

East Cheshire Sub Aqua Club

Loch Fyne Pioneer

Combined Expedition Project Highball

15-23 July 2017

Loch Striven SW Scotland



Expedition Aims

This expedition will aim to survey 2 locations within Loch Striven in SW Scotland with sidescan sonar, to locate, record and raise a Highball practice round dropped in 1943 in preparation for the attack on the Tirpitz. The Highball was a bouncing bomb, designed by Sir Barnes Wallis, that skipped over anti submarine nets until it hit the side of a ship at anchor. The expedition will gift the raised Highball to the Brooklands Museum to coincide with the 75th anniversary of the Dambusters raid in 1943. These were inert rounds so no explosives are involved (see Appendix 1) and currently no complete Highball exists in any museum in the UK. In 1943 the Lancaster was modified to carry the Upkeep to attack the Ruhr dams but a smaller naval version was produced to be dropped from the Mosquito aircraft of 618 Squadron against the capital warships, principally the Tirpitz, which lay at anchor in a Norwegian fjord. The trials of Highball were conducted at Loch Striven using obsolete warships of the time eg Courbet and later HMS Malaya. Loch Striven was chosen as it resembled the Norwegian fjords and the entrance of the Loch could be obscured in smoke to maintain secrecy from anyone watching on Bute. Ultimately the RAF sent 32 Lancasters with Tallboy bombs to attack the Tirpitz before the Highballs were available to be put into action. This means they remain a little known piece of history and this provides an interesting opportunity to run a combined expedition and recover a piece of history for public display.

We intend to apply for the BSAC Expedition Grant Scheme (BEGS) which will be used to offset the expedition costs. The depth and technical nature of the diving, 35-55m, means that the expedition will bring together BSAC members from 6 different clubs to provide the relevant skill sets including 3 FCDs. However the expedition will include Advanced Divers and Dive Leaders and provide an opportunity for their development in diving for a purpose. The Loch has a long history associated with WW2 being a base for midget submarine and Commando operations. It is thought that a lost Welman mini submarine, MTB and minesweeper are to be located on the seabed and these are secondary aims of the expedition. The expedition has been working with Dr Iain Murray of Dundee University and a director of the Barnes Wallis Foundation, who is interested in the historical aspects of the Loch, to produce a combined publication of the finds. Simon Rodgers has already agreed an article in Scuba.



Fig 1: Mosquito dropping a Highball at Loch Striven

Area Overview/conditions

Loch Striven lies off the Firth of Clyde in SW Scotland. Average depths are 35-55m with steep sides but a relatively flat bottom. The depths make the expedition attractive for a range of diving including mixed gas given the depth and minimal tidal streams in the Loch. The expedition will use 2 RHIBs for mutual support operating from the Glenstriven Estate pier on the shore of the Loch. The RHIBs will allow space for 12 team members. The team will comprise of 4 dive pairs, 2 pairs in each RHIB, 2 coxswains and 2 support divers.

