be necessary to obtain some **Elimination Samples** from investigation team members, their equipment or



CORAL REEF CSI TIPS...

Wet biological evidence, whether packaged in plastic or paper, must be flash frozen, chemically preserved, or removed and allowed to completely air dry. UNDER NO CIRCUMSTANCES SHOULD EVIDENCE CONTAINING MOISTURE (i.e. seawater) BE PACKAGED IN PLASTIC OR PAPER CONTAINERS FOR MORE THAN TWO HOURS. Moisture allows growth of microorganisms which can destroy or alter evidence.

vessels in order to isolate sources relative to other evidence collected. If an impact area has high usage, elimination samples may need to be collected from all user groups, their gear, vessels, and in-water witnesses.

D. Gulko, HI DLNR

All items collected should be packaged separately to avoid contamination and cross-contamination. Identify and secure evidence in containers (e.g. label, date, initial container) underwater at the impact scene. Different types of evidence require different containers (e.g. porous, nonporous, crushproof).

Both while underwater, and again on the surface, avoid excessive handling of evidence after it is collected. Maintain the evidence while it is under your control in a manner that will diminish its degradation or loss. For biological samples, placement of evidence bags into a sealable ice cooler (marked "EVIDENCE" and not used to store food or other items). As most investigations on water occur under daytime, high temperature conditions, icing the cooler, if it can be done in a manner that doesn't result in lots of melted water being released into the samples (for example, use of Blue Ice™ or separate bagged ice).

As with other forms of evidence collected underwater, transport and submit evidence items for secure storage. Note that in case of biological marine evidence, you may need to store the samples in a secure low-temperature freezer in sealed containers. Avoid trying to maintain live marine organisms in captivity as evidence.

Often during a coral reef incident, the question arises as to whether to try and restore a damaged coral head, let it naturally recover, and/or collect some of the damaged material? The answer will be based upon your NRT's abilities & policies, and the age/size and ecological function of the damaged colony.

STOP

Evidence at an underwater impact scene that is undergoing the process of documentation, collection, preservation, or packaging should be handled with attention to scene integrity and protection from contamination or deleterious change to the best extent possible. During the processing of the scene, and following documentation (the Impact Assessment Phase), evidence should be appropriately packaged once brought to the surface, labeled, and maintained in a secure, temporary manner until final packaging and submission to a secured evidence storage facility or an analytical/forensic/crime laboratory.

POST-EVIDENCE COLLECTION ACTIVITIES AT THE IMPACT SCENE

After evidence has been collected and secured as part of the Impact Assessment, efforts should be made to conduct **emergency restoration** of any appropriate habitat components that can be saved or immediately restored. This will have the effect of maximizing shelter habitat for displaced organisms. Under certain circumstances involving large-scale injuries or injuries to extremely fragile or high value resources, emergency restoration may have to take place before the Impact Assessment.

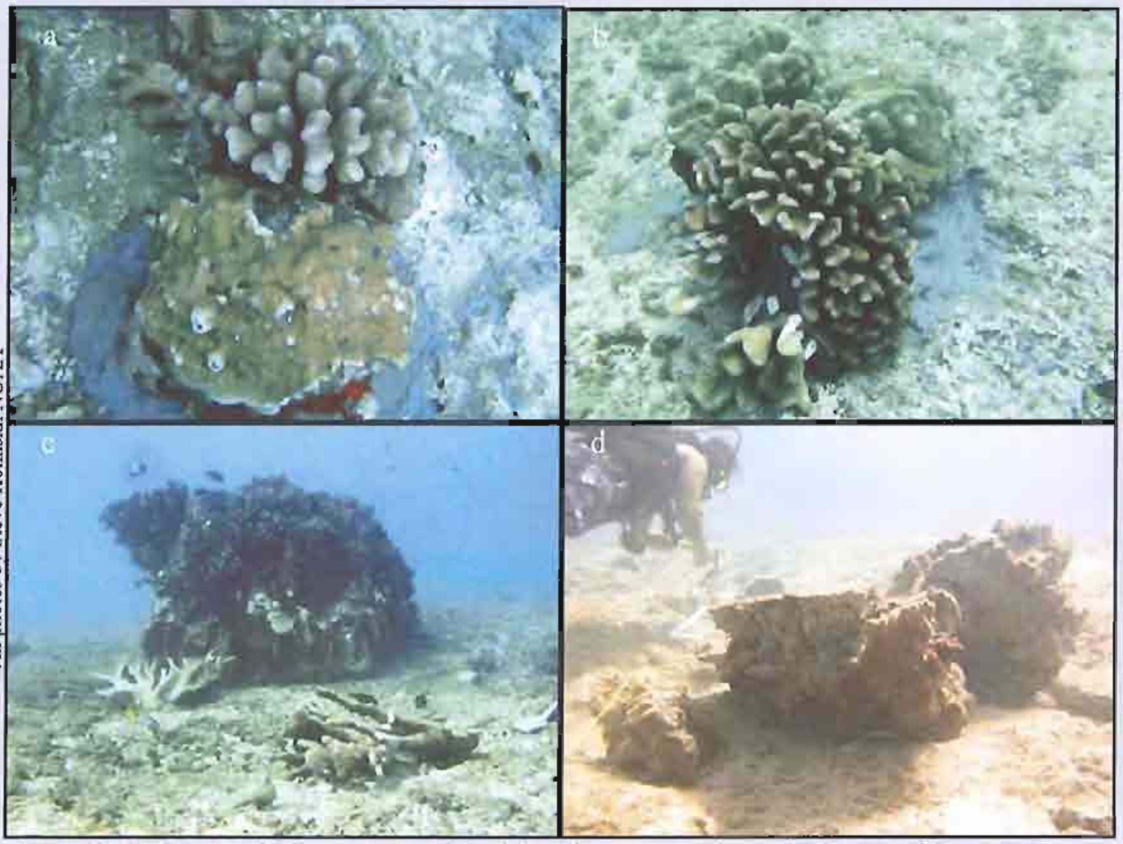

Steve Kolinski, NOAA

Intact large colony of *Pocillopora eydouxi* serving as shelter for a variety of fish species.


