SUMMARY

Pilot investigation of the origins and pathways of marine debris found in the northern Australian marine environment

Introduction

Every year hundreds of lost or abandoned fishing nets are found along parts of the northern Australian coastline, especially areas of the Gulf of Carpentaria. To find out where these derelict nets come from, and the paths they may drift to reach the coast, a pilot project was commissioned.

The project involved the use of a computer model and floating satellite transmitters to predict the likely pathways of these derelict nets in waters north and east of Australia.

The pilot project found that derelict nets entering the Gulf of Carpentaria could originate in the South Pacific and Coral Sea (off Australia's east coast), before being blown through the Torres Strait during the dry season by the south-east trade winds.

This document provides a non-technical summary of the full technical report of the pilot project undertaken by Dr David Griffin (CSIRO, Centre for Australian Weather and Climate Research), entitled 'Pilot investigation of the origins and pathways of marine debris found in the northern Australian marine environment' http://www.environment.gov.au/coasts/publications/index.html).

Project background

Marine debris is a growing global problem that many nations are trying to address. Fishing nets that have been lost accidentally or deliberately abandoned at sea are a particularly concerning component of this marine debris, because of the navigational hazards they pose and the number of marine creatures that they harm and kill as they drift through the oceans with the currents and tides.

Derelict nets are found in large numbers on parts of Australia's northern shores and particularly within the Gulf of Carpentaria (Figure 1). The direction of the winds and ocean currents at different times of the year influences where and when these derelict nets wash ashore. On the eastern side of the Gulf (Cape York) the derelict nets arrive with the north-west monsoon winds of the wet season (generally November to March) and the easterly-flowing surface water currents. On the western shores of the Gulf (Arnhem Land), derelict nets arrive with the south-east trade winds of the dry season (generally May and September), when surface currents flow west or west-south-west.

Studies undertaken by a number of groups in northern Australia have concluded that many of the derelict nets washed up in the Gulf of Carpentaria are likely to be from south-east Asian fisheries. One study author (White 2003) hypothesised that the combined influence of the north-west monsoon winds and the Indonesian Throughflow (a series of currents that transport water between the Pacific and Indian oceans via the Indonesian Archipelago) drag derelict nets through Asian waters, before pushing them into the Gulf of Carpentaria, where they eventually strand along some beaches.

