2008 Main Hawaiian Islands
Derelict Fishing Gear Survey

NOAA

PACIFIC ISLANDS
FISHERIES
SCIENCE CENTER

Coral Reef Ecosystem Division

Science, Service, Stewardship

U.S. Department of Commerce | National Oceanic and Atmospheric Administration | National Marine Fisheries Service

PIFSC Mission

To conduct high-quality, timely research to support the stewardship of fisheries resources, protected species, and ecosystems in the central and western Pacific Ocean.

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Background

Debris pile on the windward side of Lana`i (Debris type—trawl/seine, Size 3).

The National Oceanic and Atmospheric Administration (NOAA) defines marine debris as "any persistent solid material that is manufactured or processed and directly or indirectly, intentionally or unintentionally, disposed of or abandoned into the marine environment or the Great Lakes."

A significant component of marine debris is *derelict fishing gear* (DFG), consisting of discarded fishing nets, lines, and rope. DFG is one of the most significant marine debris problems within Hawai`i's coastal and marine habitats. It presents a lethal entanglement hazard to numerous marine species, including the critically endangered Hawaiian monk seal, the threatened green sea turtle, the endangered humpback whale, seabirds, and other wildlife. In addition to posing an entanglement threat to wildlife, DFG significantly damages coastal and coral reef habitats, presents a hazard to boat navigation, mars beaches important to local communities for recreation and tourism, and is a potential conduit for the unwanted introduction of alien species. In recent years, DFG has received greater attention from the media and coastal communities in Hawai`i and elsewhere. In response to this expanding concern, the U.S. Congress passed the *Marine Debris Research, Prevention, and Reduction Act* in 2006.

In 2006, the Pacific Islands Fisheries Science Center (PIFSC) Coral Reef Ecosystem Division (CRED) received funds from the NOAA Marine Debris Program to initiate a series of aerial DFG surveys to characterize the extent of DFG accumulation in the nearshore environment of the main Hawaiian Islands (MHI). Surveyed islands included Kaua`i, O`ahu, Lana`i, Maui, Moloka`i, and Hawai`i (Big Island). Completed in May 2006, these aerial surveys demonstrated the widespread existence of DFG on the shores of all of the MHI. These surveys identified a

total of 711 individual DFG sites throughout the MHI. Debris was identified by air and classified into 10 categories: trawl/seine, monofilament gillnet, multifilament gillnet, cargo net, miscellaneous line, longline, fish aggregating device, trawl cod end only, hauser, and other.

Findings from the aerial surveys were presented to local resource management agencies, including the Division of Aquatic Resources of the Hawai`i Department of Land and Natural Resources and NOAA's Pacific Islands Regional Office and Hawaiian Islands Humpback Whale National Marine Sanctuary.

In June 2006, the CRED Marine Debris Team conducted a pilot DFG cleanup effort on O`ahu, removing 225 individual piles of DFG weighing a cumulative 16 metric tons and most of the DFG on O`ahu's coastline.

Also with 2006 funding from the NOAA Marine Debris Program, the team completed a highly technical DFG removal operation along the remote northern shoreline of Lana`i in January 2007. Logistically, the Lana`i project was especially challenging. The team used all-terrain vehicles and helicopters and often hiked to remote shoreline areas to reach large conglomerations of debris. Helicopter slingloads were required to remove large piles of debris from inaccessible regions of coastline. In total, the CRED removed 156 individual DFG piles, totaling 17.4 metric tons, from the shoreline of Lana`i. CRED marine debris removal in remote areas, such as the northern coast of Lana`i, is especially critical because local governments and communities in Hawai`i often lack the infrastructure to overcome the logistical challenges presented by a DFG survey and removal effort of this magnitude.

In 2008, funding was granted to resurvey the six MHI surveyed in 2006. Approximately 50 hours were spent over 14 days in July and August 2008 to complete these aerial surveys.

Maps of DFG survey data provide insight into the nature of DFG accumulation patterns. This booklet provides local government agencies, nongovernmental organizations, natural resource managers, and interested stakeholders with updated Geographic Information System (GIS) maps that serve as a powerful tool to facilitate management planning and DFG removal efforts.

Large debris piles on South Pt., Hawai`i: (a) Debris type—trawl/seine, Size 3; (b) Debris type—trawl/seine, Size 1; (c) Debris type—trawl/seine, Size 3; (d) Debris type—trawl/seine, Size 2.

The Effects of Marine Debris

Three Wedged-tailed Shearwaters found adrift and entangled in derelict fishing gear. (Photo by NOAA Observer Program)

The presence of marine debris in the Hawaiian Islands is of concern for both ecological and economic reasons.

Derelict fishing gear poses a hazard for many species of marine and terrestrial wildlife. Of particular concern are the critically endangered Hawaiian monk seal and the threatened green sea turtle. For these animals, entanglement in DFG causes severely limited mobility, restricted breathing, and often death. In addition to DFG, other types of debris are also hazardous to marine life. Many terrestrial and avian species mistakenly ingest small fragments of plastic created by the breakdown of larger masses of debris pieces, an act that often proves fatal for these animals.

The debris that accumulates in Hawai`i threatens more than seals, turtles, and birds. DFG often becomes tangled on the coral reefs that surround our islands. Under the influence of wave ac-

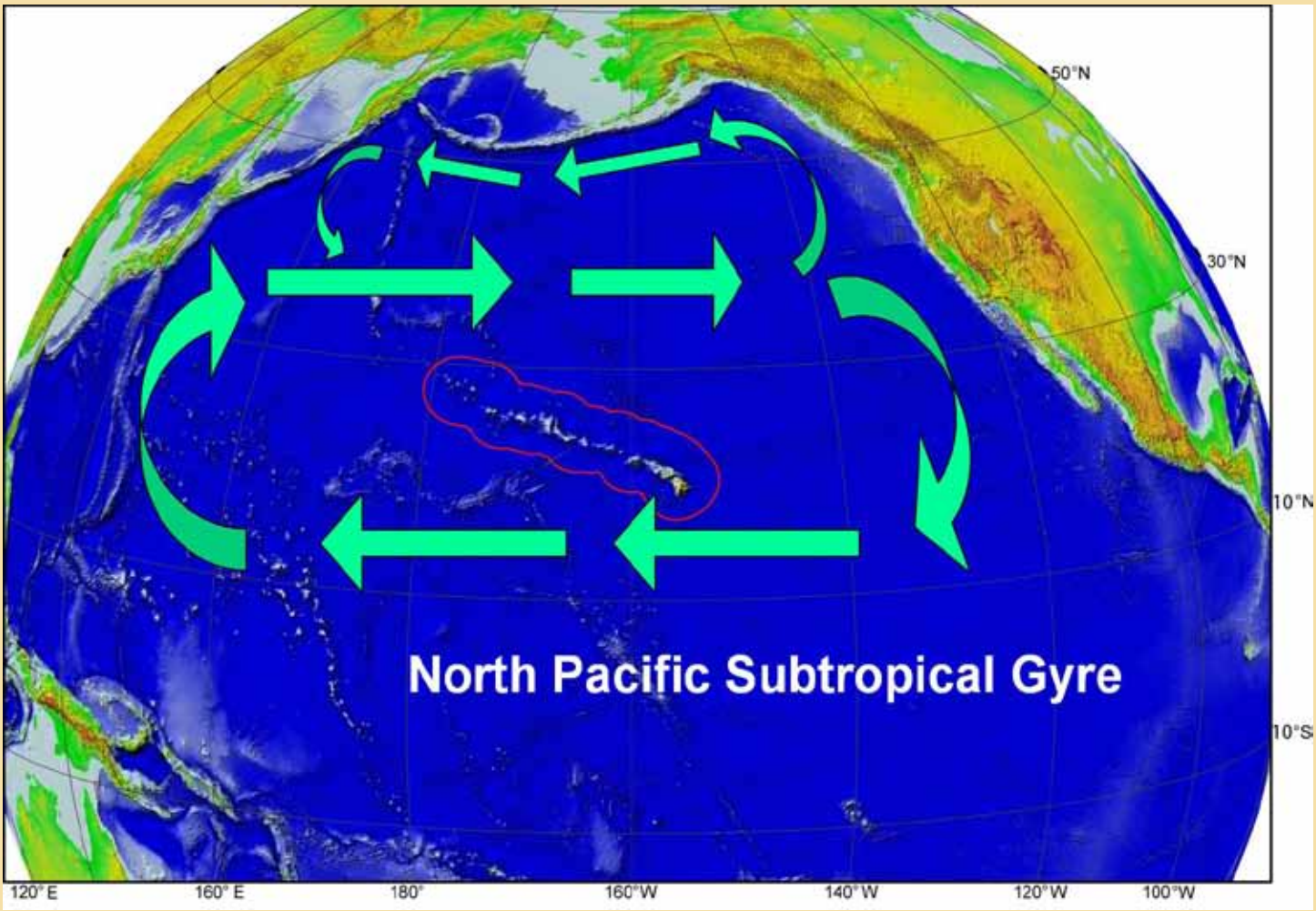
tion, tides, and currents, tangled debris damages reef structures by killing corals and destroying important habitats. Furthermore, floating debris can foul boat propellers, causing damage and potential economic loss and posing potential risks to human safety. Debris that washes up on beaches and shorelines in Hawai`i is an unsightly deterrent to recreation and tourism as well as a pollution problem.

Marine invertebrate biofouling has been observed on net debris in the Northwestern Hawaiian Islands (NWHI). Most species seen on DFG have been common species indigenous to Hawaii and known to be found in fouling and benthic communities. The majority of these organisms likely took up residence or recruited to nets after arrival in the NWHI. However, taxonomic analysis of organisms collected from DFG removed from the NWHI, performed by Scott Godwin of the Hawaii Institute of Marine Biology, resulted in the identification of at least 3 non-native species, 2 of which were new records for the NWHI.

The highly isolated ecosystems in Hawai`i are particularly vulnerable to the potentially devastating effects of alien species. Floating DFG acts as a transportation ecosystem that can carry numerous marine species from small algae to larval fish. Originating anywhere in the Pacific, debris may drift thousands of miles before ending up on one of Hawai`i's beaches or reefs, depositing its cargo of alien species. Once an alien species is introduced, it might reproduce, establish itself, and compete with native species. Some alien species become so invasive that the native species can no longer effectively compete and begin to decline. The presence of invasive species can radically change the ecology of local benthic habitats.

Green sea turtle found entangled at Pearl and Hermes Atoll.

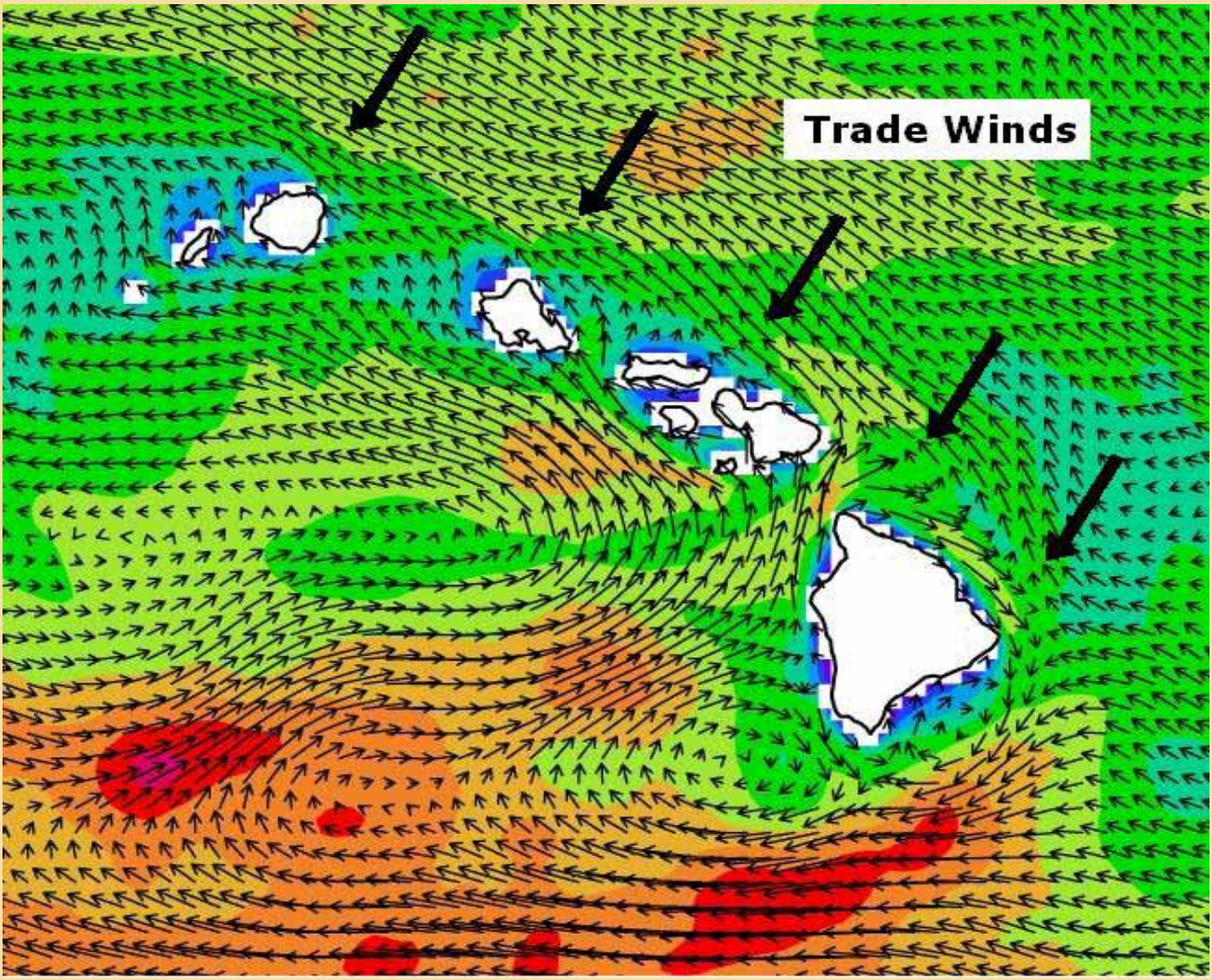
Currents of the Pacific



Current diagram of the Pacific Ocean illustrating the North Pacific Subtropical Gyre.