Steve Kolinski, NOAA

Smashed large colony of *Pocillopora eydouxi;* the loss of upright three-dimensional shelter results in almost a complete lack of fish in this location. These live fragments, can be cemented upright to the substrate to jump-start the three-dimensional shelter substrate lost during the injury event.

Examples of the Need for Coral Reef Emergency Restoration



All photos by Steve Kolinski, NOAA

a). *Pocillopora meandrina* and *Montipora patula* colonies after being cemented back onto the substrate.

b). *Pocillopora eydouxi* and *Porites lobata* fragments of large colonies cemented in a cluster together to create complex habitat and provide mutual support.

c). Large broken *P. eydouxi* branches (>1 m) and large displaced *Porites evermanni* colony before restoration.

d). Overturned and fragmented large colony of *P. lobata.*

Examples of Emergency Restoration & Secondary Response

To be clear, Emergency Restoration is NOT the same as Restoration (which would take place AFTER all response and investigation activities are concluded). Emergency Restoration is done to immediately prevent imminent, additional natural resource damage resulting from the injury; examples might include:

- Removal of loose rubble and debris (which could act as bulldozers and scourers with additional wave action or storm activity).
- Cementing of live coral fragments underwater (to prevent additional coral loss and associated animal usage).
- Prevention of alien species colonizing damaged substrate.

Cementing Corals Underwater

The use of cement underwater poses a series of issues that need to be considered in planning for emergency restoration. Certain cements and epoxies actually can release toxic materials over time in seawater that can affect marine organisms, including the cemented corals; other cements are not well designed for use in seawater, and do not set or hold well. You may have to investigate mixing in carbonate (such as 'Plaster of

Cementing Coral Fragment Clusters 101

(1) After NRTs identify the priority restoration areas (which might include or emphasize large corals that are boulder-like, branches, or overturned colonies which are most likely to survive), the loose coral pieces and damaged reef areas need to be prepared for reattachment. This is accomplished by scraping (picks, hoes), brushing and scouring (wire brushes) the surface to clean it of any loose material and create a rough, grooved area for the cement.

(2) Loose coral pieces are gathered together for movement to the reattachment site.

(3) Fresh cement is then placed onto the cleaned surfaces of the ocean floor to serve as adhesive for the broken corals and divers cement the loose coral fragments onto the reef. Cement is usually mixed aboard the dive platform in small batches and lowered down or delivered by a diver to the restoration site in short order.

(4) The new coral fragment clusters mimic the arrangement of corals in natural reef habitats allowing a variety of fish and coral reef invertebrates to quickly return to the injured area.

(5) After emergency restoration, injured live coral is clustered to create shelter habitat, provide a size refuge for the fragments themselves, and limit loose rubble from having a secondary "bull-dozing" effect over time. Long-term monitoring is required to assure the cement holds and secondary predation or algal infestations do not impact the coral clusters.

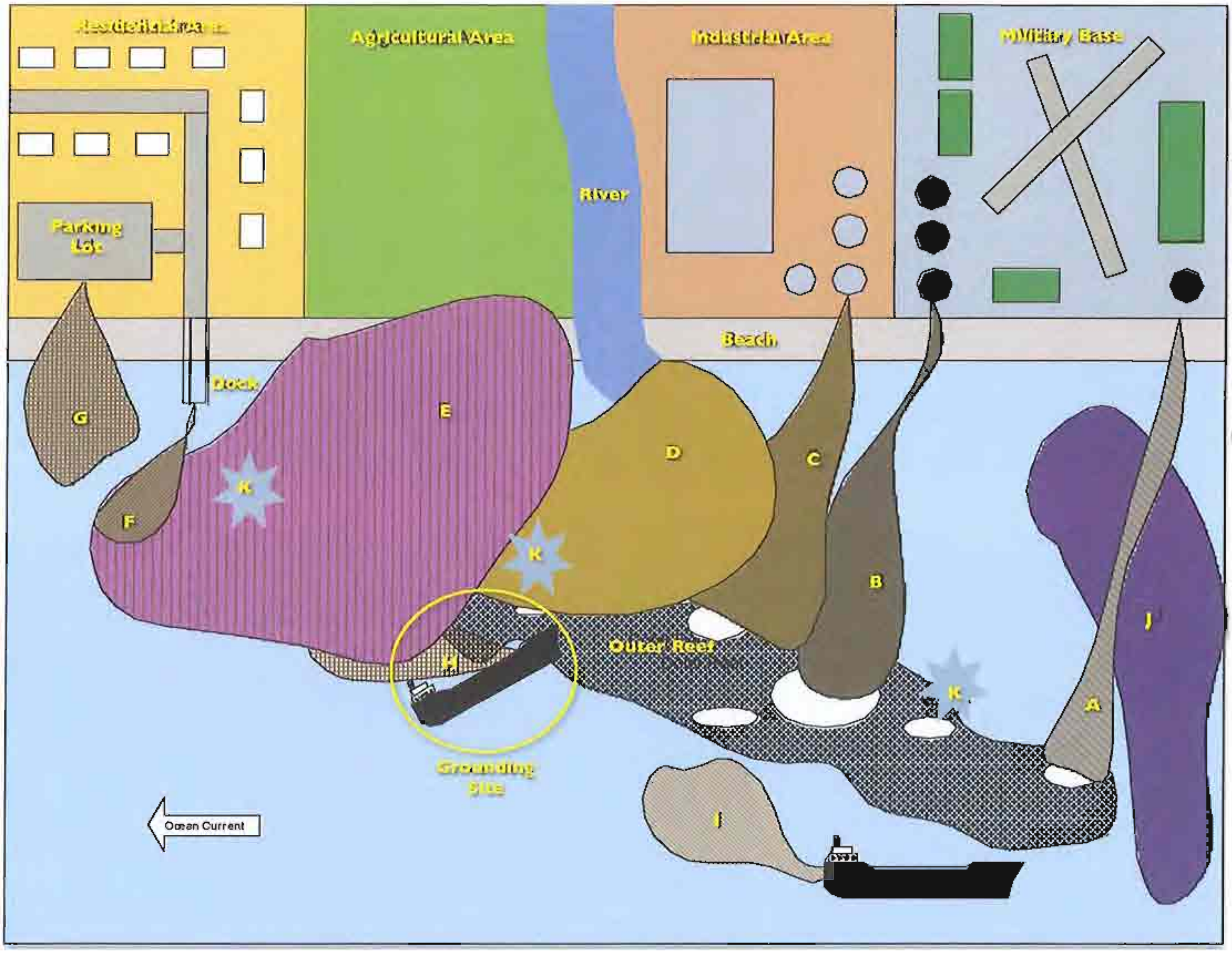
Photos by Steve Kolinski, NOAA (www.darrp.noaa.gov/Pacific)