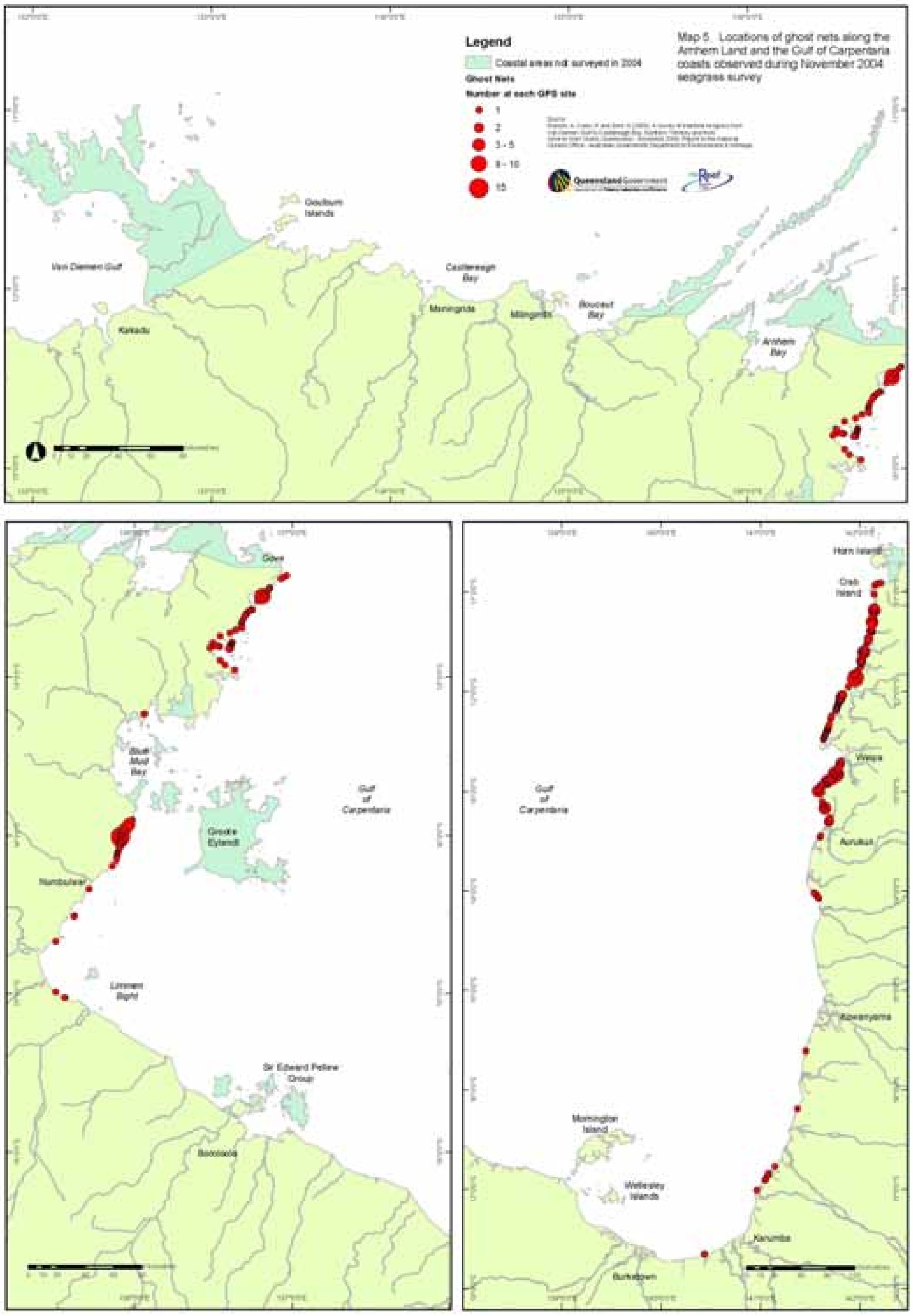

Figure 1: Derelict nets recorded during a helicopter seagrass survey around the Gulf of Carpentaria, Northern Australia (Roelofs *et al.* 2005). Reproduced with permission from A. Roelofs, Queensland Department of Primary Industries and Fisheries.

To test this hypothesis a pilot project was commissioned by the Department of the Environment, Water, Heritage and the Arts and undertaken by the Centre for Australian Weather and Climate Research (a CSIRO and Bureau of Meteorology collaboration).

The pilot project used two methods for predicting pathways of derelict nets with currents and winds in different seasons:

- 920 drifting buoys containing satellite transmitters that allow them to be tracked as they drift across the oceans. These ‘satellite drifters’ consist of a 30-40 cm diameter surface buoy holding sensor and communication electronics, and a 12 m-long wire connected to a 6 m-long sea-anchor that ensures the drifter moves with the water, rather than the wind (Figure 2).
- A computer model that can simulate global ocean currents and winds to predict the pathways of derelict nets as they drift throughout Asia-Pacific and Australian waters.

Figure 2: Satellite drifters consist of a floating buoy holding sensor and communication electronics, connected to a sea-anchor. (Reproduced from http://www.aoml.noaa.gov/phod/dac/gdp_drifter.html)

The geographic study area of the pilot project was large enough to allow the possibility of finding pathways to the Gulf of Carpentaria from nearly as far away as Taiwan (Figure 3).