Marine debris is transported to Hawai`i from its many points of origin by ocean currents. The North Pacific Subtropical Gyre is a massive circular ocean current system encompassing much of the North Pacific Ocean. It is located between 8° N latitude and 50° N latitude and covers an area of approximately 10 million square miles (34 million km^2). The North Pacific Subtropical Gyre flows in a clockwise pattern and is composed of these prevailing ocean currents: the southern flowing California Current, the western flowing North Equatorial Current, the northward flowing Kuroshio Current, and the eastward flowing Kuroshio Extension Current and North Pacific Current.

Marine debris aggregates in a region of the North Pacific Subtropical Gyre known as the "Pacific Garbage Patch." The Hawaiian Archipelago, consisting of the MHI and NWHI, is situated southwest of the center of this gyre. The de-



Hybrid Coordinate Ocean Model (HYCOM) developed in partnership with the International Pacific Research Center (IPRC), University of Hawai`i, and NOAA shows the currents around the main Hawaiian Islands.

bris is carried by the wind and currents and deposited onto the shallow reef environments of the various islands, islets, reefs and atolls of Hawai`i.

Winds play a large role in determining where this debris eventually ends up. The earth's rotation allows the wind to drive surface currents toward the center of the gyre, thereby causing an accumulation of floating material. Trade winds blow from a NE to SW direction at speeds of 5–20 knots and account for most of the wind in Hawai`i and remain present in some form throughout the year.

Ocean current models show that a northwesterly current exists on the east side of the entire MHI chain. This current and the trade winds pushing down from the northeast explain why DFG can be found on most windward and east-facing coastlines. On the west side of these islands, we see much more variability in the currents. This high level of variability and the trade winds blowing offshore cause DFG to get blown away from leeward coastlines.

Methods

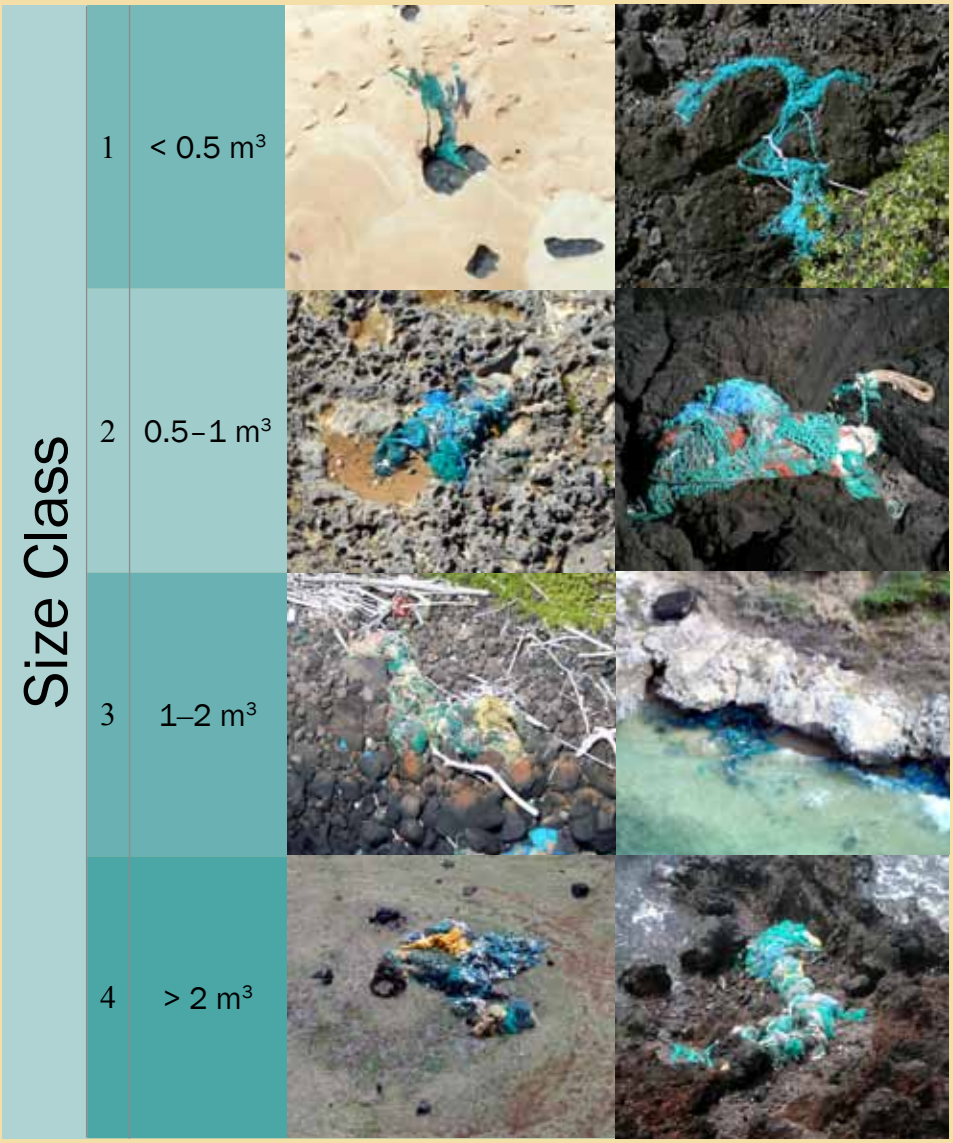
Illustration of the aerial survey methods.

Size Class	Volume m^3	Approximate Weight Range kg (lb)	Personnel Required for Removal	Level of Difficulty for Removal Effort
1	< 0.5	0.5–15 (~1–33)	1	Easy
2	0.5–1	15–30 (~ 33–66)	1–2	Easy–Moderate
3	1–2	30–200 (~ 66–440)	2–3	Moderate–Difficult
4	> 2	200–600	3–5	Very Difficult

Size-class key designed to help better understand the actual size of debris surveyed and the amount of effort it would take to remove it.

Aerial surveys were conducted from a Hughes 500 helicopter flying at speeds of 20–60 knots on a flight path following the shoreline of each island at altitudes of 31–92 m. Two observers were positioned on the right side of the aircraft; the pilot and data recorder remained on the left side. When DFG was observed, its location (a GPS waypoint called a "DFG point") was recorded along with descriptive data about the debris (color, size class, and DFG type).

Four size classes of DFG were developed as a quick means to estimate the amount of DFG observed at each point during the brief time permitted by the moving aircraft. The assigned size class reflects the apparent volume of an observed pile of DFG. This rough classification of size enables a better understanding of the level of DFG accumulation throughout the MHI and allows for efficient planning and delegation of human resources in removal efforts.

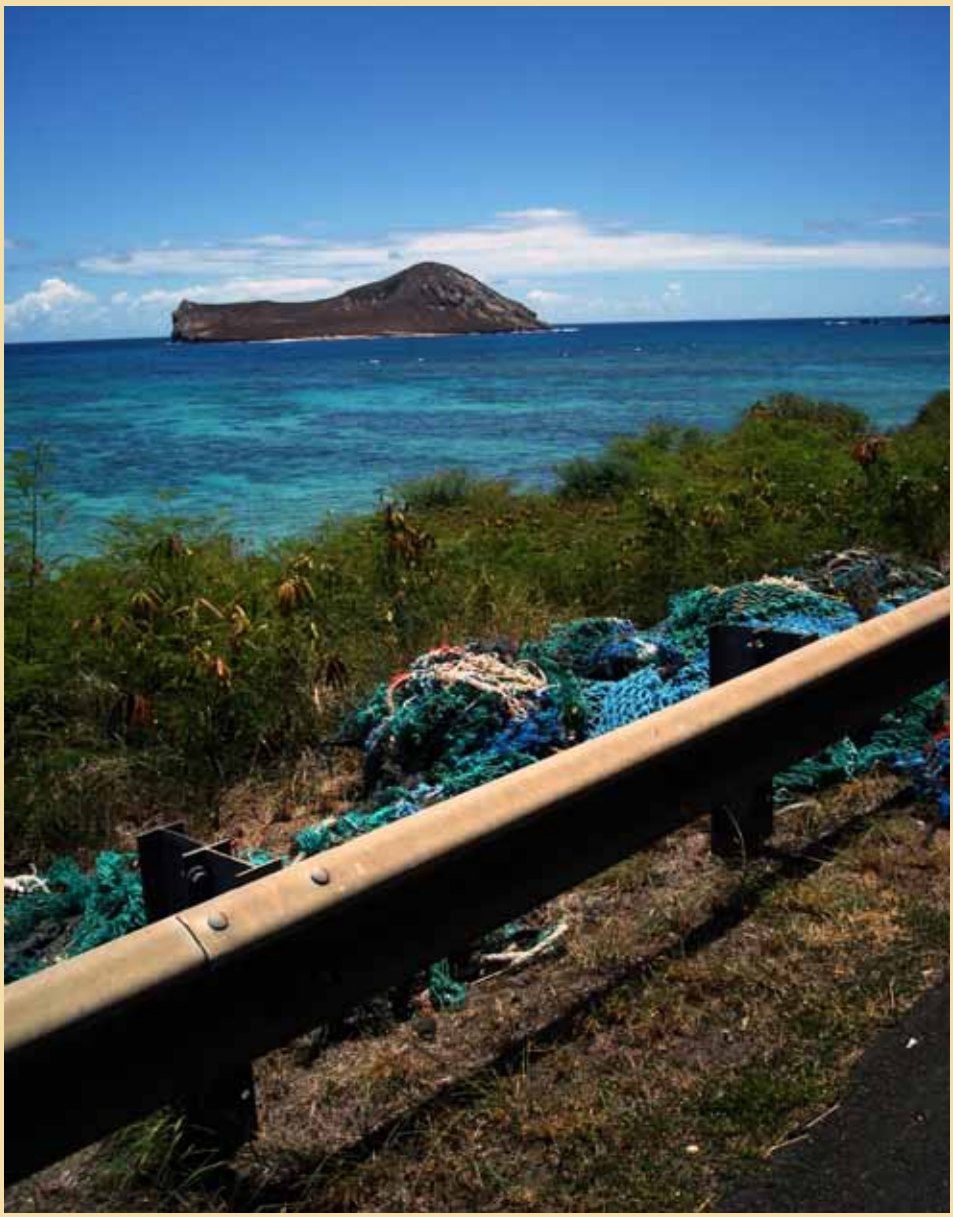


Photographic examples of debris in various size classes. All size classes are an estimation of size.

Results

The 2008 aerial surveys identified 1086 DFG points in the MHI, while the 2006 survey identified 711 DFG points. The difference between the 2 surveys does not necessarily indicate an increased rate of DFG accumulation but likely reflects the more refined flight methods used in 2008. The 2006 surveys were conducted at an altitude of 305 m, whereas the 2008 surveys were conducted at 92 m. This difference in altitude may have allowed for observation of smaller debris points that were overlooked during the 2006 flights. Furthermore, accumulation of DFG that was not removed may have added to the larger amounts of DFG observed in 2008. An additional factor to consider is that the surveys were not conducted during the same time of year; the 2006 survey was conducted in May and the 2008 survey occurred in July and August.

At islands where removal efforts have not taken place, the size classes of DFG recorded during 2008 surveys were often larger than those observed in 2006. Larger size classes of DFG are formed as small amounts of DFG become entangled with each other by wave action, leading to the formation of more massive conglomerations. Results presented in this report are strictly based on NOAA surveys and removal efforts and do not take into consideration efforts by grassroot community groups that were involved with DFG removal between the 2006 and 2008 NOAA surveys.



Debris staged near a roadside awaits pick-up after removal from beaches on the windward coast of O`ahu.

Survey Results for Islands Where NOAA Removal Efforts Have Not Occurred

The following results for the islands of Kaua`i, Maui, Moloka`i, and Hawai`i are based on a 2-year survey interval without any NOAA-funded cleanup effort. The cleanup efforts completed by nongovernmental organizations between surveys are unknown so the results are strictly year-to-year numbers.

Kaua`i

The 2006 aerial survey identified 171 DFG points at Kaua`i, and the 2008 survey recorded 202 points. DFG was found primarily on east-facing shores from Kīlauea Bay to Po`ipū Pt. during both 2006 and 2008 surveys.

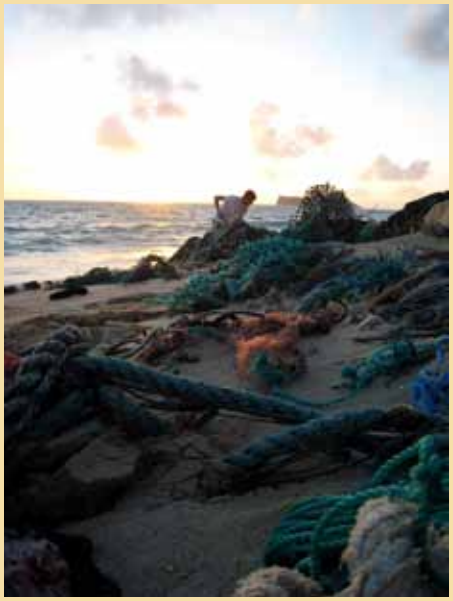
Maui

The 2006 aerial survey identified 89 DFG points at Maui, and the 2008 survey recorded 110 points. DFG was found primarily from Po`elua Bay to Kahului Harbor and from Ka`inalimu Bay to Hōkū`ula during both 2006 and 2008 surveys.

Moloka`i

The 2006 aerial survey identified 75 DFG points at Moloka`i, and the 2008 survey recorded 133 points. DFG was found primarily on the east side from Hālawa Bay to Pauwalu and on the west side from Kawa`aloa to the east dead end of Lee Shore Road during both 2006 and 2008 surveys.

