

Stability analysis

SAILING STATE

Vessel.....: HAITIAN SLOOP  
 Condition.: Condition on passage  
 State.....: Hull without added appendages  
 Water SG...: 1.025

Longitudinal dimensions about Transom (-ve aft, +ve forward)  
 Vertical dimensions about USK (+ve above, -ve below)  
 Transverse dimensions about centreline (+ve Port, -ve Stbd)

Deadweight Item	Weight tonnes	LCG metres	Longitudinal moment t.m	TCG metres	Transverse moment t.m	VCG metres	Vertical moment t.m	FSM t.m
1 Ballast	1.5	4.5	6.75	0	0	0.4	0.6	-
2 125 pers in hold	8.125	4.5	36.563	0	0	1.3	10.563	-
3 25 pers on deck	1.625	4.5	7.313	0	0	3	4.875	-
DEADWEIGHT TOTAL	11.25	4.5	50.625	0	0	1.426	16.038	0
LIGHTSHIP	3	4.5	13.5	0	0	1	3	-
DISPLACEMENT	14.25	4.5	64.125	0	0	1.336	19.038	0
Free Surface Correction (Total Free Surface Moment/Displ)	0							
VCG fluid	1.336							

DRAFT SUMMARY (DIMENSIONS IN METRES)

	Maximum	Actual
Draft forward (about USK at FP).....	-	1.152
Draft midships (about USK).....	-	1.249
Draft aft (about USK at AP).....	-	1.346

FREEBOARD SUMMARY (DIMENSIONS IN METRES)

	Minimum	Actual
F/B fwd.....	-	1.597
F/B midships.....	-	0.95
F/B aft.....	-	1.153

STABILITY DATA

Heel angle degrees	Trim about baseline metres on LBP	Draft at midships about Base Line	KN metres	KGxSIN(Heel) metres	Righting mom tonne.metres	GZ fluid metres
0	0.194 by stern	1.249	0	0	0	0
5	0.193 "	1.241	0.19	0.116	1.042	0.073
10	0.190 "	1.216	0.371	0.232	1.979	0.139
15	0.186 "	1.174	0.543	0.346	2.817	0.198
20	0.180 "	1.115	0.709	0.457	3.59	0.252
25	0.174 "	1.041	0.868	0.565	4.317	0.303
30	0.168 "	0.953	1.02	0.668	5.016	0.352
35	0.161 "	0.854	1.159	0.766	5.599	0.393
40	0.152 "	0.749	1.28	0.859	6.001	0.421
45	0.144 "	0.639	1.383	0.945	6.245	0.438
50	0.136 "	0.525	1.469	1.023	6.352	0.446
55	0.129 "	0.408	1.539	1.094	6.343	0.445
60	0.122 "	0.29	1.595	1.157	6.238	0.438
65	0.125 "	0.169	1.637	1.211	6.078	0.427
70	0.139 "	0.049	1.669	1.255	5.895	0.414
75	0.154 "	-0.071	1.688	1.29	5.66	0.397
80	0.170 "	-0.198	1.678	1.316	5.17	0.363
85	0.188 "	-0.328	1.651	1.331	4.562	0.32
90	0.207 "	-0.459	1.607	1.336	3.864	0.271

STABILITY SUMMARY

	Minimum	Actual
Angle of immersion of de2 (degrees).....	-	28.374
Maximum GZ (metres).....	-	0.337
Angle of heel at which maximum GZ occurs (degrees)..	-	28.374
Positive GZ heel range (degrees).....	-	28.374
GM solid (metres) (upright).....	-	0.865
Free Surface correction (metres).....	-	0
GM fluid (metres) (upright).....	-	0.865

SAILING STATE

Vessel....: HAITIAN SLOOP  
 Condition.: Condition with 75 persons on deck  
 State.....: Hull without added appendages  
 Water SG...: 1.025

Longitudinal dimensions about Transom (-ve aft, +ve forward)  
 Vertical dimensions about USK (+ve above, -ve below)  
 Transverse dimensions about centreline (+ve Port, -ve Stbd)