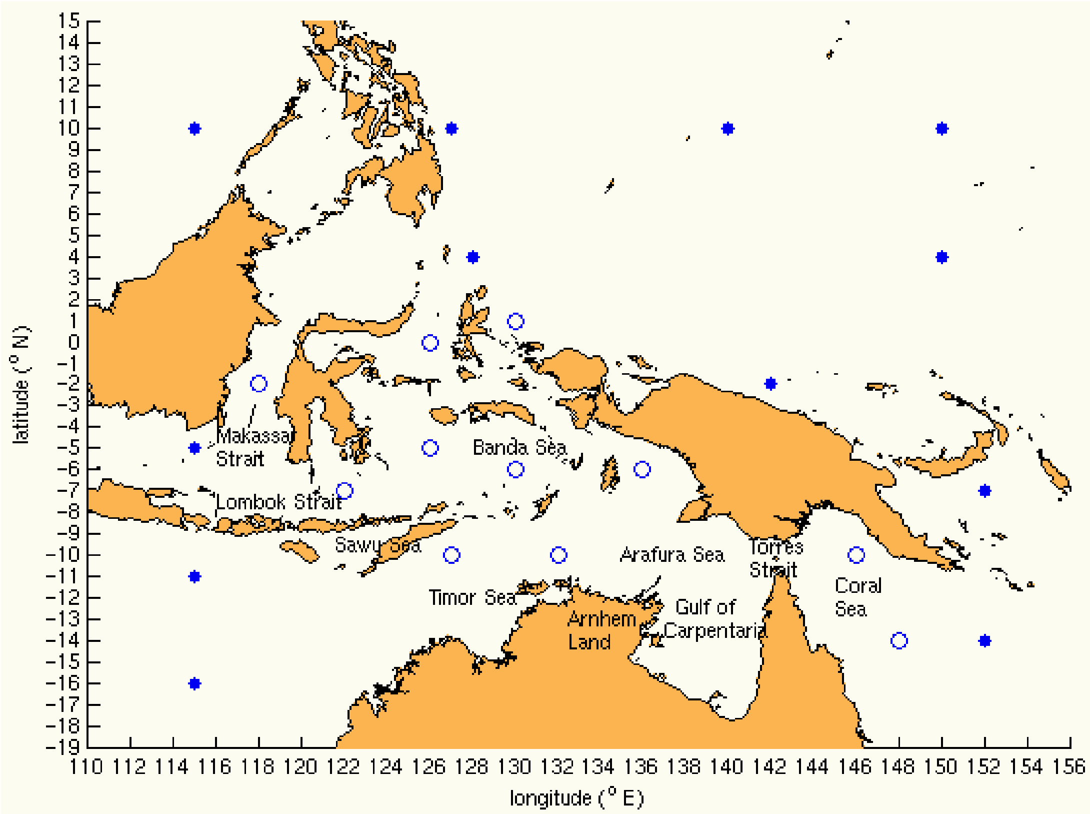

Figure 1: Map of study region showing geographic names and the 'Far Field' (solid circles) and Near Field (open circles) subsets of points where virtual drifters were released in the model.

Project findings

Only five of the 920 satellite drifters recorded in the project region travelled to the Arafura Sea (north of the Gulf of Carpentaria). Three of these satellite drifters were deployed in the Coral Sea, before passing through Torres Strait during the dry season, and drifting west. Two of them immediately stranded on the Papua New Guinea Coast, while the third stranded on the island of Palau Jamdena, directly north of the Northern Territory, 72 days after moving through the Strait (Figure 4).