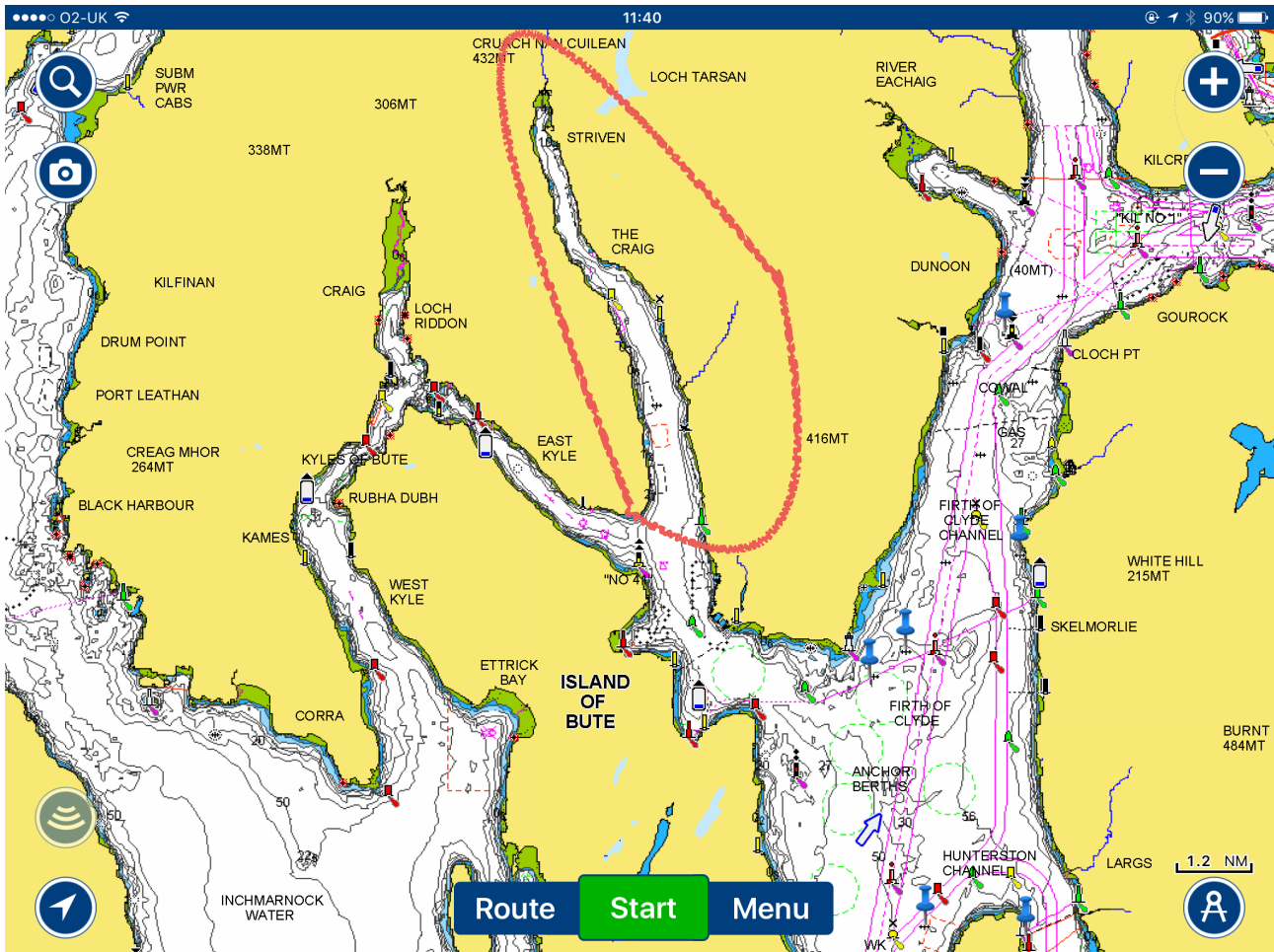


Fig 2: Area of interest, Loch Striven

Weather

The area is sheltered from all directions other than a southerly and shelter is available in the lee of the Island of Bute should this occur. July has been chosen in the expectation of settled weather conditions. Due to the sheltered nature of the Loch even non seasonal weather systems producing westerly or south westerly winds would not severely impact the expedition. Belfast CG will be consulted in addition to the Expedition Managers weather assessment.

Current

Tidal streams are weak. The expedition is based at Neaps. Tidal streams will be assessed against HW Dover using a Tidal Stream atlas of the Clyde, tidal diamonds and a Navionics tidal stream predictor.

See Appendix 1

Visibility

The inshore nature of the Loch will mean reduced visibility the further up the Loch the expedition dives. The nature of the diving will be target target diving using lines to perform a circular search from a shotline to investigate points of interest. Reduced visibility can therefore be mitigated. The team should be prepared for reduced visibility and be competent with distance lines.

Diving Overview

The varying depths of the Loch will allow for work up to 55m should anyone not be current at these depths. The Highballs are known to be located in 2 areas one is 35m and the other 55m. The team will use a trapeze and day 1 will be used to train the dive team in its protocols whilst the initial scanning takes place.

The expedition is based around 2 RHIBs carrying 8 divers, 2 Coxwains and 2 support divers. The 2 boats allow for mutual support in case of engine trouble and a towing bridle will be carried in event of breakdown. The 12 members of the team will be divided into 6 pairs A-F. The roles of Cox, navigator and support diver will be rotated allowing for a break during the week for off gassing (see Appendix 3). The initial dives on day 1 will be conducted from Topcat (ECSAC RHIB) and allow practice of trapeze deployment, circular searches and trapeze protocol for decompression. The second RHIB, equipped with the sidescan sonar will spend day 1 commencing the survey.