Paris') or silicate to make the quick-drying cement more conforming to the marine environment of your specific area. We strongly recommend that your team conduct a variety of small scale tests of various re-attachment techniques in your area as a formal training exercise in order to determine what works best for you prior to a major incident, and build this knowledge into your regional response plan.

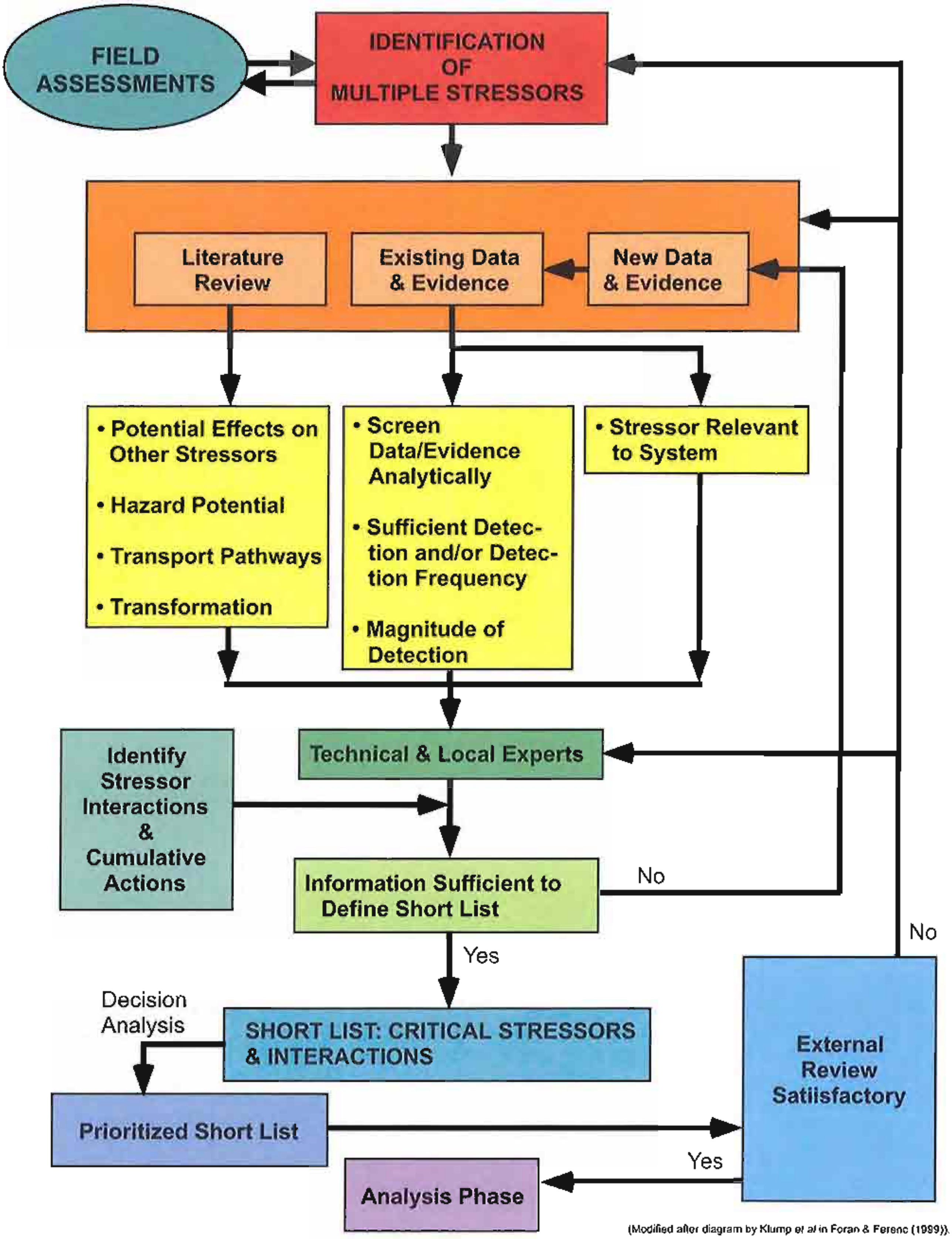
Investigating Multiple Stressor Impacts

The results of the Reconnaissance Survey, the Pre-Assessment and the Impact Assessment may suggest that there are multiple influences which are affecting the injury habitat and leading to a situation where the secondary effects of the the incident are either expanding or compounded. Such situations require detailed analysis and consultations with a variety of interested parties in relatively short order to determine mitigative solutions. Frequently decisions need to be made relative to limited funding, field resources, or time factors. The determination in short order of the critical stressors and interactions from the total list of possible stressors is a priority.