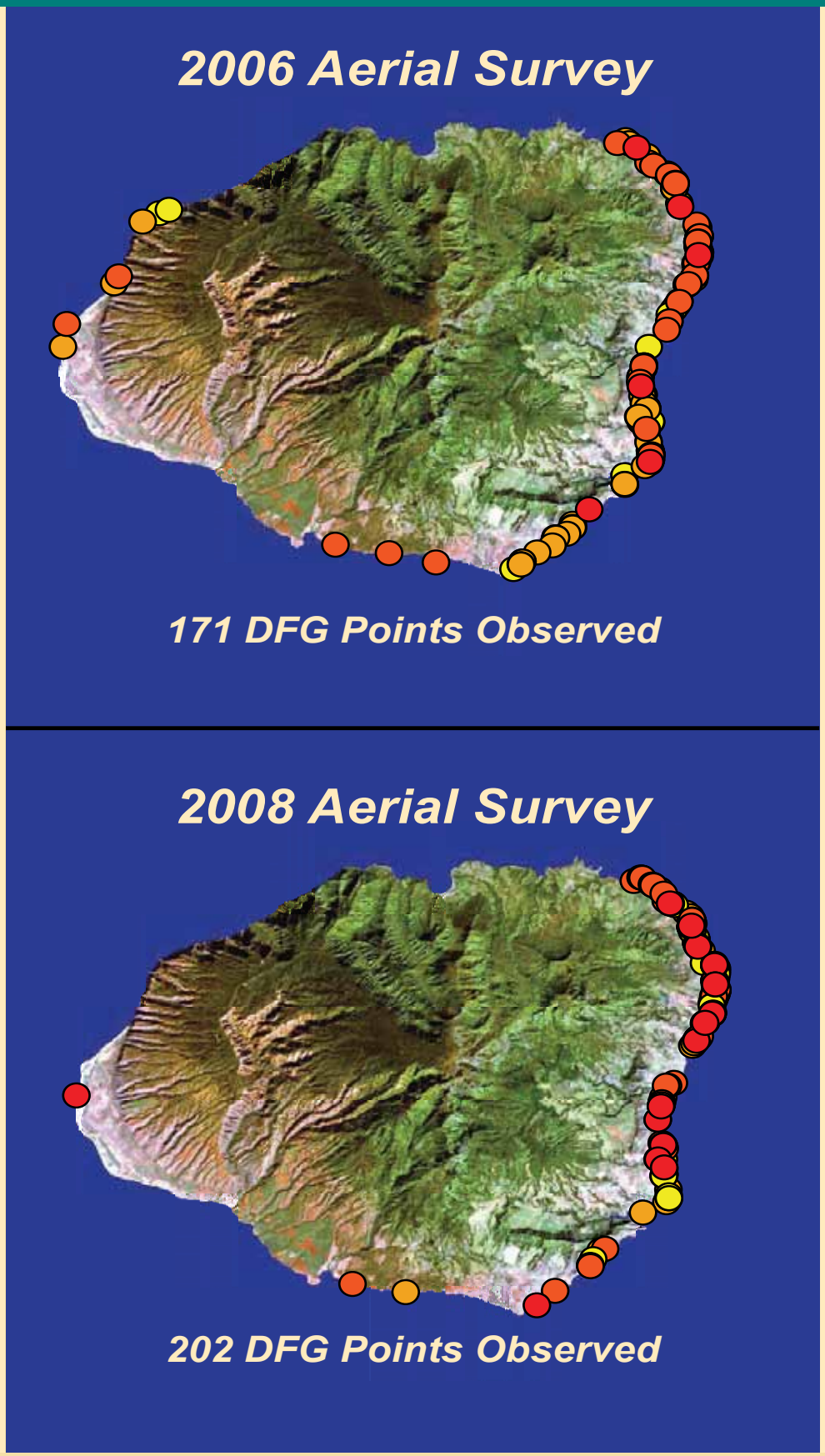
Photo taken from helicopter while conducting aerial surveys.

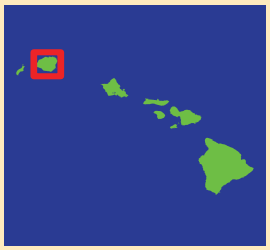


Marine debris found on the windward coast of O`ahu (Debris type—trawl/seine, Size 1).

Hawai`i Island

The 2006 aerial survey identified 78 DFG points at Hawai`i Island, and the 2008 survey recorded 246 points. DFG was found primarily on the east-facing shores of South Pt. and from Kona Airport to Waimanu Bay during both 2006 and 2008 surveys.





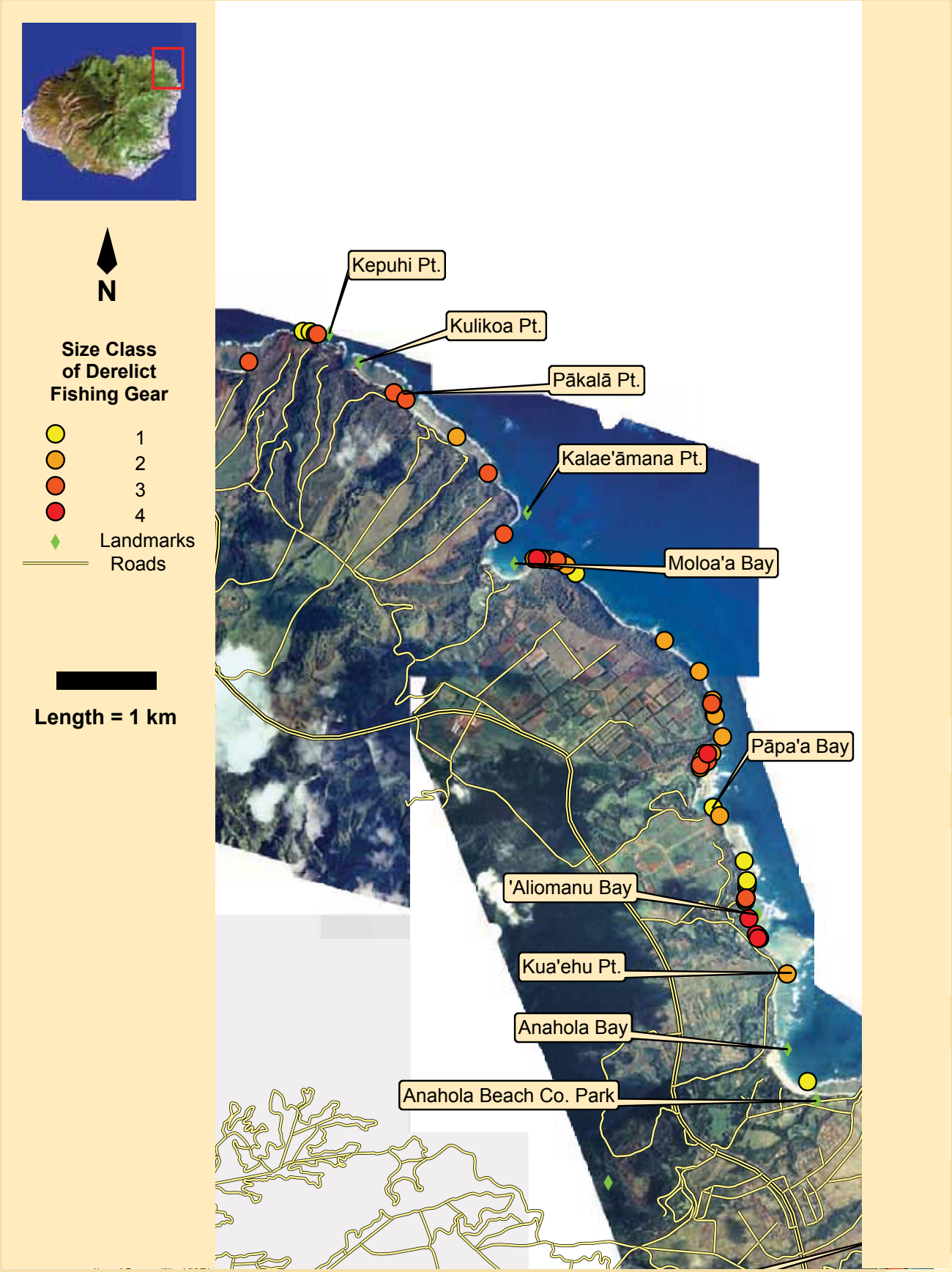
N

Size Class of Derelict Fishing Gear

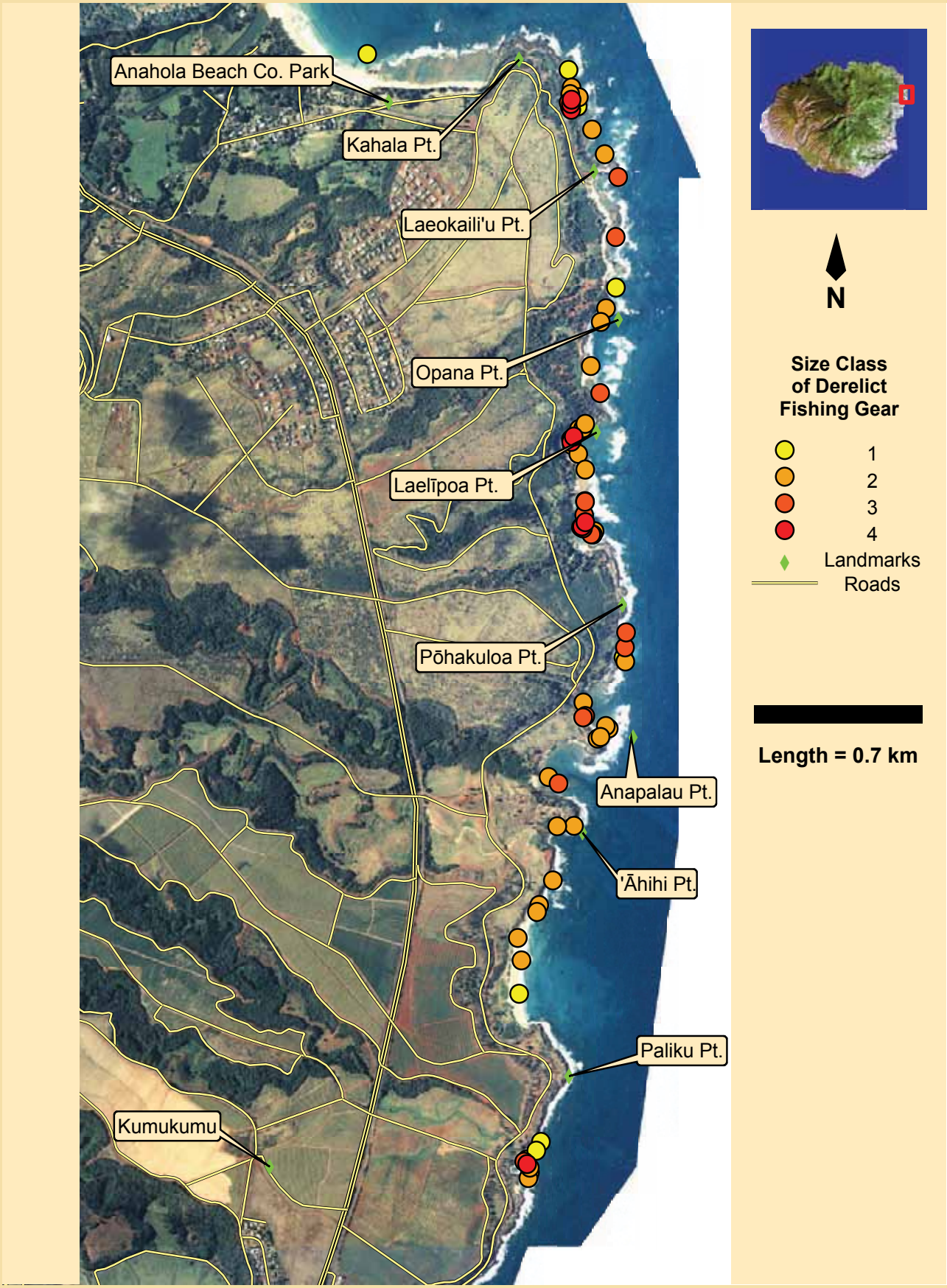
1
2
3
4

Length = 10 km

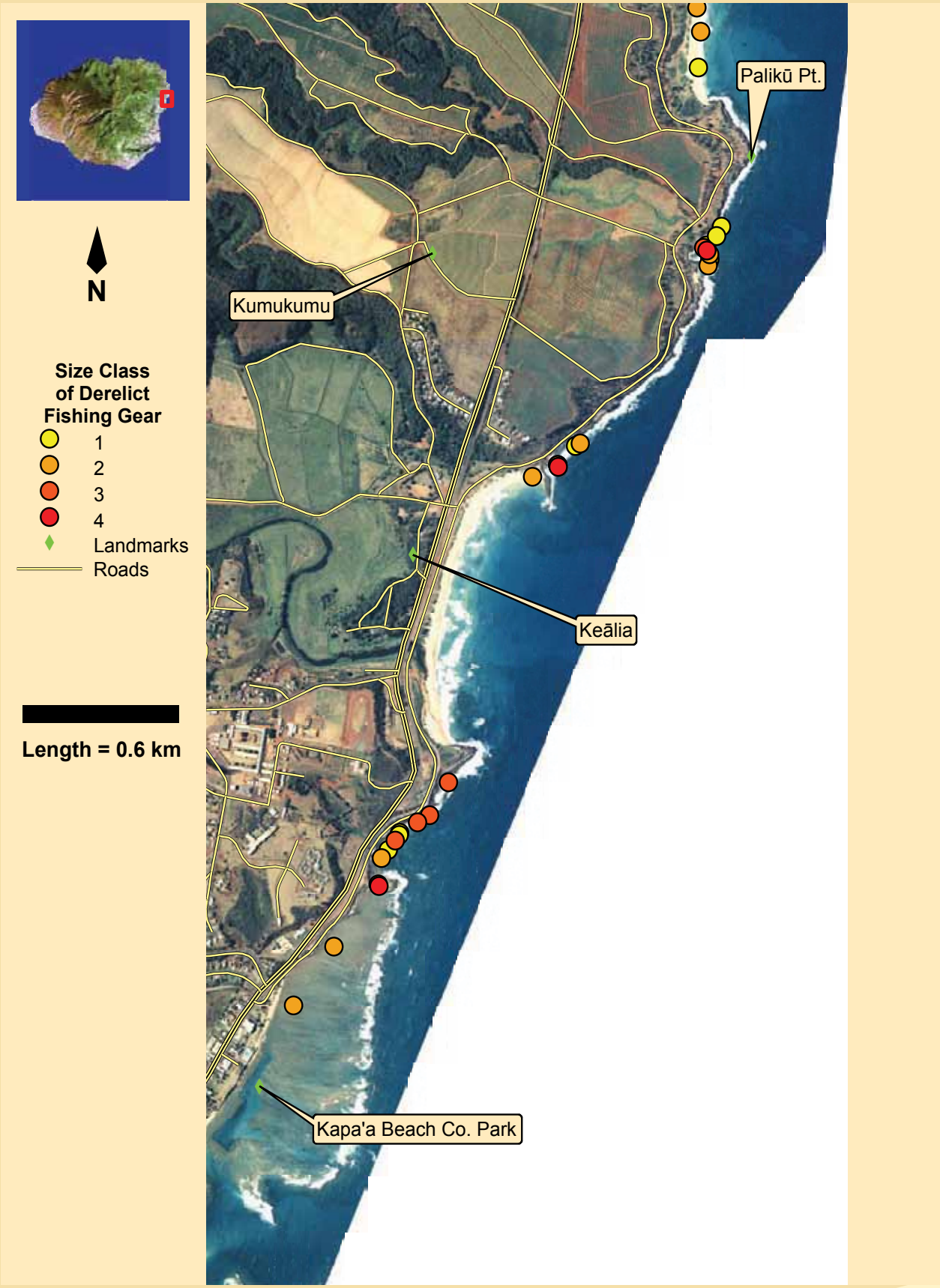
Kaua`i—Results from the 2006 and 2008 aerial surveys for derelict fishing gear (DFG).