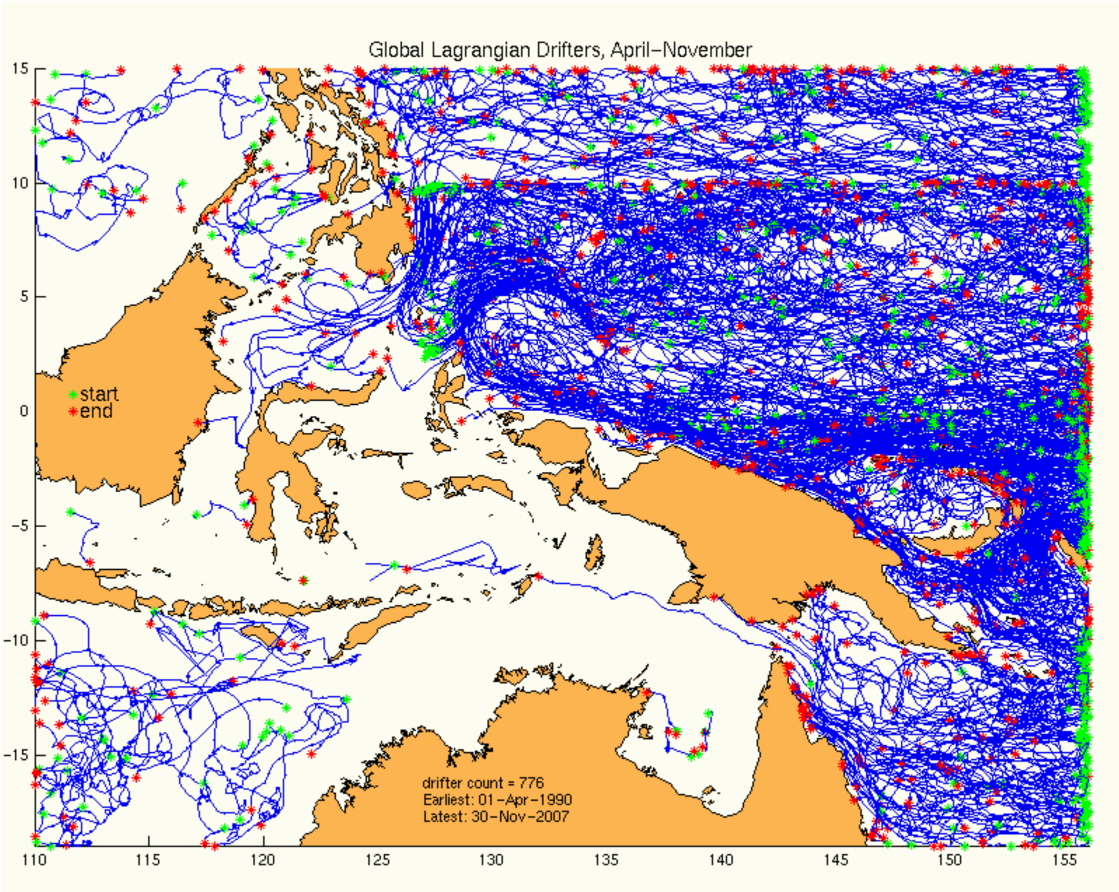

Figure 4: Tracks of satellite drifters during the dry season (April-November) for 1990-2007. Start and end points of track segments are shown in green and red, respectively. Note that three drifters moved from the Coral Sea through the Torres Strait. Two stranded on the Papua New Guinea coast and the third moved west to the island of Palau Jamdena, directly north of the Northern Territory.

The other two satellite drifters travelled from the northern Indian Ocean during the wet season into the northern Arafura Sea, where their tracks ended (Figure 5).

Five satellite drifters that were released in the Gulf of Carpentaria were tracked and found to stay in the Gulf of Carpentaria. Otherwise there were no satellite drifters that were tracked through the Indonesian Archipelago to Australian waters.

These results are very interesting because they do not support the idea that nets originating from south-east Asian waters travel through the Indonesian Archipelago into Australian waters. However, the absence of drifters completing a passage through the Indonesian Archipelago does not prove that derelict nets do not travel this way. This is because satellite drifters may be salvaged by mariners in the region, or removed from circulation for other reasons. It is also possible that satellite drifters, with their 18 m-long sea anchors, may become snagged, preventing them traversing the islands and reef systems bordering the Gulf of Carpentaria.