Possible Stressors at a Hypothetical Grounding Site	
A - Depleted Uranium	F - Boat Discharges at Dock
B - Jet Fuel or Military Wastes	G - Oil & Lubricant Run-offs
C - Industrial Chemicals	H - Fuel Spill
D - Wastes Discharged in River	I - Fuel &/or Waste Discharge
E - Fertilizer Run-offs	J - Waste Drifting in Current
	K - Fish-Stunning Poisons



Investigating Multiple Stressor Impacts



(Modified after diagram by Klump *et al* in Foran & Ferenc (1999)).

Final Steps in a Impact Assessment

As the impact assessment events in the field reach the final stages, a series of off-site actions will need to be contemplated and decisions made relative to their impacts on the follow-on phases of the field investigation:

- Evidence collected must be secured, processed and analyzed in a documented and careful manner.
- Other non-NRT government or enforcement agencies should be notified of the results (to the extent that this does not jeopardize any on-going enforcement investigations or actions; and in concurrence with your region or country's laws and agreements regarding the sharing and release of such information).
- Results from the Impact Assessment might result in additional charges and/or claims against the RP by the NRTs or other agencies.
- Adjacent land owners, primary commercial and recreational organizations/operations which make us of the impacted area, and targeted user groups might need to be briefed and specific efforts directed to educate them regarding the impacts of the event and the on-going investigation. Such efforts should be undertaken in order to maximize public safety and minimize additional natural resource damage.
- The Media (and through them, the general public) may need to be briefed regarding the impact event and the on-going investigation. Often this is best handled through a formal Press Release by the lead NRT agency. Care needs to be taken to ensure that the media involvement and public notification does not release sensitive details, effect future legal proceedings or decision-making relative to the NRT, or inhibit the field investigation from proceeding (see Introduction Module: Enhancing Notification of an Impact Event Section (Dealing with the Media)).

Summary

The function of the impact assessment is to formally document and measure the range of injuries occurring at the impact site. The second major function of this assessment is to collect evidence at the scene using proper collection and documentation techniques and following established chain-of-custody procedures. After all evidence collection activities are concluded, emergency restoration techniques may need to be considered to prevent further natural resource injuries.

The Impact Assessment is the second of three in-water components involved in a marine impact event field investigation

Beth Lumsden, NOAA

REVIEW SHEET

CONDUCTING AN IMPACT-ASSESSMENT

OUTLINE OF ACTIVITIES:

1. Search/Examine Impact Scene	Prepared	Conducted	Documented
a) Surface photograph scene, photograph data sheets and other recorders (GPS, dive computer, etc.). At impact scene, photograph depth gauge.			
b) Diagram damage pathway; include distances, depths and area measurements. Label diagram carefully.			
c) Produce a Impact Scene Diagram; Carefully represent all damaged resources relative to habitat features. Diagram should include major features, impacts and references area to be photographed.			
d) Document damage to wildlife. Numbers, location, visible injuries, discoloration.			
e) Document damage to bottom habitat. Note scratches, marks, breakage; pay attention to discoloration and unusual overgrowth.			

Important Tools, Forms or Other Aids:

Incident Report Form

Search Pattern Technique

Pelican-Type Float

GPS Device

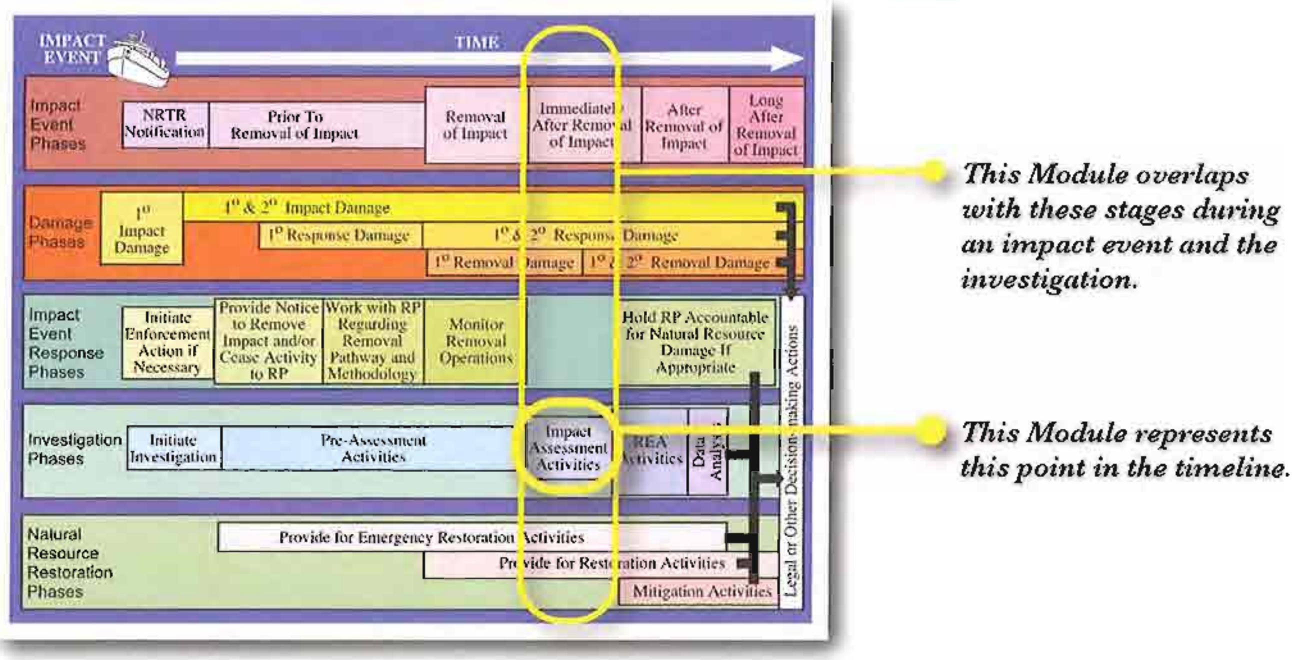
2. Photograph Impact Site	Prepared	Conducted	Documented
a) Photograph impact site from a wide perspective. Capture images in all (360 degrees) directions, preferably with compass at bottom of photos.			
b) Take photo series of all reference and impact materials/locations. First photo should be without a evidence marker, remaining photos in the series should have the evidence marker in place. End of each series should include a number of close-up shots.			
c) Track location, depth, etc. for each photo on underwater slate.			