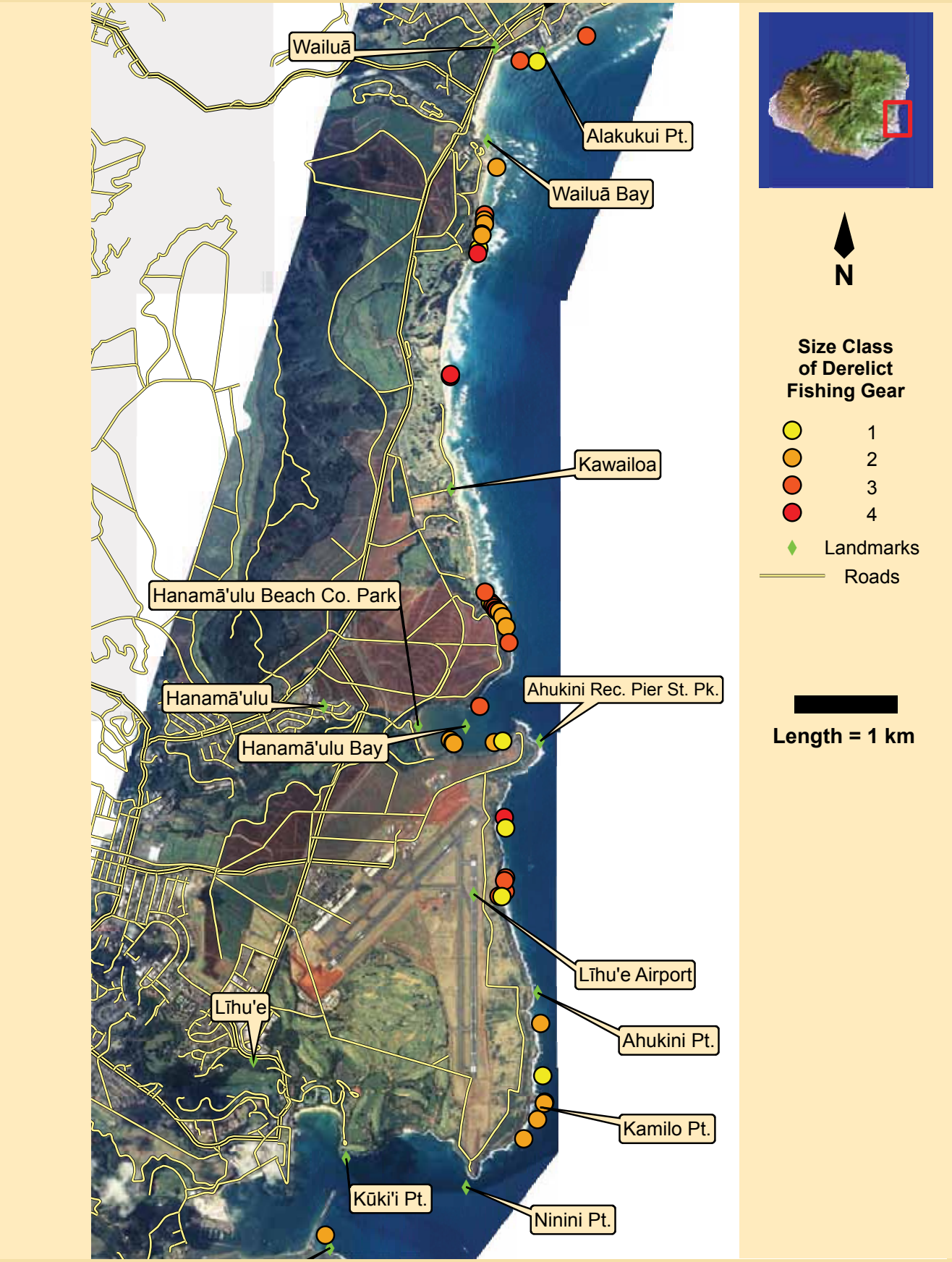
Kaua`i, Region 1—Regions of high-density DFG accumulation observed during the 2008 aerial surveys.



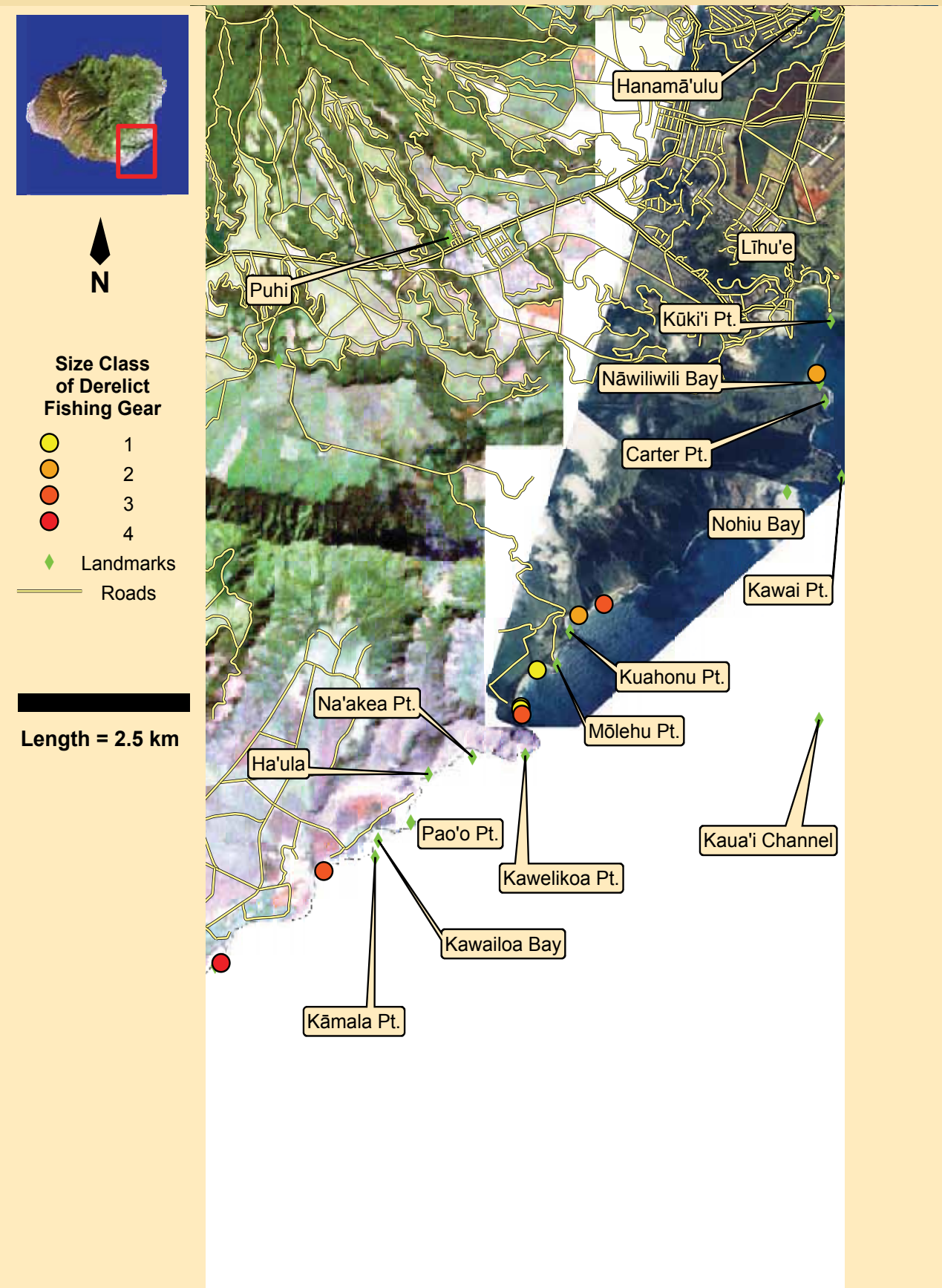
Kaua`i, Region 2—Regions of high-density DFG accumulation observed during the 2008 aerial surveys.



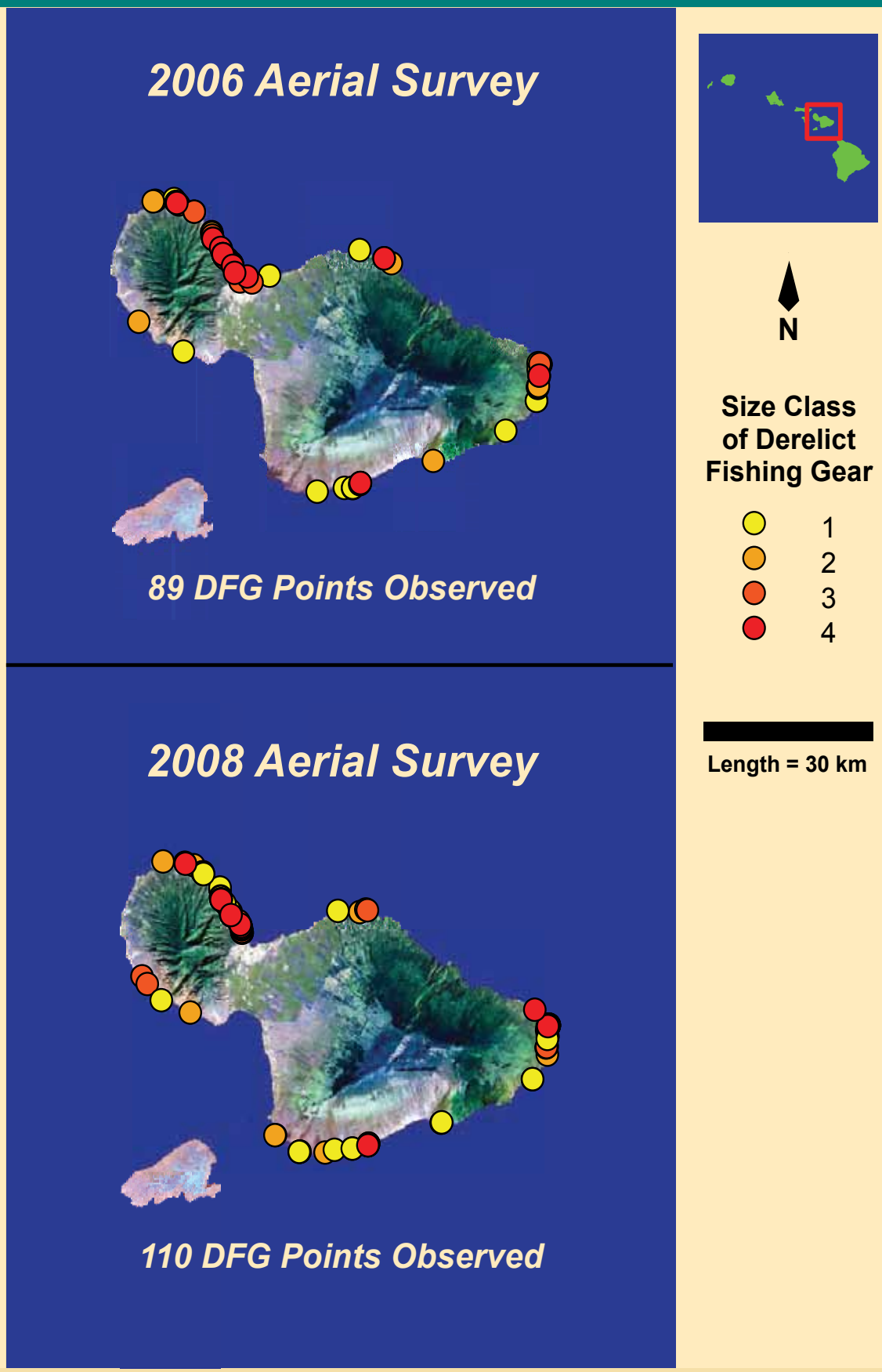
Kaua`i, Region 3—Regions of high-density DFG accumulation observed during the 2008 aerial surveys.