Deadweight Item	Weight tonnes	LCG metres	Longitudinal moment t.m	TCG metres	Transverse moment t.m	VCG metres	Vertical moment t.m	FSM t.m
1 Ballast	1.5	4.5	6.75	0	0	0.4	0.6	-
2 75 pers in hold	4.875	4.5	21.938	0	0	1.3	6.337	-
3 75 pers on deck	4.875	4.5	21.938	0	0	3	14.625	-
<b>DEADWEIGHT TOTAL</b>	<b>11.25</b>	<b>4.5</b>	<b>50.625</b>	<b>0</b>	<b>0</b>	<b>1.917</b>	<b>21.563</b>	<b>0</b>
LIGHTSHIP	3	4.5	13.5	0	0	1	3	-
DISPLACEMENT	14.25	4.5	64.125	0	0	1.724	24.563	0
Free Surface Correction (Total Free Surface Moment/Disp)	0							
VCG fluid	1.724							

DRAFT SUMMARY (DIMENSIONS IN METRES)

	Maximum	Actual
Draft forward (about USK at FP).....	-	1.152
Draft midships (about USK).....	-	1.249
Draft aft (about USK at AP).....	-	1.346

FREEBOARD SUMMARY (DIMENSIONS IN METRES)

	Minimum	Actual
F/B fwd.....	-	1.597
F/B midships.....	-	0.95
F/B aft.....	-	1.153

STABILITY DATA

Heel angle degrees	Trim about baseline metres on LBP	Draft at midships about Base Line	KN metres	KGxSIN(Heel) metres	Righting mom tonne.metres	GZ fluid metres
0	0.194 by stern	1.249	0	0	0	0
5	0.193 "	1.241	0.19	0.15	0.56	0.039
10	0.190 "	1.216	0.371	0.299	1.019	0.072
15	0.186 "	1.174	0.543	0.446	1.387	0.097
20	0.180 "	1.115	0.709	0.59	1.7	0.119
25	0.174 "	1.041	0.868	0.728	1.982	0.139
30	0.168 "	0.953	1.02	0.862	2.254	0.158
35	0.161 "	0.854	1.159	0.989	2.43	0.17
40	0.152 "	0.749	1.28	1.108	2.449	0.172
45	0.144 "	0.639	1.383	1.219	2.338	0.164
50	0.136 "	0.525	1.469	1.32	2.12	0.149
55	0.129 "	0.408	1.539	1.412	1.817	0.127
60	0.122 "	0.29	1.595	1.493	1.454	0.102
65	0.125 "	0.169	1.637	1.562	1.071	0.075
70	0.139 "	0.049	1.669	1.62	0.704	0.049
75	0.154 "	-0.071	1.688	1.665	0.323	0.023
80	0.170 "	-0.198	1.678	1.697	-0.271	-0.019
85	0.188 "	-0.328	1.651	1.717	-0.942	-0.066
90	0.207 "	-0.459	1.607	1.724	-1.661	-0.117

STABILITY SUMMARY

	Minimum	Actual
Angle of immersion of de2 (degrees).....	-	28.374
Maximum GZ (metres).....	-	0.152
Angle of heel at which maximum GZ occurs (degrees).....	-	28.374
Positive GZ heel range (degrees).....	-	28.374
GM solid (metres) (upright).....	-	0.471
Free Surface correction (metres).....	-	0
GM fluid (metres) (upright).....	-	0.471

SAILING STATE

Vessel.....: HAITIAN SLOOP  
 Condition.: Condition with 90 pass left on deck  
 State.....: Hull without added appendages  
 Water SG...: 1.025

Longitudinal dimensions about Transom (-ve aft, +ve forward)  
 Vertical dimensions about USK (+ve above, -ve below)  
 Transverse dimensions about centreline (+ve Port, -ve Stbd)

Deadweight Item	Weight tonnes	LCG metres	Longitudinal moment t.m	TCG metres	Transverse moment t.m	VCG metres	Vertical moment t.m	FSM t.m
1 Ballast	1.5	4.5	6.75	0	0	0.4	0.6	-
2 90 pers on deck	5.85	4.5	26.325	0	0	3	17.55	-
DEADWEIGHT TOTAL	7.35	4.5	33.075	0	0	2.469	18.15	0
LIGHTSHIP	3	4.5	13.5	0	0	1	3	-
DISPLACEMENT	10.35	4.5	46.575	0	0	2.043	21.15	0
Free Surface Correction (Total Free Surfa		0						
VCG fluid	2.043							
VCG fluid	1.724							

DRAFT SUMMARY (DIMENSIONS IN METRES)	Maximum	Actual
Draft forward (about USK at FP).....	-	0.994
Draft midships (about USK).....	-	1.079
Draft aft (about USK at AP).....	-	1.164

FREEBOARD SUMMARY (DIMENSIONS IN METRES)	Minimum	Actual
F/B fwd.....	-	1.756
F/B midships.....	-	1.121
F/B aft.....	-	1.336