3. Collect Evidence/Samples	Prepared	Conducted	Documented
a) Identify proper types of samples and make sure you do not contaminate during collection; minimize field damage during collection.			
b) Fully document samples underwater prior to collection. Store in appropriate containers for transport. Keep cool, process quickly.			
c) Store samples separately and securely; maintain chain-of-custody.			

Important Tools, Forms or Other Aids:

CROCI Form

Chain-of-Custody Form

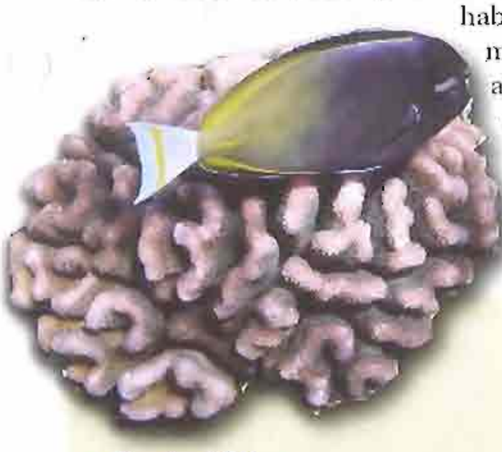


Conducting Rapid Ecological Assessments (REAs)

B. lumsden, NOAA

One of the major roles of the Rapid Ecological Assessment (REA) is to try and determine what biological resources and ecological functions were lost from an impact event and establish the rate of recovery for the habitat.

During an injury investigation, the first part of the investigation (the Pre-Assessment) is dedicated to determining that a damage event occurred and what habitats or subhabitats may have been affected, while the second part (the Impact Assessment) measures the area of injury and collects evidence of damage. The final part of the field investigation is a Rapid Ecological Assessment, which is used to quantify exactly what biological resources were lost, what ecological functions were affected, and what the rate of recovery might be based.



Setting Control or Reference Sites

In order to determine what specifically was lost in an injured area, comparisons need to be done with appropriate **control or reference sites** that did not incur any of the injury being investigated. A site that is composed of the same habitat or subhabitat type, at the same depth, and under similar water regimes as the injured site being studied. In most cases, control

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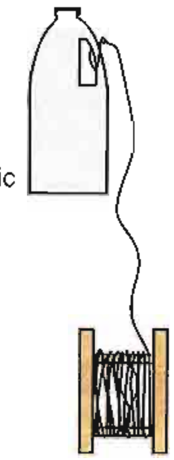
Key Terms

- *Control Sites*
- *Surface Safety Float*
- *Fish REA Team*
- *Benthic REA Team*
- *Transect Line*
- *DACOR*
- *Algal Ecologist/Specialist*
- *Invertebrate Specialist*
- *Coral Ecologist/Specialist*
- *Rugosity*
- *Ecological Function*

sites are located in close proximity to the injured area, unless such an area is suspected of also being impacted in some way such as to make its use as a reference questionable.

A Word About Surface Safety Floats

Commercially-purchased PAM Float



Home-made Float & Spool

During an REA, two (2) surface safety floats are used and serve four main functions:

1) The positions of the two floats allow the surface boat operator (or shore-based support personnel) to know approximately where both REA teams (Fish and Benthic) are at all times.

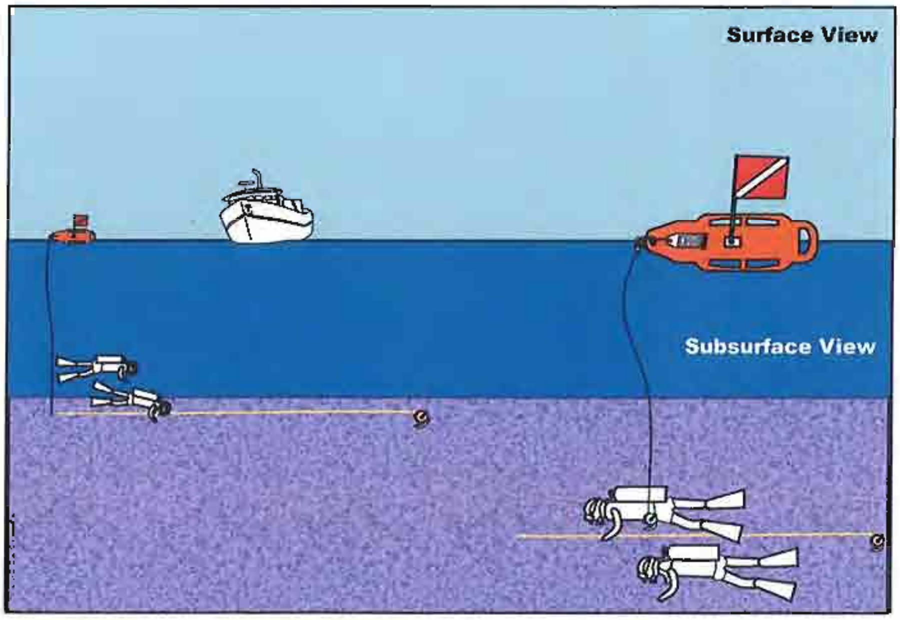
2) The movement of the second float away from the first provides an accurate timing for the Benthic team's descent onto the first transect line, such that the Benthic team does not interfere with the data collection of the Fish team by causing additional disturbance to fish populations during the counts.

3) When using a commercially-purchased PAM float, the float provides a safety stop line during strong current conditions (common during remote REAs) while still allowing the surface boat operator to follow the divers as the current moves them away during their safety stops. Additionally, in an emergency, these floats (the PAM floats) can support three divers holding onto it at the surface (using its multiple handles, and thereby keeping divers together while awaiting recovery) and are highly visible from a distance.