Fig 3: Fynepioneer RHIB



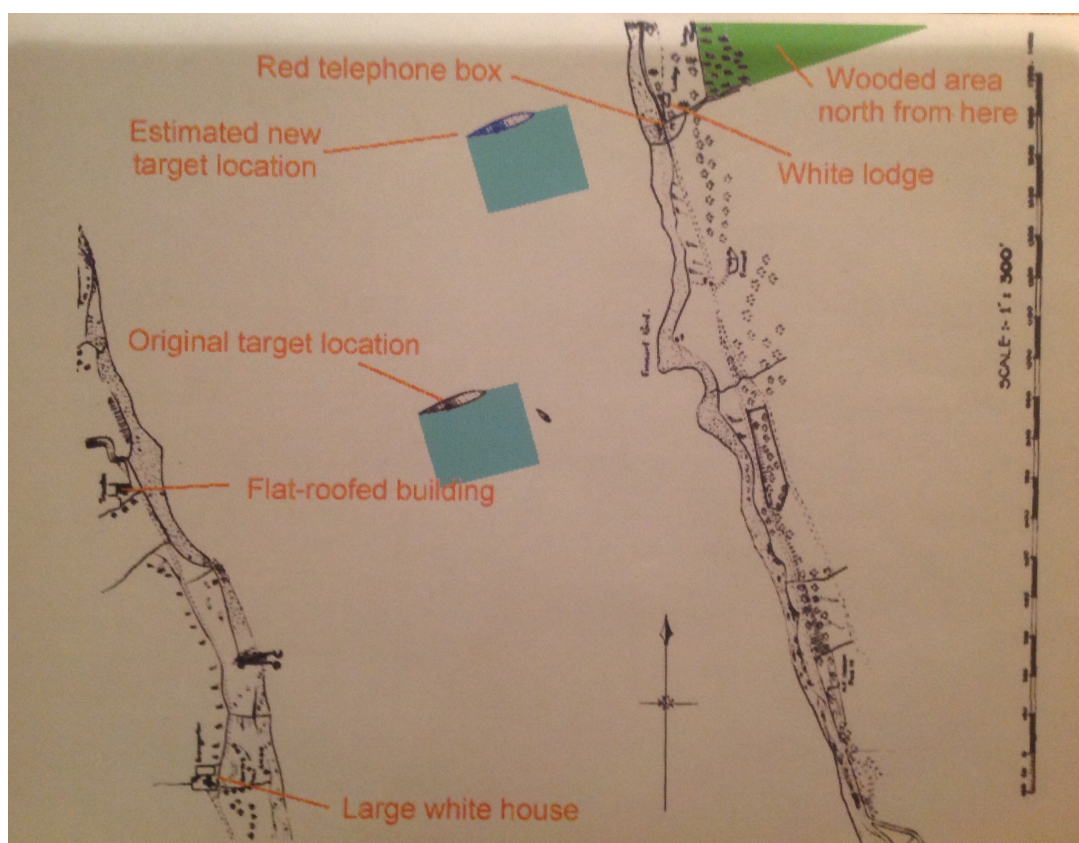
Fig 4: Topcat RHIB

We plan to conduct no more than 1 dive per day per diver below 40m but multiple dives will be possible on the shallower sites subject to cylinder filling. The target search dives will be kept short to minimise decompression but interesting finds will have run times of up to 70 minutes. Transit times to sites will be relatively short and the long slack water times will allow this even if the RHIBs have to return to base between dives.

As the maximum depth is 55m and with run times of 70 minutes for the OC divers a bottom time of 30 minutes is realistically achievable.

The chart extract below shows the Highball location areas in blue. Exact GPS coordinates are known to the expedition.

Fig 5: Diving locations and search areas



Travel

The boats will be prepared beforehand. Fyne Pioneer will come by sea from her base and Topcat will be trailered by road on 15/7/17 to be in position for the start of the expedition. The boats will use the pier pontoon available at the Glenstriven Estate next to the accommodation. The dive briefing will be at 0900 on the 16/7/17 for the initial work up dives and start of the survey. The 23/7/17 will see the team depart for home after clean up and boat packing. Contact 07990605646 if travel delayed on 15/7/17.

Accommodation

Accommodation for 12 has been booked in 2 houses on the Glenstriven estate for 8 nights. This is self catering and costs £1200 in total.