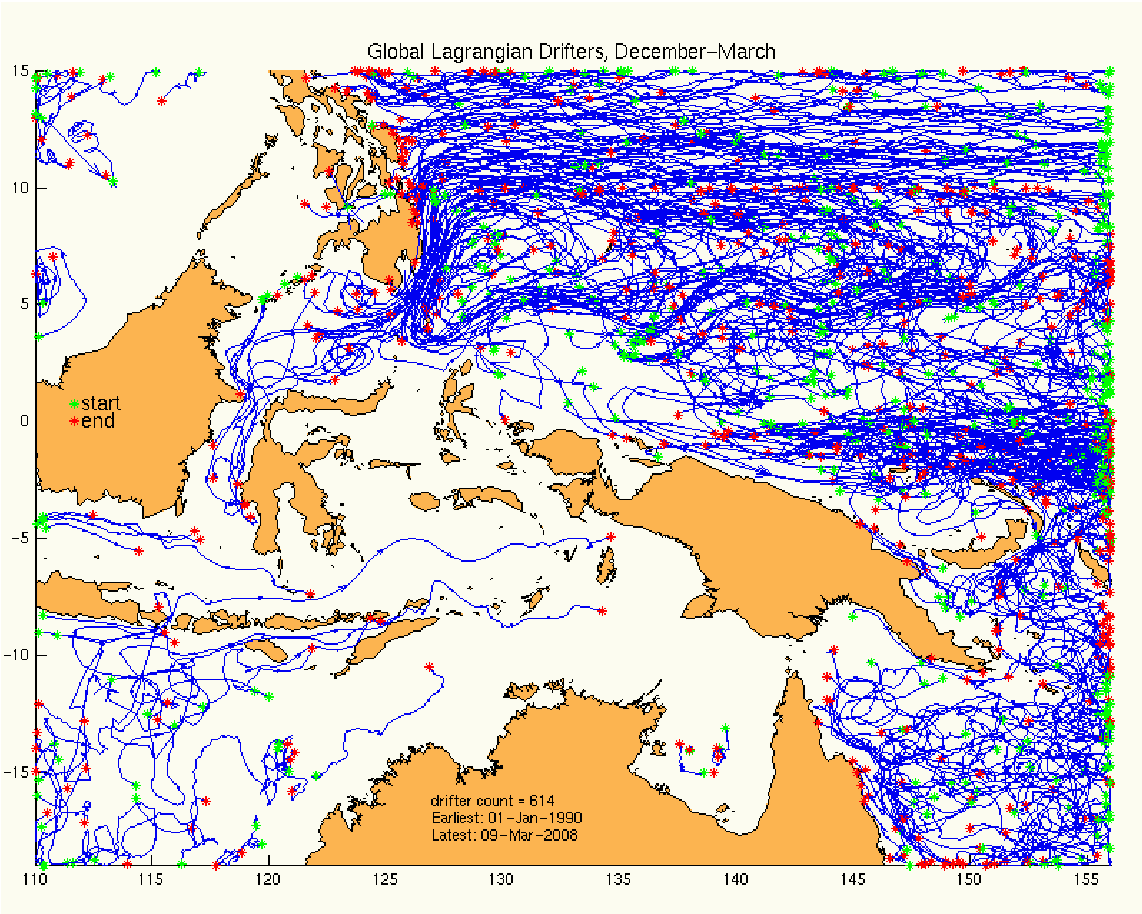

Figure 5: Tracks of satellite drifters during the wet season (December-March). Start and end points of track segments are shown in green and red, respectively. Note that two drifters have entered the Arafura Sea from the northern Indian Ocean.

The second method used in the pilot project – the computer model that simulates the movement of drifting items – involved a programme that used wind patterns and ocean currents to predict the movement of 'virtual' derelict nets within the study region over a two year period.