4) The attachment of a GPS recorder to the second PAM float provides a more accurate record of the three transect locations than using the GPS on-board the support platform.

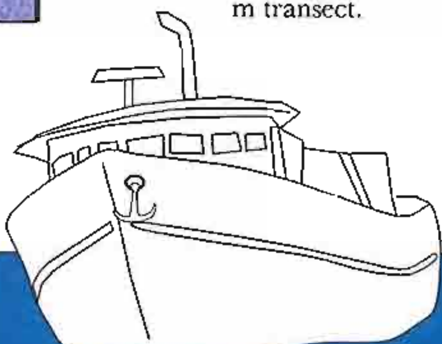
Other features: Use of the floats to follow Benthic & Fish REA teams allows

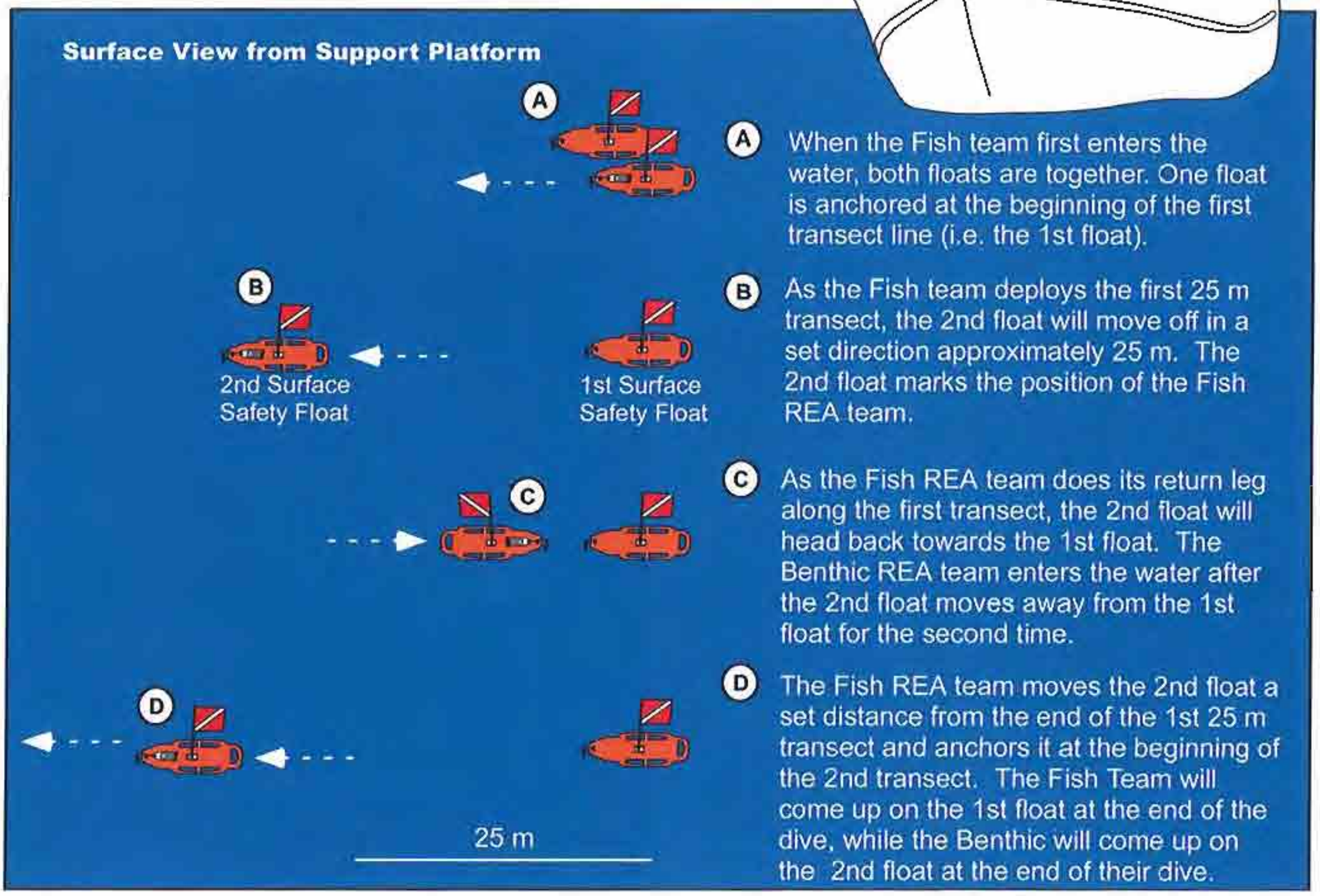
- The boat operator to more easily spot Pelican-type floats released by the divers to mark unique sub-surface features or specific impact sites.
- The CROC or other surface support personnel to quickly measure distances from the REA site to surface features such as shore-based outfalls, harbors, etc.

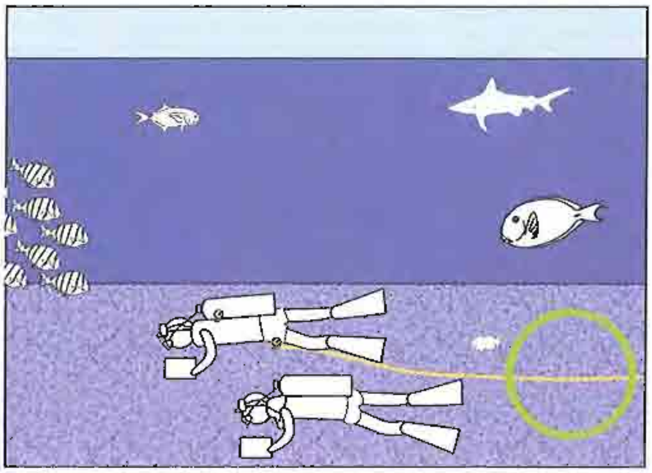


Surface Safety Floats are a critical piece of safety gear for submerged divers used to identify their location and serve as an emergency support platform upon surfacing. In an REA, the float also holds a working GPS and is used to time various aspects of the REA for both the surface support team and the benthic team.