Pier Cottage

Sleeps 4/6 Self-Catering

This wonderfully located property was originally a fisherman's cottage. It is located directly on the Loch side and still has the original pier and smoke house with direct access to the shingle beach and unspoilt views of Loch Striven and Rothesay.

Set in a peaceful location it has access to all the extensive walks, mountain bike trails, as well as fishing, clay shooting, walking, stalking, hillwalking and golf.



Two bedrooms, bathroom, shower room with sauna, drawing room with open fire and patio doors leading onto a decked balcony area with fantastic views over the Loch. There is additional sleeping accommodation suitable for 15 years plus in the smoke house, which is next to Pier Cottage and accessed via ladder stairs. It also houses its own bathroom.

Invervegain Farmhouse

Sleeps up to 8 guests. Self-Catering

This is a traditional stone farmhouse with adjoining outbuildings sitting in an elevated position with wonderful views south over Loch Striven.

Constructed of stone under a slate roof, Invervegain sits in a most private location at the end of one of the estate roads.



The accommodation comprises of a games room with French doors, utility room, four bedrooms and two bathrooms.

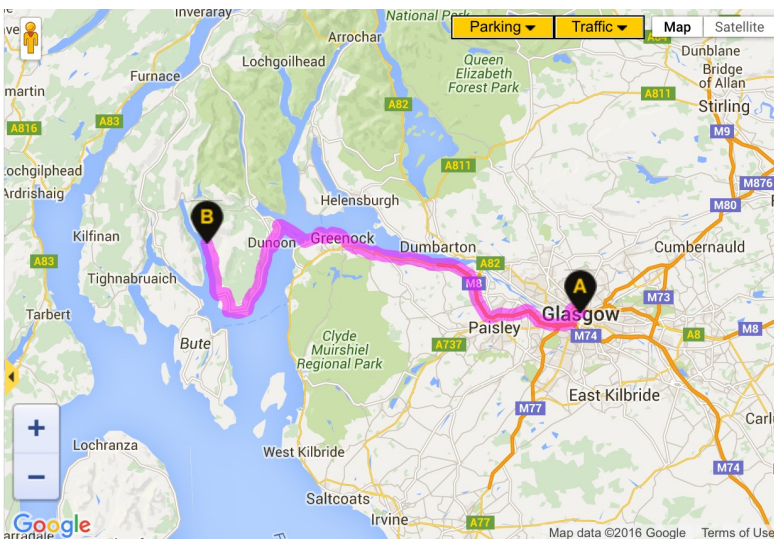
This is the perfect accommodation for smaller shooting parties or holiday lets. Placed in the most wonderful tranquil setting it offers an exceptional highland experience with deep glens, waterfalls, rivers and acres of forest and hills to explore.

Address is:

Glenstriven Estate
Toward
By Dunloon
Argyllshire
PA23 7U

Directions from Glasgow including ferry journey Greenock-McInroy Point.

29.9	Take the McInroy's Point - Hunter's Quay ferry
32.5	Continue straight
32.6	Turn left onto Marine Parade/A815 Continue to follow A815
34.1	At the roundabout, take the 1st exit onto Alexandra Parade/A815
34.4	At the roundabout, take the 1st exit onto Argyll St/A815 Continue to follow A815
34.6	At the roundabout, take the 1st exit onto Pier Esplanade/A815 Continue to follow A815
44.8	Turn right onto Glenstriven Rd Destination will be on the right
49.4	Arrive: Glenstriven House, Toward, Dunoon, Argyll and Bute PA23 7UN, UK
Section time: 2 h 13 min, Total time: 2 h 13 min	



Training weekend

The team will attend a training weekend from 29 April- 1 May 2017 at Loch Fyne using the Fyne Pioneer RHIB. The aim of these 3 days is to familiarise the team members with the side scan sonar and the nature of target diving in preparation for the expedition including use of the trapeze and the lifting operation now the lifting license has been granted by Marine Scotland

Hannah.Gooch@gov.scot

06162 - East Cheshire Sub Aqua Club - Recovery of Highball - Loch Striven, Firth of Clyde, Argyll - Consultation Ended

To: Mark

Dear Mr Paisley,

I can confirm that the consultation period has concluded. I have previously sent you the consultation responses from the Port Authority and Historic Environment Scotland. Please find attached responses received from MCA, NLB, SNH, Argyll & Bute Council and RYA.