This computer model showed that even when the 'virtual' derelict nets were tracked through the Indonesian Archipelago, very few entered the Gulf of Carpentaria. Those that did enter the Gulf of Carpentaria originated close to the Australian coastline, either in the northern Arafura Sea (Figure 6) or eastern Banda Sea. These 'virtual' drifting nets that were tracked to the Gulf of Carpentaria also all moved with the wet season currents, and were only a very small proportion of all the 'virtual' pathways of derelict nets predicted by the computer model.

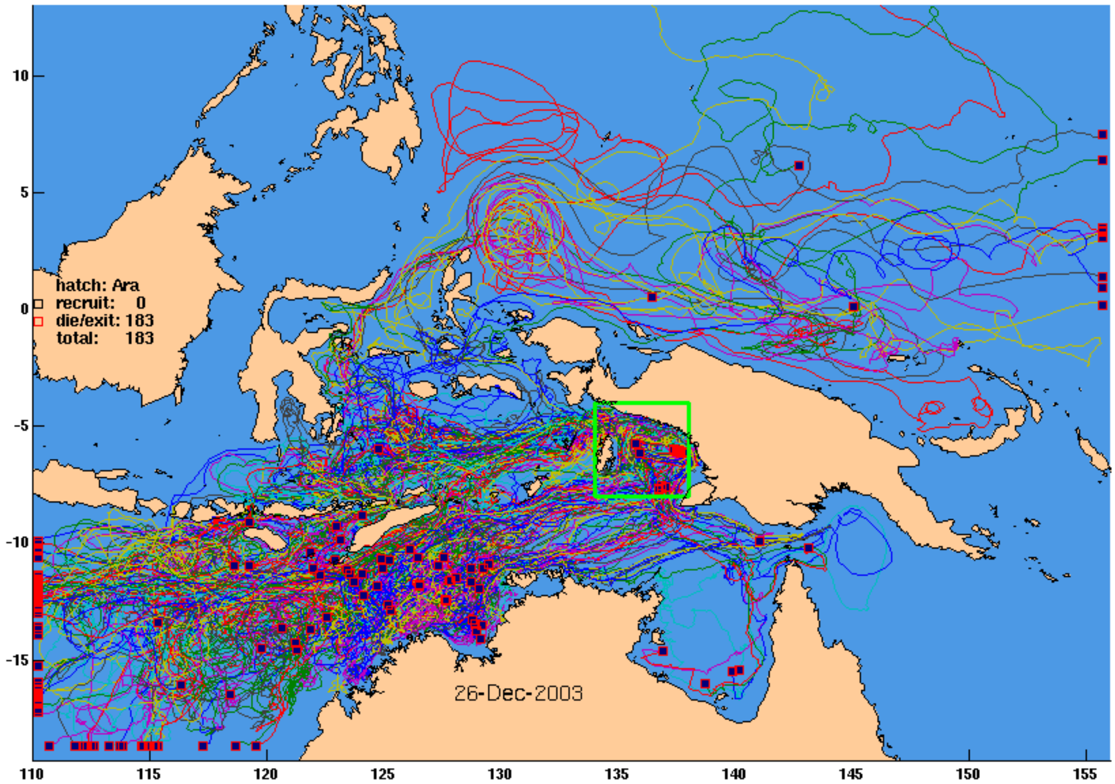

Figure 6: Pathways of "virtual" derelict fishing nets modelled by a computer simulation over one year. The origin of the "virtual" nets in this map is the area shown by the green box.

An interesting and surprising finding, however, was that the computer model showed that all virtual derelict nets that were released in the Coral Sea and South Pacific, would take a pathway with the dry season wind and ocean current patterns, west through Torres Strait, in to the Gulf of Carpentaria or close to Arnhem Land (Figure 7).