STABILITY DATA

Heel angle degrees	Trim about Base Line metres on LBP	Draft at midships about Base Line	KN metres	KGxSIN(Heel) metres	Righting mom tonne.metres	GZ fluid metres
0	0.170 by stern	1.079	0	0	0	0
5	0.171 "	1.068	0.182	0.178	0.037	0.004
10	0.171 "	1.04	0.357	0.355	0.019	0.002
15	0.169 "	0.996	0.525	0.529	-0.043	-0.004
20	0.165 "	0.936	0.686	0.699	-0.135	-0.013
25	0.161 "	0.863	0.842	0.864	-0.222	-0.021
30	0.158 "	0.775	0.994	1.022	-0.284	-0.027
35	0.157 "	0.675	1.143	1.172	-0.297	-0.029
40	0.155 "	0.566	1.284	1.314	-0.307	-0.03
45	0.153 "	0.451	1.407	1.445	-0.395	-0.038
50	0.147 "	0.334	1.512	1.565	-0.551	-0.053
55	0.141 "	0.214	1.602	1.674	-0.742	-0.072
60	0.137 "	0.093	1.676	1.77	-0.969	-0.094
65	0.138 "	-0.027	1.739	1.852	-1.171	-0.113
70	0.137 "	-0.156	1.764	1.92	-1.616	-0.156
75	0.139 "	-0.291	1.763	1.974	-2.18	-0.211
80	0.144 "	-0.428	1.741	2.012	-2.809	-0.271
85	0.149 "	-0.565	1.7	2.036	-3.477	-0.336
90	0.156 "	-0.702	1.642	2.043	-4.158	-0.402

STABILITY SUMMARY	Minimum	Actual
Maximum GZ (metres).....	-	0.004
Angle of heel at which maximum GZ occurs (degrees).....	-	5.861
Positive GZ heel range (degrees).....	-	11.873
GM solid (metres) (upright).....	-	0.052
Free Surface correction (metres).....	-	0
GM fluid (metres) (upright).....	-	0.052
GM fluid (metres) (upright).....	-	0.471

SAILING STATE

Vessel.....: HAITIAN SLOOP  
 Condition.: Condition at capsize  
 State.....: Hull without added appendages  
 Water SG...: 1.025

Longitudinal dimensions about Transom (-ve aft, +ve forward)  
 Vertical dimensions about USK (+ve above, -ve below)  
 Transverse dimensions about centreline (+ve Port, -ve Stbd)

Deadweight Item	Weight tonnes	LCG metres	Longitudinal moment t.m	TCG metres	Transverse moment t.m	VCG metres	Vertical moment t.m	FSM t.m
1 Ballast	1.5	4.5	6.75	0	0	0.4	0.6	-
2 25 pers in hold	1.625	4.5	7.313	0	0	1.3	2.112	-
3 125 pers on deck	8.125	4.5	36.563	0	0	3	24.375	-
<b>DEADWEIGHT TOTAL</b>	<b>11.25</b>	<b>4.5</b>	<b>50.625</b>	<b>0</b>	<b>0</b>	<b>2.408</b>	<b>27.087</b>	<b>0</b>
LIGHTSHIP	3	4.5	13.5	0	0	1	3	-
<b>DISPLACEMENT</b>	<b>14.25</b>	<b>4.5</b>	<b>64.125</b>	<b>0</b>	<b>0</b>	<b>2.111</b>	<b>30.087</b>	<b>0</b>
Free Surface Correction (Total Free Surface Moment/Displ) VCG fluid	0 2.111							

DRAFT SUMMARY (DIMENSIONS IN METRES)	Maximum	Actual
Draft forward (about USK at FP).....	-	1.152
Draft midships (about USK).....	-	1.249
Draft aft (about USK at AP).....	-	1.346

FREEBOARD SUMMARY (DIMENSIONS IN METRES)	Minimum	Actual
F/B fwd.....	-	1.597
F/B midships.....	-	0.95
F/B aft.....	-	1.153