Thank you for the further letter that you sent on 02 December 2016, after discussion with Historic Environment Scotland, Marine Scotland are content with this proposed project and have determined in favour of your application for which a licence will be issued shortly using the details from your application form. Please let me know as soon as possible if there are any details on your application form that need to be updated.

Kind regards,

Hannah

Hannah Gooch
Marine Licensing Officer
Marine Scotland - Marine Planning & Policy

Scottish Government | Marine Laboratory | 375 Victoria Road | Aberdeen | AB11 9DB

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Email: hannah.gooch@gov.scot
Website: <http://www.gov.scot/Topics/marine/Licensing/marine>

Frequently Asked

Expedition timeline BST

Date July	Time	Activity	Notes
Saturday 15th		Tow boat to Loch Striven Assemble. Dry run trapeze. EM briefing. Dinner	Launch Topcat on arrival Topcat may need launch from Largs and transit to base.
Sunday 16th	0800 0900 0930-1000 1000-1600 1630 1700-1830 1900	Breakfast DM briefing Load boats Diving operations Debrief Process sidescan data Dinner	Fynepioneer sidescan Topcat diving ops
Monday 17th	0800 0900 0930-1000 1000-1600 1630 1700-1830 1900	Breakfast DM briefing Load boats Diving operations Debrief Process sidescan data Dinner	Fynepioneer sidescan Topcat diving 16th marks
Tuesday 18th	0800 0900 0930-1000 1000-1600 1630 1700-1830 1900	Breakfast DM briefing Load boats Diving operations Debrief Process sidescan data Dinner	Fynepioneer sidescan Topcat diving 17th marks
Wednesday 19th	0800 0900 0930-1000 1000-1600 1630 1700-1830 1900	Breakfast DM briefing Load boats Diving operations Debrief Process sidescan data Dinner	Fynepioneer sidescan Topcat diving 18th marks
Thursday 20th	0800 0900 0930-1000 1000-1600 1630 1700-1830 1900	Breakfast DM briefing Load boats Diving operations Debrief Process sidescan data Dinner	Both boats diving
Friday 21st			Lifting operations
Saturday 22nd			Reserve day
Sunday 23rd		Pack and clean boats. Tidy accommodation. Depart.	

Gas

The expedition will be self sufficient for gas. J cylinders of He and O2 will be purchased by the expedition from BOC depot, Dunoon, along with a compressor and mixing panel. £500 budget has been allowed for movement of the mixing panel. Gas costs are included under costs.

Food

The expedition will be self catering. There are shops available in Dunoon. Team members should note that up to 6 hours will be spent on the water each day and should cater/water appropriately. It is considered important to hydrate when decompression diving. An overall catering manager will be appointed but Appendix 3 shows the rota for breakfast/lunch and dinner preparation.

RHIBS

The 2 coxes are responsible for ensuring the RHIBs are set up for sea. Routes to the target sites will be loaded into the GPS before ropes off time. The expedition has backup handheld GPS units. Divers will kit prep beforehand having analysed and labelled all gasses. The support divers will be responsible for maintaining the dive slate. Transit will be in drysuits on and zipped. Coxswains will wear life jackets and use kill chords. Divers will kit up on site with the aid of support divers. Entry will be via a sideways roll and the shotline. Recovery will be via the shotline and trapeze. Divers are to dekit and hand kit to the support divers prior to RHIB entry. Divers should continue with rich nitrox whilst on the RHIB. Support divers will recover the shot and trapeze. Coxes will display the A flag and maintain a visual and VHF dual watch on CH13/16. CH 13 is the bridge to bridge channel and should be used if shipping approaches the trapeze. Should a ship threaten to overrun the trapeze the Cox is responsible for positioning the RHIB between the ship and trapeze. If this is unsuccessful the Cox can signal the divers via a karabiner sent down the trapeze line. Divers will then descend down the transfer line until the threat is passed. A red DSMB sent up at the trapeze indicates all divers are present. A yellow DSMB at the trapeze will indicate not all divers are present and a surface search should then commence using an expanding sector search. Should the missing divers not be located within 10 minutes the CG must be contacted. Team members will have AIS beacons which indicate a triangle symbol on the plotter with a MOB code and will aid diver location away from the trapeze.