Conclusion

This pilot project used satellite drifters and a computer model to predict the pathways of derelict nets that are found washing ashore on parts of the northern Australian coastline, particularly in the Gulf of Carpentaria. Contrary to a hypothesis that these derelict nets are originating in the south-east Asian seas, both the satellite drifters and the computer model analysed by this project showed that the origin of derelict fishing nets found on the northern Australian coast could be the Coral Sea and South Pacific. Instead of pathways through the Indonesian Archipelago, these derelict nets may be drifting through the Torres Strait.

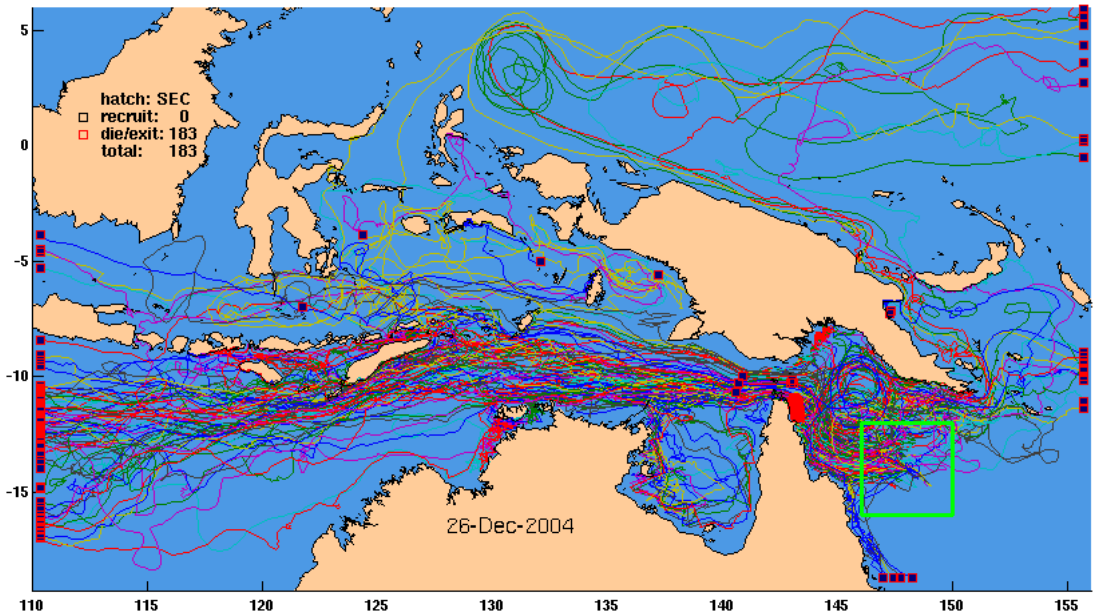

Figure 7. Pathways of “virtual” derelict fishing nets modelled by a computer simulation over one year. The origin of the “virtual” nets in this map is the area shown by the green box.

Further work

To test how accurate the findings of this pilot project are, we need to consider whether derelict nets are stranding on the Great Barrier Reef. Large numbers of satellite drifters are known to strand on the Great Barrier Reef off the northern Queensland coast, which suggests that many derelict nets might wash ashore there too. There are very few records of derelict nets found around the Great Barrier Reef, but due to the difficulty of doing surveys in the Great Barrier Reef region, the possibility that many derelict nets are washing ashore there cannot yet be ruled out.

Further research is also needed to test the project finding that derelict nets are not moving from waters north or west of the Arafura Sea into the Gulf of Carpentaria by the ocean current known as the Indonesian Throughflow. A way to test this finding is for researchers to release satellite drifters that are not easily visible to people on vessels at sea (to prevent the drifters being ‘stolen’) at the beginning of the wet season (November), in the region shown by the green box in Figure 8. If most of these satellite drifters are found to move eastwards through the Arafura Sea and into the Gulf of Carpentaria, rather than south-westwards as the present-generation model predicts, it will show that the model is presently under-estimating the effect of the NW monsoon, and thereby erroneously casting doubt on the hypothesis that derelict nets found on the northern Australian coastline could come from south-east Asian waters. A possible cause of this model bias is already understood, and it is hoped that it will be corrected in the next version of the model, due to be run in 2009.