STABILITY DATA

Heel angle degrees	Trim about Base Line metres on LBP	Draft at midships about Base Line	KN metres	KGxSIN(Heel) metres	Righting mom tonne.metres	GZ fluid metres
0	0.194 by stern	1.249	0	0	0	0
5	0.193 "	1.241	0.19	0.184	0.079	0.006
10	0.190 "	1.216	0.371	0.367	0.06	0.004
15	0.186 "	1.174	0.543	0.546	-0.043	-0.003
20	0.180 "	1.115	0.709	0.722	-0.189	-0.013
25	0.174 "	1.041	0.868	0.892	-0.353	-0.025
30	0.168 "	0.953	1.02	1.056	-0.509	-0.036
35	0.161 "	0.854	1.159	1.211	-0.739	-0.052
40	0.152 "	0.749	1.28	1.357	-1.102	-0.077
45	0.144 "	0.639	1.383	1.493	-1.569	-0.11
50	0.136 "	0.525	1.469	1.617	-2.113	-0.148
55	0.129 "	0.408	1.539	1.73	-2.709	-0.19
60	0.122 "	0.29	1.595	1.829	-3.331	-0.234
65	0.125 "	0.169	1.637	1.914	-3.936	-0.276
70	0.139 "	0.049	1.669	1.984	-4.488	-0.315
75	0.154 "	-0.071	1.688	2.039	-5.013	-0.352
80	0.170 "	-0.198	1.678	2.079	-5.713	-0.401
85	0.188 "	-0.328	1.651	2.103	-6.446	-0.452
90	0.207 "	-0.459	1.607	2.111	-7.186	-0.504

STABILITY SUMMARY	Minimum	Actual
Angle of immersion of fwd hatch (degrees).....	-	77.891
Maximum GZ (metres).....	-	0.006
Angle of heel at which maximum GZ occurs (degrees).	-	6.536
Positive GZ heel range (degrees).....	-	13.226
GM solid (metres) (upright).....	-	0.078
Free Surface correction (metres).....	-	0
GM fluid (metres) (upright).....	-	0.078

SAILING STATE

Vessel.....: HAITIAN SLOOP  
 Condition.: Condition with 30 pass left on deck  
 State.....: Hull without added appendages  
 Water SG...: 1.025

Longitudinal dimensions about Transom (-ve aft, +ve forward)  
 Vertical dimensions about USK (+ve above, -ve below)  
 Transverse dimensions about centreline (+ve Port, -ve Stbd)

Deadweight Item	Weight tonnes	LCG metres	Longitudinal moment t.m	TCG metres	Transverse moment t.m	VCG metres	Vertical moment t.m	FSM t.m
1 Ballast	1.5	4.5	6.75	0	0	0.4	0.6	-
2 30 pers on deck	1.95	4.5	8.775	0	0	3	5.85	-
<b>DEADWEIGHT TOTAL</b>	<b>3.45</b>	<b>4.5</b>	<b>15.525</b>	<b>0</b>	<b>0</b>	<b>1.87</b>	<b>6.45</b>	<b>0</b>
LIGHTSHIP	3	4.5	13.5	0	0	1	3	-
<b>DISPLACEMENT</b>	<b>6.45</b>	<b>4.5</b>	<b>29.025</b>	<b>0</b>	<b>0</b>	<b>1.465</b>	<b>9.45</b>	<b>0</b>
Free Surface Correction (Total Free Surfa	0							
VCG fluid	1.465							
VCG fluid	1.724							

DRAFT SUMMARY (DIMENSIONS IN METRES)	Maximum	Actual
Draft forward (about USK at FP).....	-	0.807
Draft midships (about USK).....	-	0.873
Draft aft (about USK at AP).....	-	0.94

FREEBOARD SUMMARY (DIMENSIONS IN METRES)	Minimum	Actual
F/B fwd.....	-	1.943
F/B midships.....	-	1.326
F/B aft.....	-	1.56

STABILITY DATA

Heel angle degrees	Trim about Base Line metres on LBP	Draft at midships about Base Line	KN metres	KGxSIN(Heel) metres	Righting mom tonne.metres	GZ fluid metres
0	0.133 by stern	0.873	0	0	0	0
5	0.136 "	0.864	0.154	0.128	0.169	0.026
10	0.139 "	0.836	0.313	0.254	0.38	0.059
15	0.143 "	0.79	0.477	0.379	0.629	0.098
20	0.148 "	0.73	0.638	0.501	0.881	0.137
25	0.150 "	0.657	0.797	0.619	1.148	0.178
30	0.153 "	0.572	0.956	0.733	1.441	0.223
35	0.154 "	0.476	1.115	0.84	1.774	0.275
40	0.154 "	0.369	1.277	0.942	2.164	0.336
45	0.163 "	0.252	1.44	1.036	2.608	0.404
50	0.180 "	0.13	1.589	1.122	3.009	0.467
55	0.193 "	0.007	1.729	1.2	3.409	0.529
60	0.196 "	-0.125	1.814	1.269	3.515	0.545
65	0.202 "	-0.268	1.854	1.328	3.395	0.526
70	0.202 "	-0.414	1.864	1.377	3.141	0.487
75	0.196 "	-0.561	1.848	1.415	2.789	0.432
80	0.189 "	-0.708	1.81	1.443	2.365	0.367
85	0.179 "	-0.853	1.752	1.46	1.889	0.293
90	0.168 "	-0.995	1.679	1.465	1.377	0.213