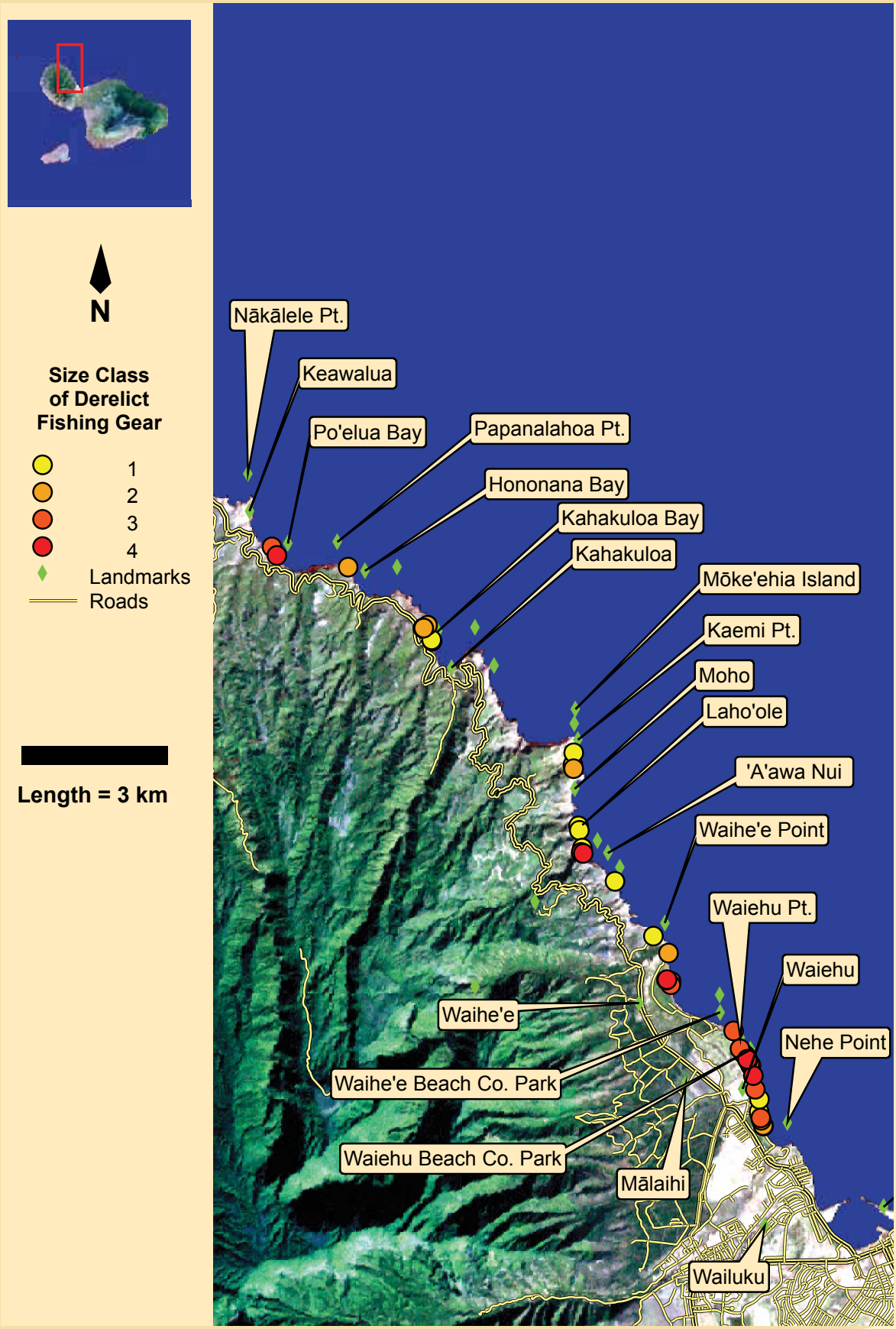
Kaua`i, Region 4—Regions of high-density DFG accumulation observed during the 2008 aerial surveys.



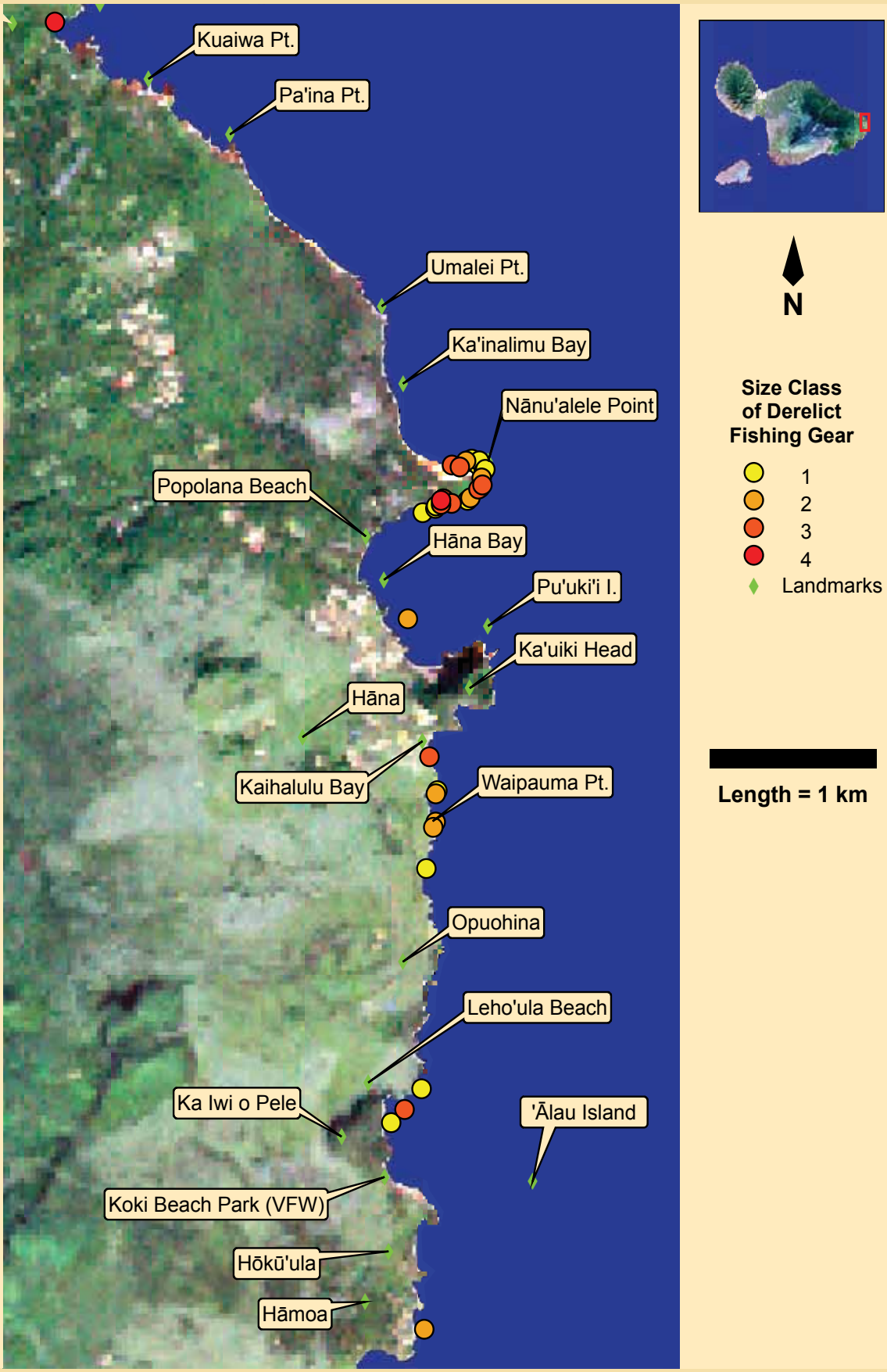
Kaua`i, Region 5—Regions of high-density DFG accumulation observed during the 2008 aerial surveys.



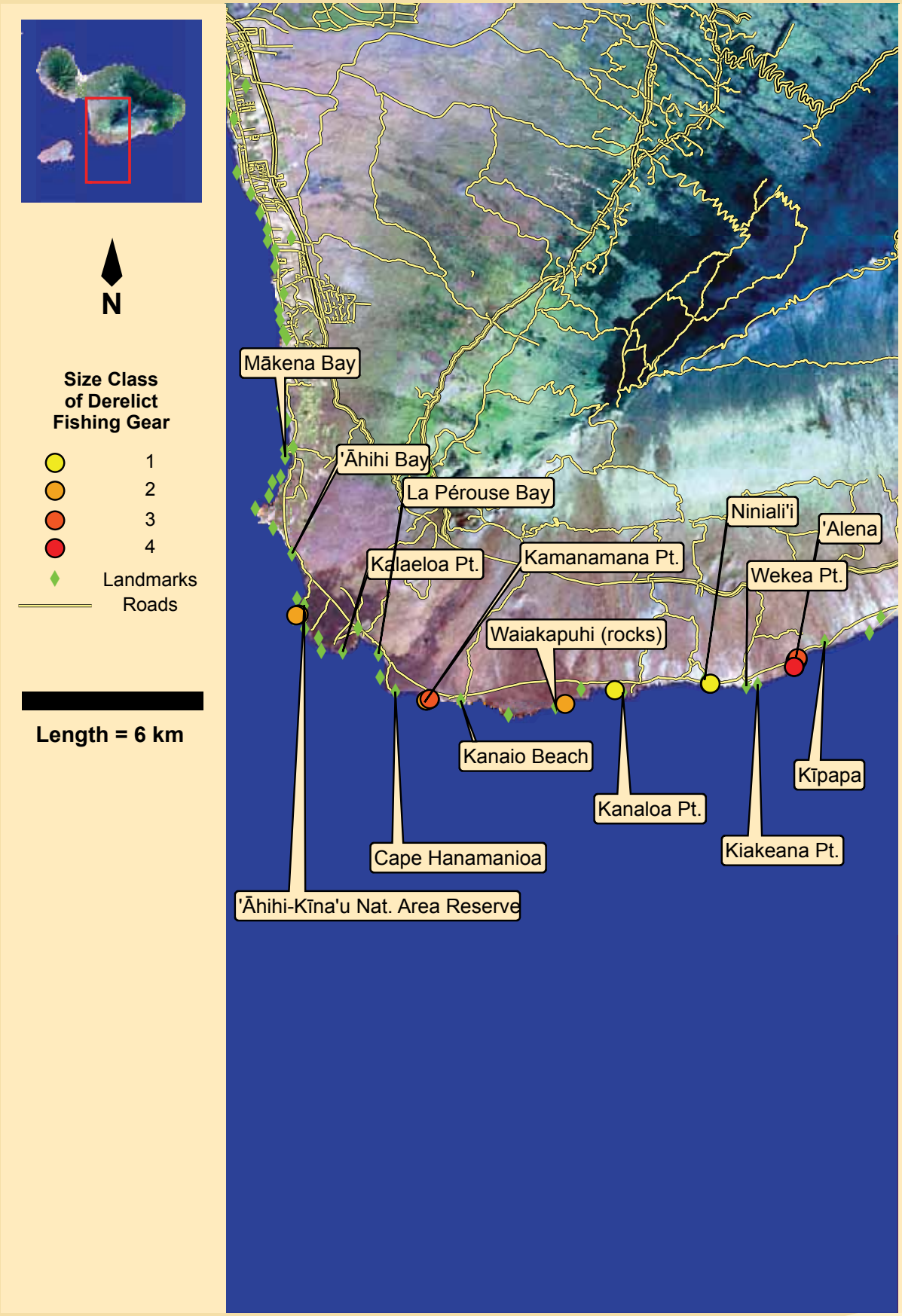
Maui—Results from the 2006 and 2008 aerial surveys for DFG.



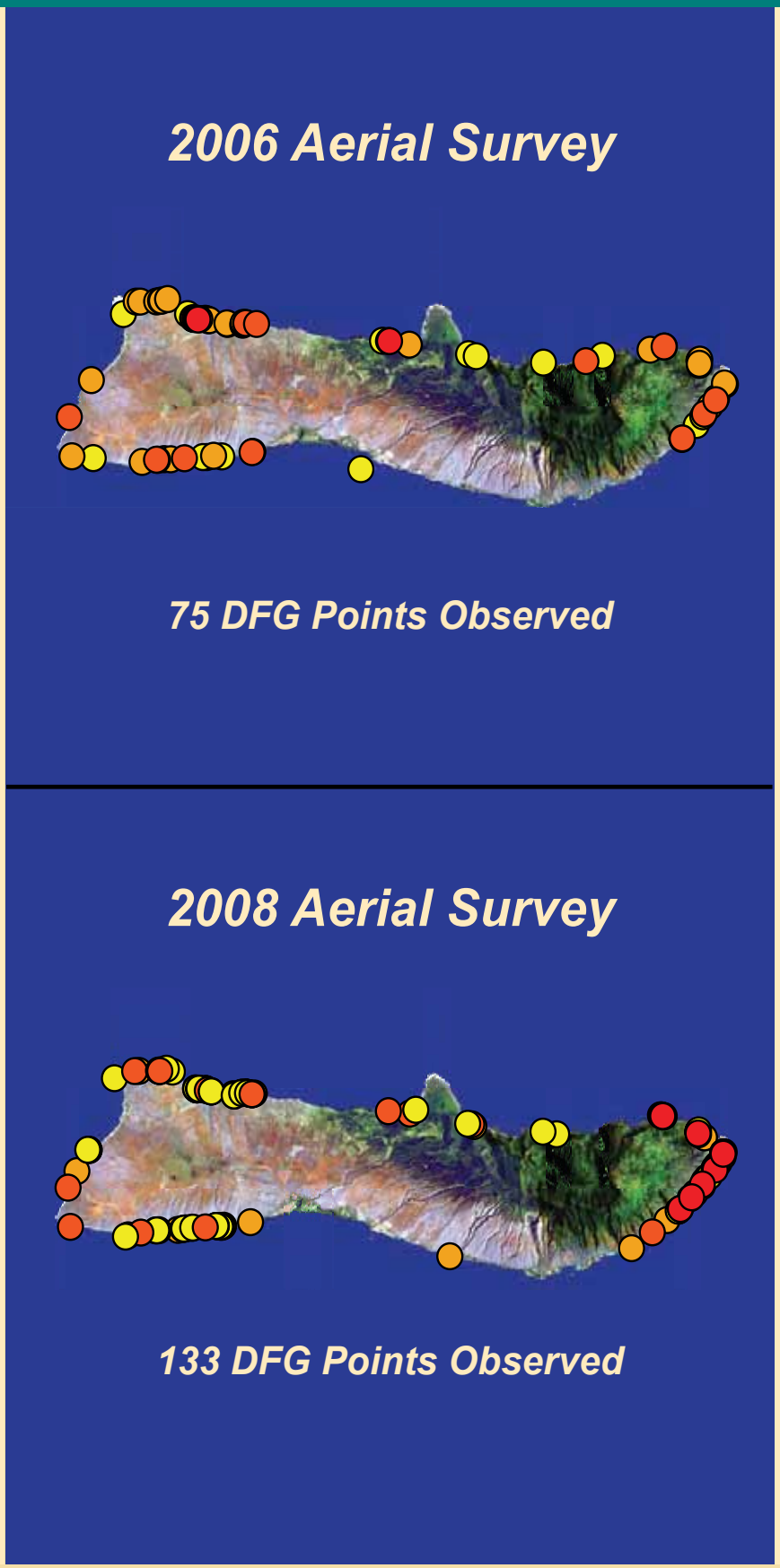
Maui, Region 1—Regions of high-density DFG accumulation observed during the 2008 aerial surveys.