The **Fish REA Team** deploys both surface safety floats. The 1st float is immediately anchored to the bottom at the beginning of the first 25 m transect line. The second float is carried by one member of the fish team (by way of a reel and line) until the fish team completes the first transect and begins to set the second 25 m transect. The second float is anchored at the beginning of the 2nd 25 m transect.



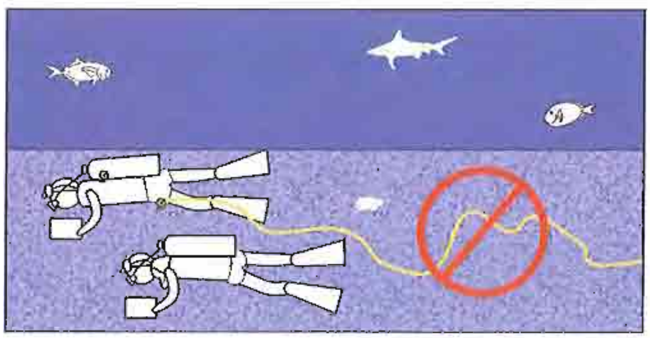




LAYING THE TRANSECT LINE

The **Transect Line** is a fixed length of line marked every meter and half meter which is used to delineate an area to be assessed which is then used in replicate as a subsample for a larger impacted or control area. The transect line is back-deployed passively by one of the divers as they swim the first leg of their transect. This is accomplished by clipping the line off to one of the divers as shown above. Prior to initiating the transect, both divers will agree upon a compass direction to set the line and attach the free end to a bottom feature near where they have anchored the first surface safety float. Both divers will swim at the same rate in the pre-agreed upon direction. When the transect is fully deployed, the diver will feel a tug where the reel is attached to him/her. The divers stop their transect and unclip the reel, attaching it lightly to a bottom feature.

Care must be taken at all times while deploying the transect line to keep the line straight and untangled. This can be easily done by maintaining a slight tension on the line while deploying it and by the deploying diver maintaining his/her buoyancy above the substrate by at least 1 meter.



Desirable Features:

- Durable
- Minimal Tangling
- High Visibility
- Easily Deployed & Retrieved
- Easily Anchored
- Easy to Read Markings
- Easy to Carry

B. Lumsden, NOAA

B. Lumsden, NOAA

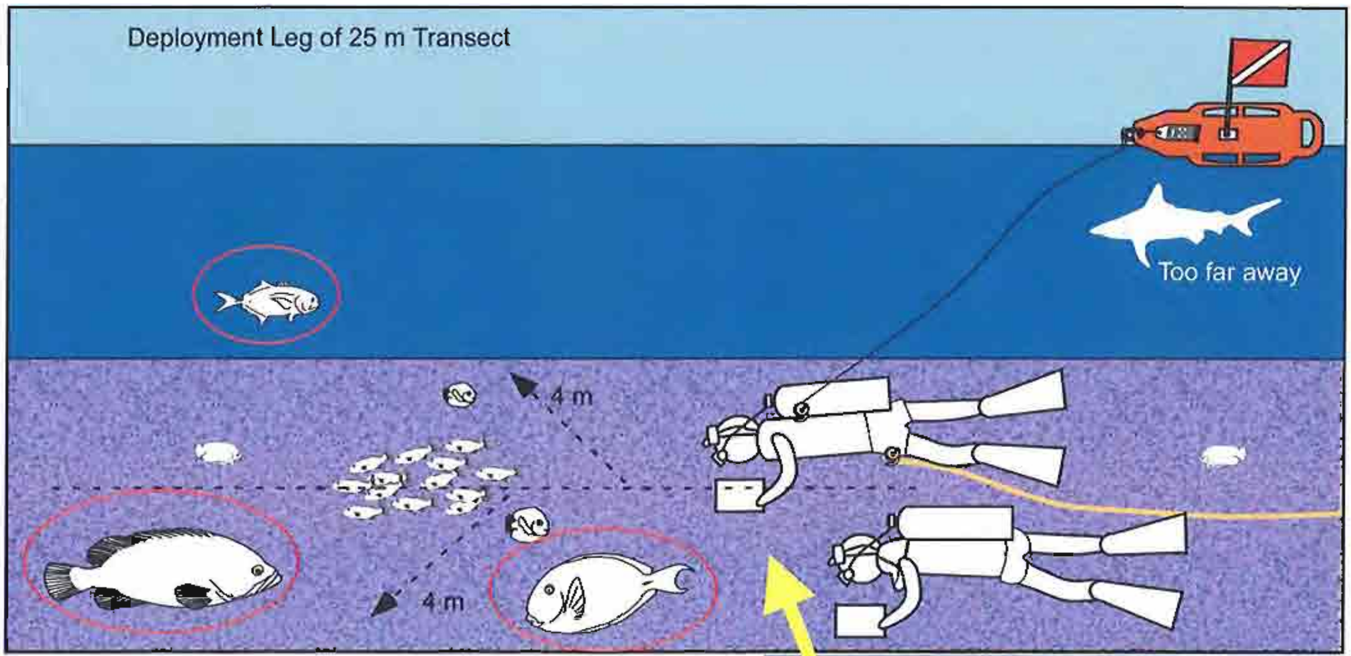
The transect line can be anchored using either a clip, tying the loose end, or by use of an anchor weight. Care should be taken to minimize any damage to natural or impacted resources while anchoring the line.

Fiberglass Tape Reel

Parachute Cord Reel

CORAL REEF CSI TIPS...