STABILITY SUMMARY	Minimum	Actual
Angle of immersion of de2 (degrees).....	-	41.132
Maximum GZ (metres).....	-	0.351
Angle of heel at which maximum GZ occurs (degrees).....	-	41.132
Positive GZ heel range (degrees).....	-	41.132
GM solid (metres) (upright).....	-	0.292
Free Surface correction (metres).....	-	0
GM fluid (metres) (upright).....	-	0.292

Safety Bulletin 1/2007

**MAIB SAFETY BULLETIN 1/2007**

Capsize of Haitian sloop, while under tow by  
Turks and Caicos Islands' Police Launch *Sea Quest*  
on 4 May 2007  
with the loss of 59 lives

## MAIB SAFETY BULLETIN 1/2007

This document, containing safety lessons, has been produced for marine safety purposes only, on the basis of information available to date.

*The Merchant Shipping (Accident Reporting and Investigation) Regulations 2005* provide for the Chief Inspector of Marine Accidents to make recommendations at any time during the course of an investigation if, in his opinion, it is necessary or desirable to do so.

The Marine Accident Investigation Branch (MAIB) is carrying out an investigation into the capsizing of a Haitian sloop, while under tow by the Turks and Caicos Islands' police launch *Sea Quest*, on 4 May 2007. The MAIB will publish a full report on completion of the investigation.



Stephen Meyer  
Chief Inspector of Marine Accidents

### NOTE

This bulletin is not written with litigation in mind and, pursuant to Regulation 13(9) of the Merchant Shipping (Accident Reporting and Investigation) Regulations 2005, shall not be admissible in any judicial proceedings whose purpose, or one of whose purposes, is to apportion liability or blame.

**This bulletin is also available on our website: [www.maib.gov.uk](http://www.maib.gov.uk)**

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Public Enquiries: 020 7944 3000**

## BACKGROUND

Late on the evening of Thursday 3 May 2007, an 11m wooden sailing sloop carrying approximately 150 economic migrants from Haiti commenced a covert approach to the south side of Providenciales Island, Turks and Caicos.

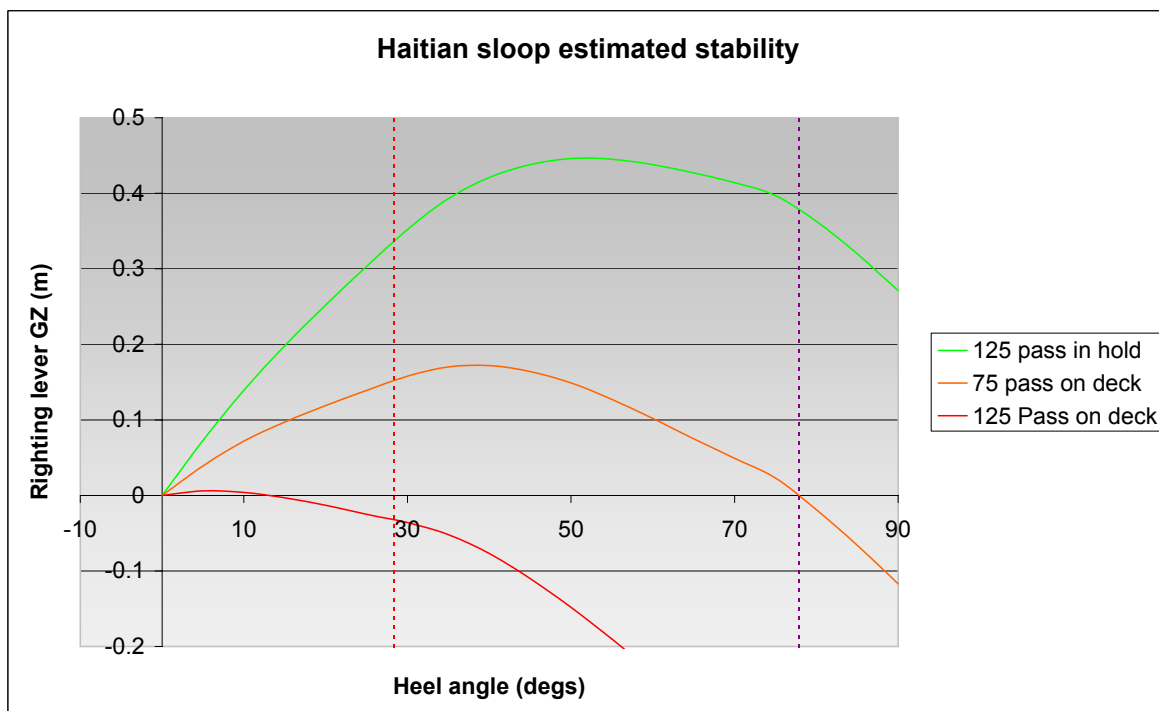
The sloop was intercepted early the following morning and taken in tow by the Turks and Caicos Islands' police launch *Sea Quest*. A short while into the tow, the sloop capsized.