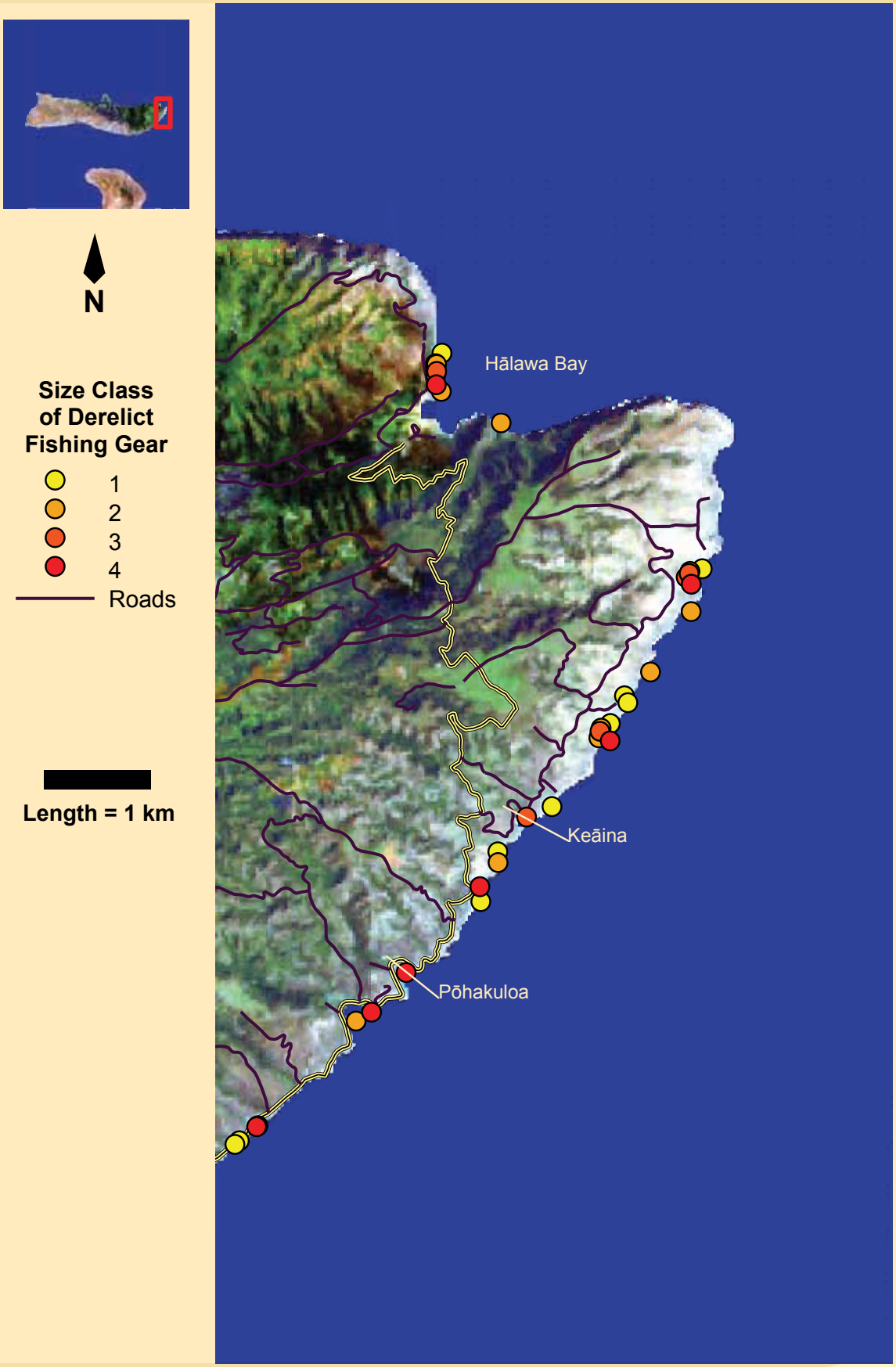
Maui, Region 2—Regions of high-density DFG accumulation observed during the 2008 aerial surveys.



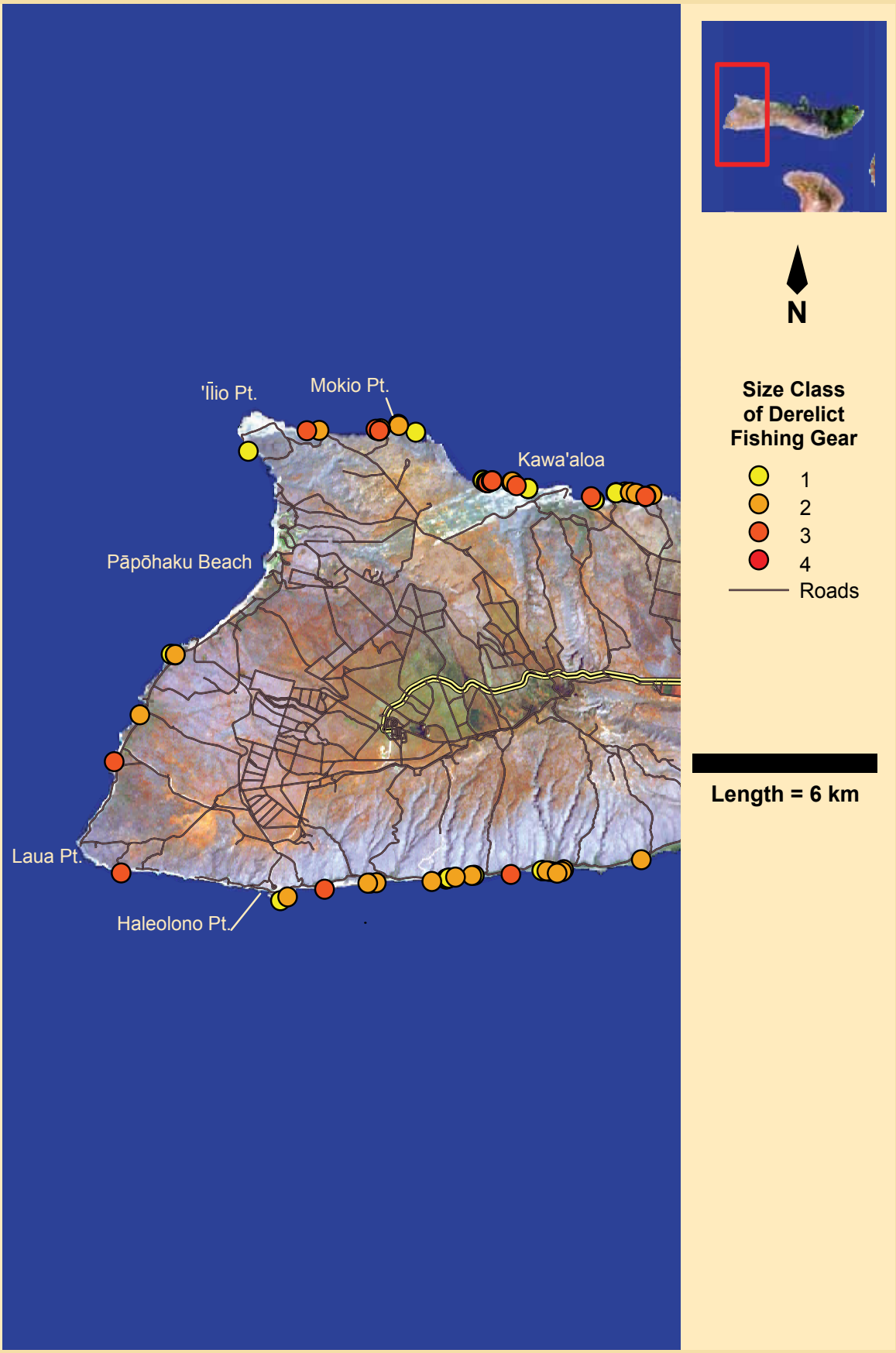
Maui, Region 3—Regions of high-density DFG accumulation observed during the 2008 aerial surveys.



Moloka`i—Results from the 2006 and 2008 aerial surveys for DFG.

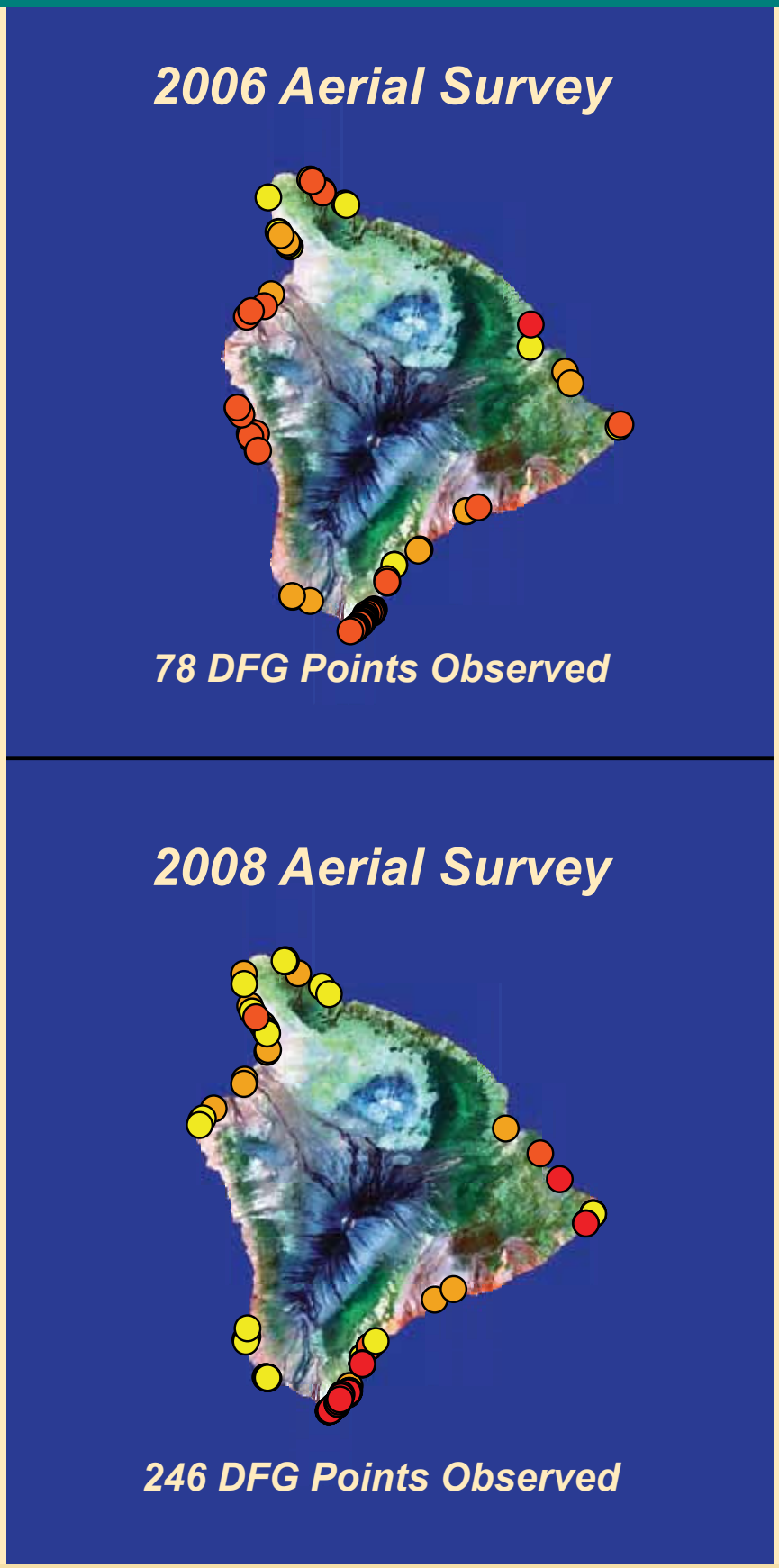


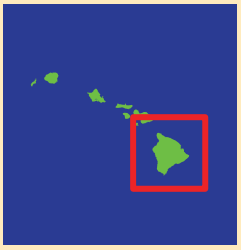
Moloka`i, Region 1—Regions of high-density DFG accumulation observed during the 2008 aerial surveys.



Moloka`i, Region 2—Regions of high-density DFG accumulation observed during the 2008 aerial surveys.

Photos from survey and O`ahu removal effort: (a) Debris on Big Island (Debris type—trawl/seine, Size 1); (b) Survey of Maui; (c) Survey of Kaua`i; (d) Debris on Big Island (Debris type— trawl/seine, Size 1); (e) and (f) Cleanup of O`ahu's Kahuku coast (Debris type—trawl/seine, Size 2).