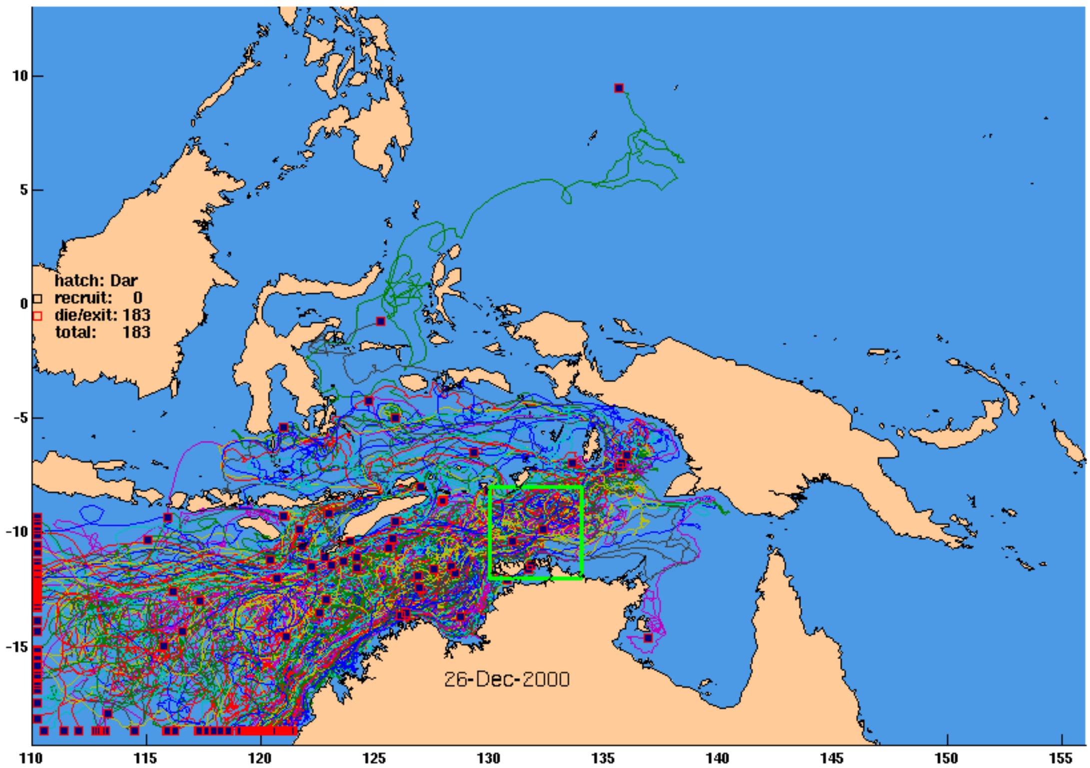

Figure 8: Tracks of "virtual" drifting objects released from the region shown by the green box. If real satellite drifters were released from this location by researchers in the wet season it could be possible to determine whether derelict nets could be moving with the Indonesian Throughflow through the Arafura Sea and into the Gulf of Carpentaria.

References

Roelofs, A., R. Coles R, and N. Smit N (2005). A survey of intertidal seagrass from Van Diemen Gulf to Castlereagh Bay, Northern Territory and from Gove to Horn Island, Queensland – November 2004. Report to the National Oceans Office, Australian Government Department of the Environment and Heritage, Canberra.

White D. (2003). Marine debris in Northern Territory waters 2002. WWF report, WWF, Sydney. http://www.nt.gov.au/nreta/wildlife/marine/pdf/marine_debris2002.pdf

Text for this Summary Report was prepared by Dr Wendy Pyper and Dr David Griffin.