During the night, *Sea Quest* rescued 66 survivors from the water, and at first light a further 11 survivors were rescued from the capsized hull of the sloop by one of the islands' Fishery Patrol launches. A total of 78 passengers were rescued, and 59 bodies were recovered, 11 from the hold of the sloop. An unknown number of bodies remains unaccounted for.

## ANALYSIS

The cause of the sloop's capsize has yet to be determined and is subject to ongoing investigation. It is apparent, however, that the sloop would have suffered a major reduction in stability as the passengers moved from the hold onto the deck following the intercept. There is evidence to suggest that no more than 25 passengers were in the hold at the time of the capsize, indicating around 125 were then on deck; an increase of about 100 passengers since the initial intercept.

Using measurements and weights taken from the wreck an estimate of the sloop's stability performance has been made (**Figure 1**). This indicates that, with most of the passengers in the hold, the sloop would have been reasonably stable. However, the movement of 100 passengers from the hold to the deck would have caused its stability to progressively diminish to almost zero. In this condition, it would have taken only the smallest of movements of the passengers towards one side, or another stimulus, to cause the vessel to capsize.



**Figure 1**

Note: The righting lever (GZ) is a measure of a vessel's ability to return to the upright when heeled by an external force. The area under the curve bounded between zero and the heeled angle is directly proportional to the moment righting the vessel. It is evident from the curves above that as the number of passengers on the deck of the sloop increases, the area under the GZ curve reduces to virtually nothing, demonstrating that only a small external force would be required to capsize the vessel.

The sloop involved in this accident was representative of other sloops (**Figure 2**) used to run economic migrants from Haiti to the Turks and Caicos Islands, and similar sloops attempting to land migrants into the USA have been intercepted by the US Coastguard. While only a few previous cases of capsizing have occurred, the sloops are known to be unstable when the majority of the passengers are on deck. This movement of passengers starts as the sloops near their destinations, but is also triggered when they are intercepted by the authorities.



**Figure 2 - Photograph courtesy of the Turks and Caicos Islands Marine Police Unit**

Once the sloop had capsized, *Sea Quest* was the only vessel conducting rescue operations until first light, some 3 hours later. Although the launch rescued 66 people from the water, had the launch been equipped with better rescue equipment it is possible that more lives could have been saved.

## **CONCLUSIONS**

This type of sloop with this number of passengers is inherently unsafe. While it might be reasonably stable while people are in the hold, as significant numbers of passengers move from the hold to the deck the stability of the vessels will diminish; in a few cases to a dangerous level. Once the sloops are intercepted by the authorities, measures need to be taken to minimize their loss of stability, and actions that might precipitate a capsizing must be avoided.

Any marine emergency resulting in large numbers of people in the water is likely to require significant quantities of lifesaving equipment; it would be a reasonable precaution for marine police unit launches to carry high capacity liferafts.

## **RECOMMENDATIONS**

Fuller recommendation can only be generated when the investigation has been completed. However, the findings to date have been of sufficient importance to warrant the MAIB issuing the following urgent safety recommendation:

**The Turks and Caicos Islands' Marine Police Unit** is recommended to:

- Improve the ability of police launch crews to convey instructions to sloop crews and passengers, with the specific aim of warning them of the dangers of passengers crowding on deck.
- Avoid taking sloops laden with passengers in tow, or any other action, such as going alongside, that could precipitate a loss of stability.
- Equip its police launches with high capacity liferafts for use in marine emergencies.