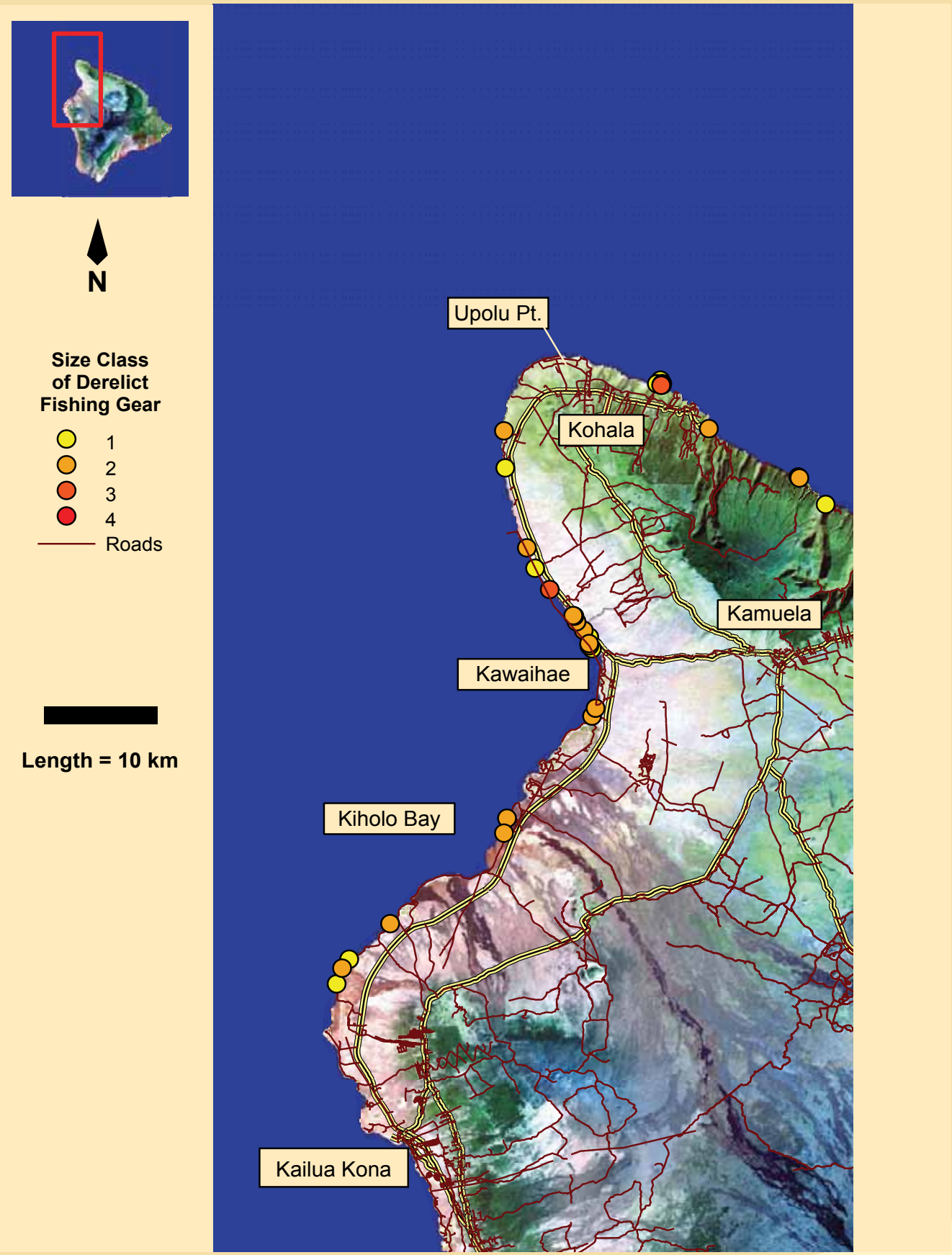
N

Size Class of Derelict Fishing Gear

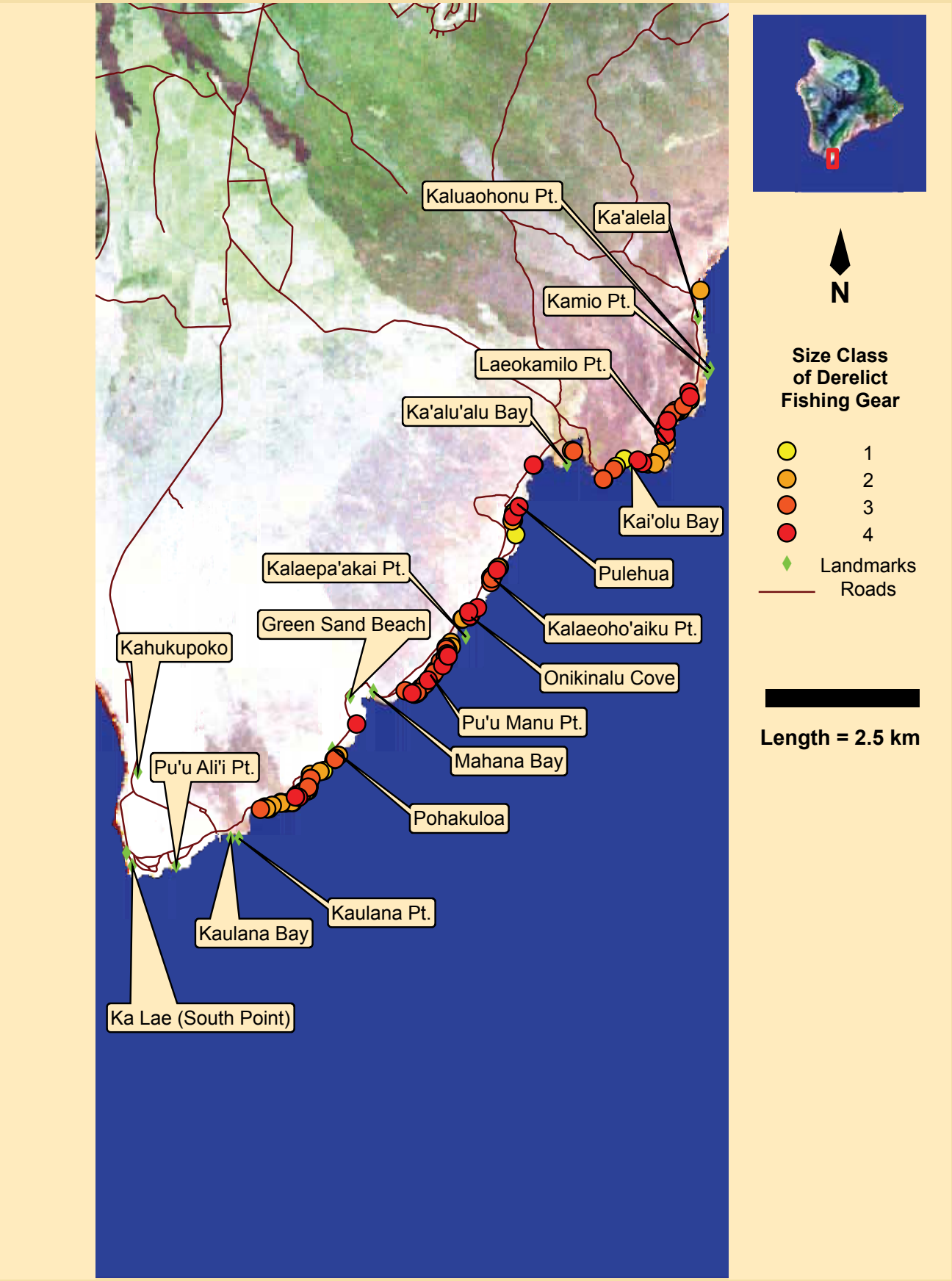
1
2
3
4

Length = 60 km

Hawai`i Island—Results from the 2006 and 2008 aerial surveys for DFG.



Hawai`i Island—Regions of high-density DFG accumulation observed during the 2008 aerial surveys.



Hawai`i Island—Regions of high-density DFG accumulation observed during the 2008 aerial surveys.

Survey Results for Islands Where NOAA Removal Efforts Have Occurred

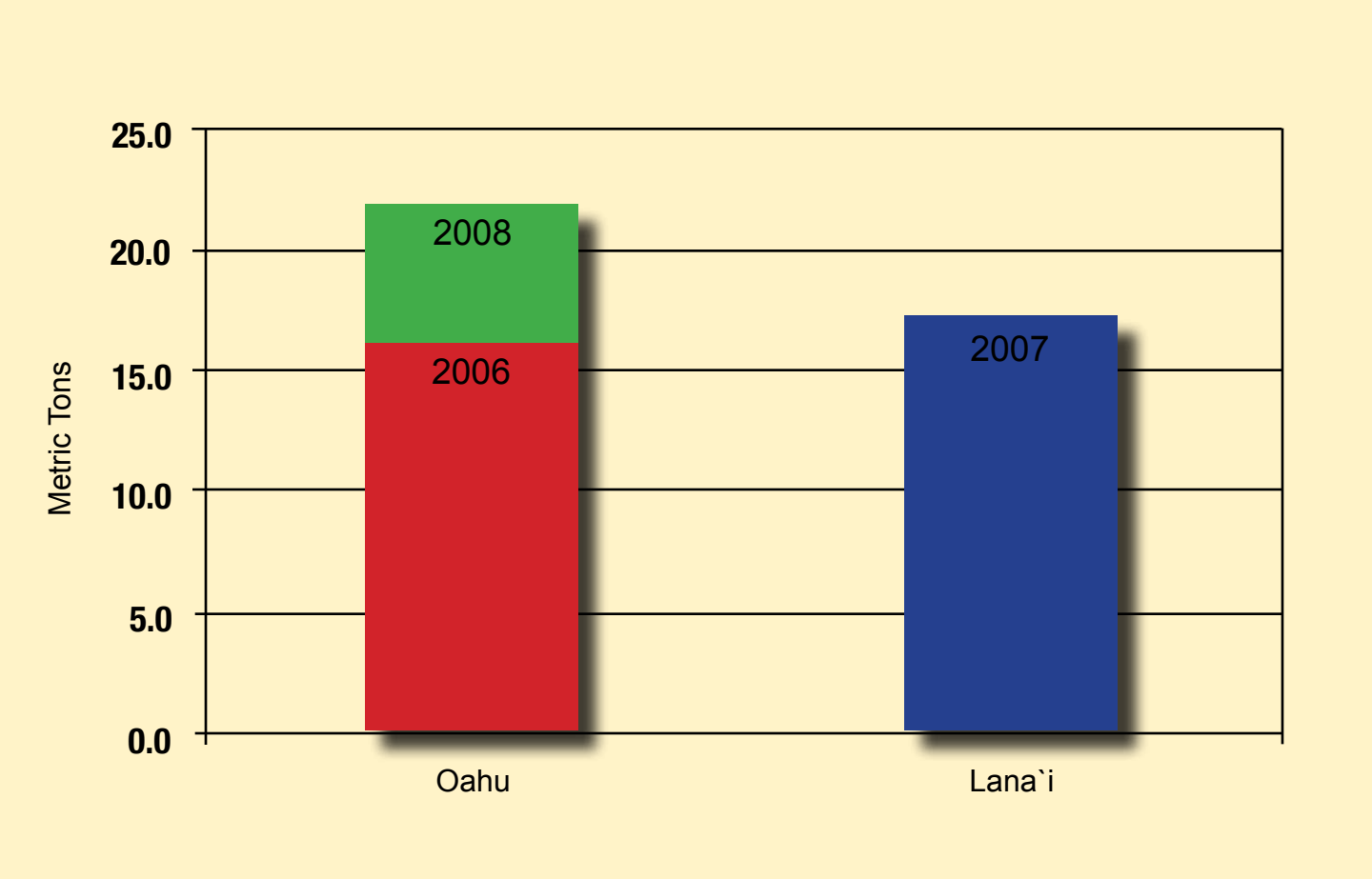
The following results are for O`ahu and Lana`i. A NOAA-funded cleanup occurred at these islands between surveys, allowing for a better understanding of debris accumulation on these islands.