When choosing a transect line, should one go with a Tape or Cord? In many jurisdictions, researchers have traditionally used open reel fiberglass measuring tapes as transecting lines underwater. The tape reels, while accurate down to the cm (or mm), have the major disadvantage of not laying straight on the substrate and being difficult to read underwater. The cord reels tend to lay easier on the substrate and can be marked with the minimal markings needed to be extremely visible.

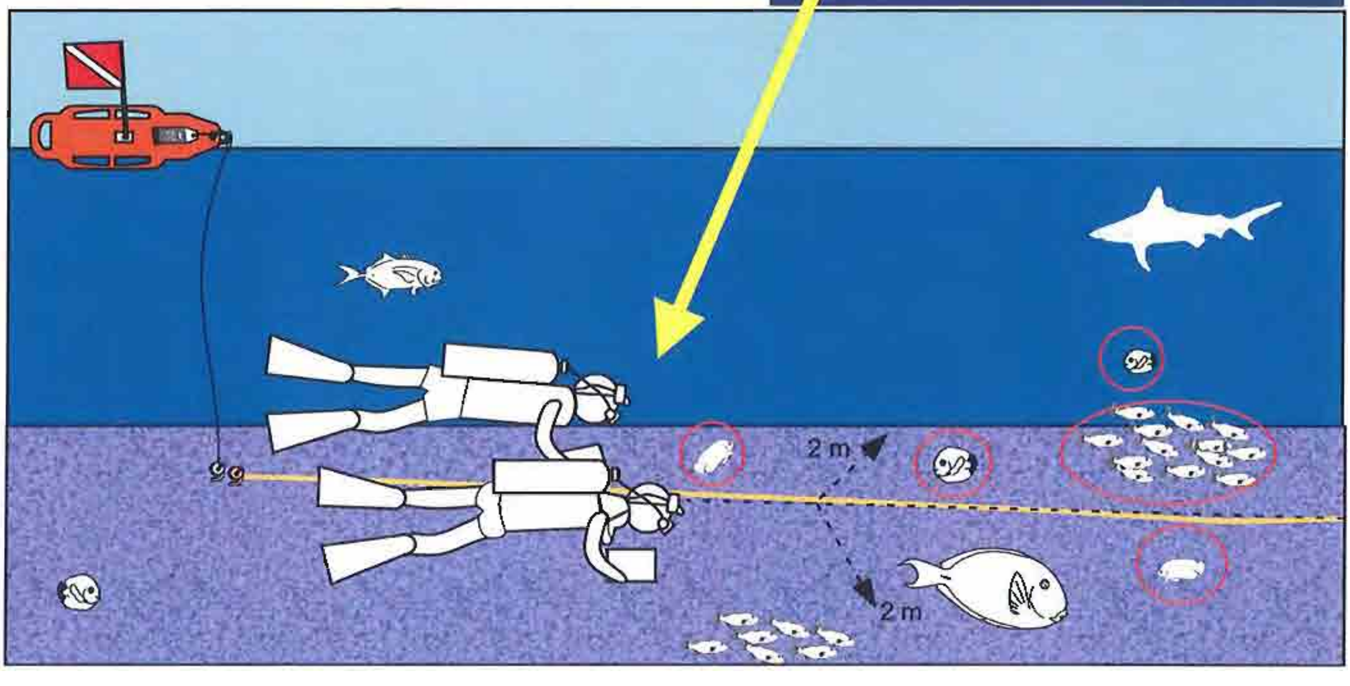


THE REA FISH TEAM

During the deployment leg of each 25 m transect, each diver records size-class-specific (Total Length, TL) counts of all fishes greater than 20 cm within visually estimated but defined belt widths (either 2 or 4 m on each side of the line), while small and cryptic fish (i.e. less than 20 cm) are counted during the "swim-back" leg. Each fish is identified to species.

The Swim-Out Leg: Deploys transect line; targets fish larger than 20 cm within 4 meters to each side of the transect line.

The Swim-Back Leg: Targets fish smaller than 20 cm within 2 meters to each side of the transect line.



The result is that each fish diver obtains a density estimate of all fishes greater than 20 cm Total length (TL) within a 25 meter long by 4 meter wide areas (or 200 m^2 total) of an initial ("swim-out") leg, followed by a density estimate by each diver of fishes less than 20 cm TL within a 25 meter long by 2 meter wide area (or 50 m^2 total) on the subsequent ("swim-back") leg, in each of two transects, for each survey dive. Two transects worth of data provide totals of 400 m^2 and 200 m^2 searched for large, relatively mobile and for small, site-attached reef fishes, respectively.

For cave and vertical wall habitats, the "swim-back" leg is combined with the deployment leg, with the divers proceeding at half the normal speed; this is necessary because we've found that with specific habitat constraints associated with vertical walls and caves, small fish move away from the divers such that they would not be counted on the return leg.

All Fish REA divers record rare species and unusual fish habitat during the dive and adjacent to (but outside) the transect. Upon completion of transects, the Fish REA divers retrieve the first transect line and ascend the safety float marking the first transect line's location.

The data are used both to estimate numerical (and biomass) densities and to describe relative abundance (post-survey DACOR analysis) of the fish assemblage for the Rapid Ecological Assessment (REA). Additional recording of species presence off transects are used to generate a parent species list for biodiversity and rare species concerns of the REA.

Surface GPS waypoints are taken for the two surface safety floats which should be at the beginnings of each transect.

What is DACOR?

DACOR is a relatively quick and qualitative way to describe abundance of organisms within a defined area or habitat. One uses the letters D-A-C-O-R to assign abundance estimates to each species encountered within a set area or during a fixed period of time.

D - Dominant

Dominant species are those representing more than 60% of the individuals encountered.

A - Abundant

Abundant species are those representing more than 25% of the individuals encountered.

C - Common

Common species are encountered many times along a transect.

O - Occasional

Occasional species are those encountered more than once but fewer than five times along a transect.

R - Rare

Rare species are those encountered only once along a transect, or found only once off the transect.