O`ahu

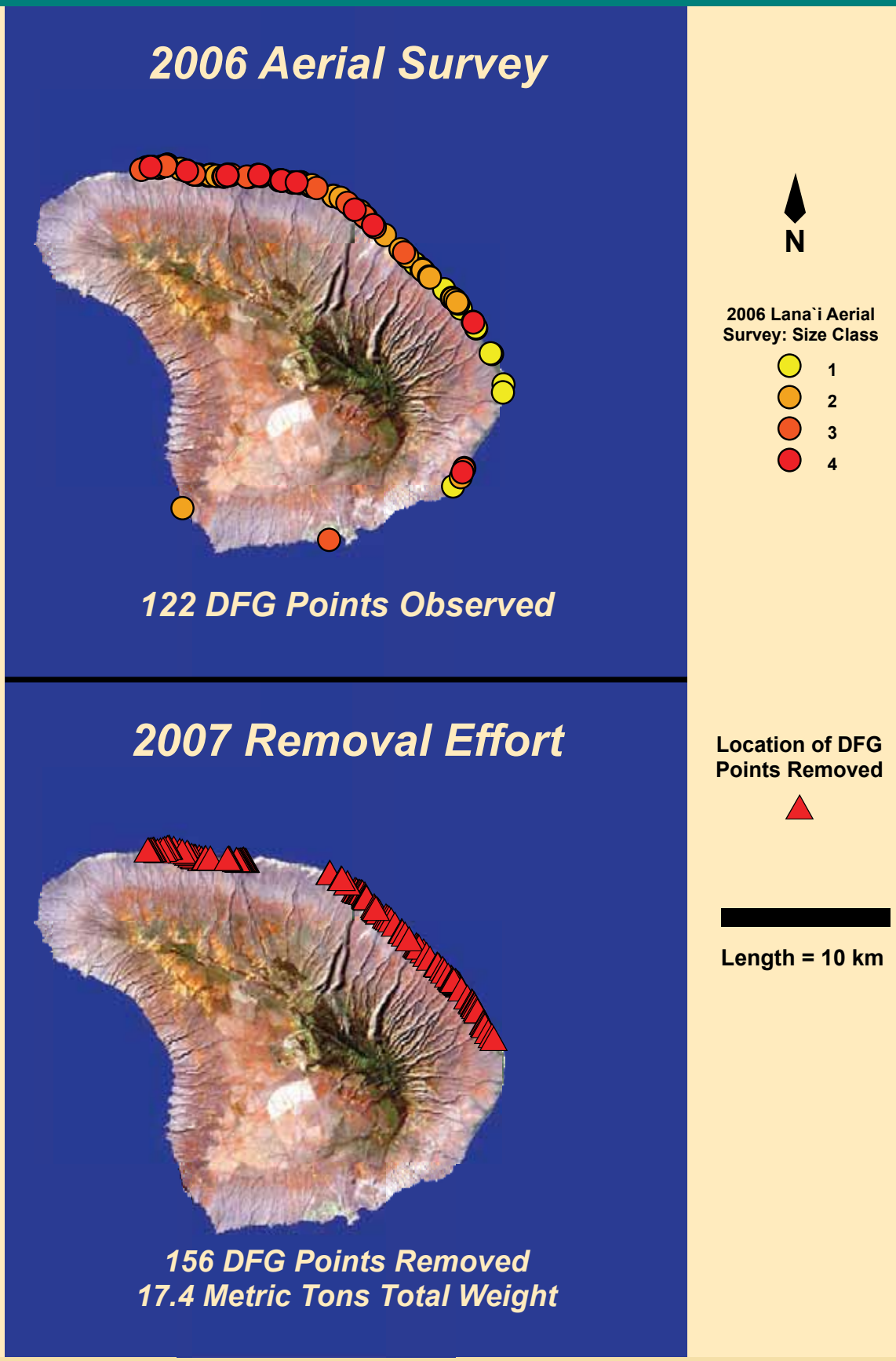
The 2006 aerial survey identified 176 DFG points at Oahu, and the 2008 survey recorded 104 points. DFG was found primarily on east-facing shores from Kīlauea Bay to Po`ipū Pt. during both 2006 and 2008 surveys.

Lana`i

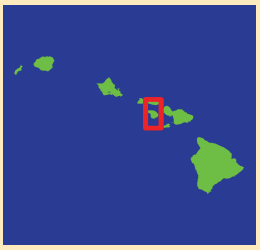
The 2006 aerial survey identified 122 DFG points at Lana`i, and the 2008 survey recorded 291 points. DFG was found primarily on east-facing shores from Kīlauea Bay to Po`ipū Pt. during both 2006 and 2008 surveys.



DFG removed from O`ahu and Lana`i during the 2006 and 2008 aerial surveys.



Lana`i—Observations from the 2006 aerial survey and locations of the DFG removed in the 2007 cleanup.



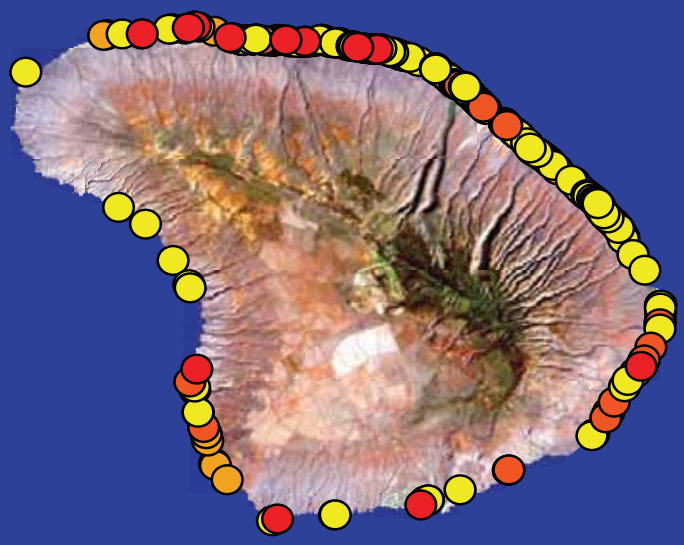
N

Size Class of Derelict Fishing Gear

1
2
3
4

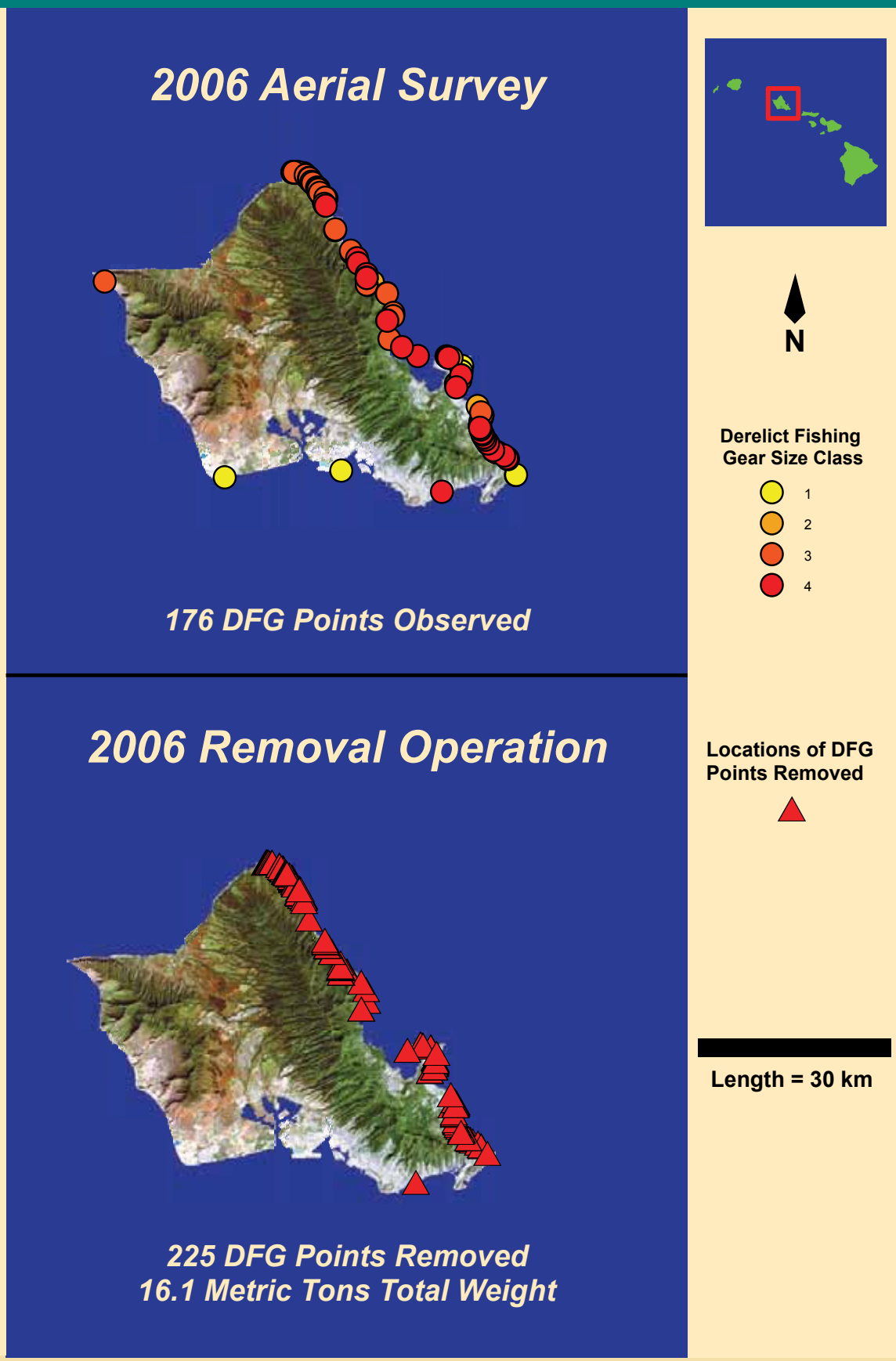
Length = 10 km

2008 Aerial Survey

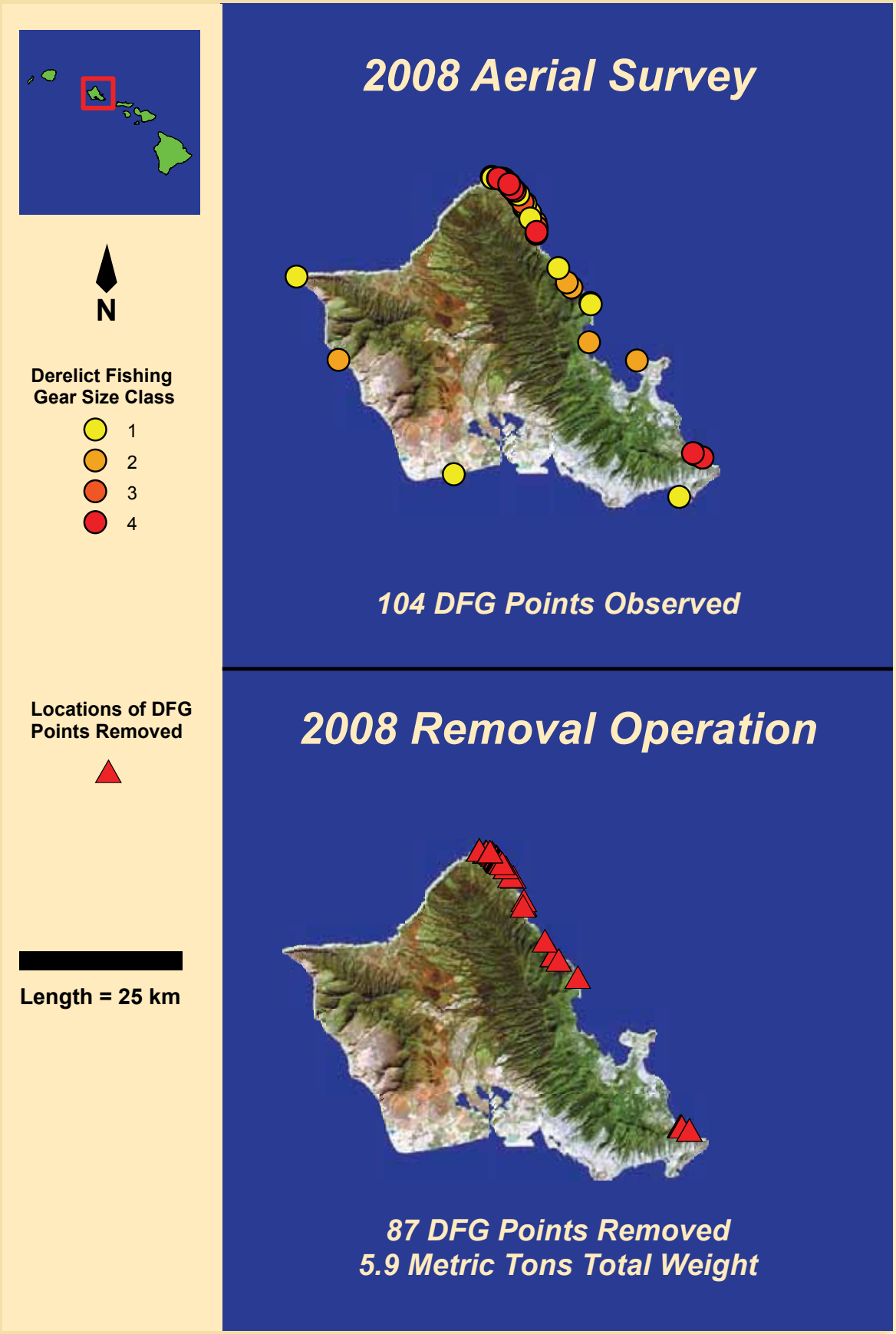


291 DFG Points Observed

Lana`i—Results from the 2008 aerial survey for DFG.



O`ahu—Observations from the 2006 aerial survey and locations of the DFG removed during the 2006 cleanup.



O`ahu—Observations from the 2008 aerial survey and locations of DFG removed during the 2008 cleanup.

Conclusion

Resurveying DFG in the MHI enabled us to better understand the magnitude of the DFG problem and the dynamics of DFG. The general geographic location of DFG remained consistent between the 2006 and 2008 surveys. The majority of DFG was found on the windward sides of the islands, with higher concentrations on east-facing shorelines. By identifying areas with high probability for DFG and comparing them with known haul-out areas for the Hawaiian monk seal and other protected species, we can establish High Entanglement Risk Zones for the MHI. By ensuring that these locations remain clear of DFG, we can reduce the chances of entanglement of a protected species and improve their chances for recovery.

O`ahu windward coast scattered with DFG (Debris type—trawl/seine, Size 4).

Marine debris removal efforts in the MHI began in 2006 with a pilot cleanup project through which 225 DFG points, weighing 16 metric tons, were removed from the coastline of O`ahu. Then, in 2007, 156 DFG points were removed from the shoreline of Lana`i for a total of 17.4 metric tons. In 2008, 87 DFG points, or 5.9 metric tons of debris, were removed from the coastline of O`ahu.

The goal of this booklet is to raise public awareness of the problem of derelict fishing gear in the main Hawaiian Islands and provide information about DFG locations. By raising awareness, it is our hope that community groups will continue to help remove derelict fishing gear from the shores and beaches of Hawai`i to preserve the flora and fauna of our beautiful state.

Pristine Kaua`i coastline with no marine debris.

2008 O`ahu Removal Effort

Photos showing DFG removal effort: (a) Debris team unloads a truck of debris after removal from the coastline; (b) Debris team removed debris lodged into the rocks on the windward coast (Debris type—Trawl/seine, Size 4); (c) and (d) Before and after pictures of a net buried by surf and sand. It took this 4-person team 8 hours to excavate this area (Debris type—trawl/seine, Size 4).

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