Diver qualification

OC/CC Trimix registered with BSAC otherwise limited to 40m

Recent dive to depth 50/40m as appropriate

Diver Coxswain

PRM/O2 admin/FAD (1 per pair required)

EMG (60m) is minimum qualification for max depth but shallower sites available

Diver Safety

BSAC safe diving practice

Max runtime of 70 minutes with maximum BT of 30 minutes

END 30m

Trimix Normoxic 18-23%

PPO2 1.4 max/1.3 CC but less with work. Max 1.6 for deco

O2 tracked and recorded max 80%, max UPTD 300

Scrubber duration will be tracked

Bottom gas rule of thirds, deco gas rule of halves

All divers return via shotline and trapeze. Distance line for searches and if visibility poor

Dive plan to be agreed with DM

CCR/OC divers to be paired with similar equipment users

Equipment

O2 equipment to be available on each boat

VHF radio each boat and back up

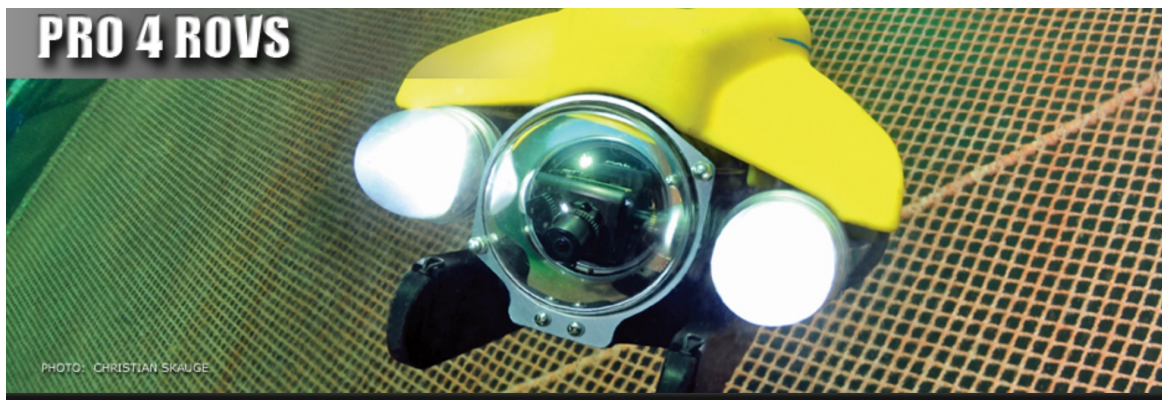
Shotline and trapeze, buoys, anchor, A flags, first aid kit, AED

Trimix and O2 analysers

2 in water bail out cylinders N30 and N70

Shotline strobe

Queens University will also supply the ROV and Spyball below for underwater filming



Monochrome Spyball Model SB-MO – Monochrome

Submertec's revolutionary Spyball combines a remote control underwater video camera with pan and tilt unit in one compact assembly that can rotate to look in any direction – without restriction.

This is the basic Spyball version which is fitted with a high resolution, low light monochrome video camera for use in a range of applications where ambient lighting may be poor and artificial lighting is not appropriate.

Being only 160mm in diameter and with a smooth spherical body, the Spyball can be safely installed into areas with delicate inhabitants, fast flowing water or areas where entanglement is a hazard.

Variable speed pan and tilt is controlled remotely from one of a range of control units which include desktop, multiple, battery portable and radio link.

The Spyball can be mounted in any orientation, above or below water, making it ideal for use in hostile environments where extreme durability and corrosion resistance is essential.

Apart from direct suspension on its cable, a number of deployment options and mounting arrangements are available including, flange mounts, tube fittings and telescopic Carbon Fibre poles up to 7 Metres long.

Please refer to the the [Spyball Deployment](#) section for mounting and deployment options.

The Spyball Model SB-MO is widely used for long term immersion in the fish farming industry due to its ruggedness and reliability with over 400 currently in service Worldwide.

All external Spyball parts are machined from solid Aluminium Bronze or Acetal Co-Polymer to ensure long and corrosion free service in seawater to depths of over 300 metres. Spyballs have been pressure tested to 700 Metres without failure.



Individual kit

All personal technical dive equipment
Red and yellow DSMB
Secondary surface signal eg flag, EPIRB/AIS unit
Spare torch
Cutter
2 computers or 1 computer and runtime slate
DPV. DPV divers will be paired together for redundancy.

Weather/harbours

Launch site for the expedition will be
Nearest Marina offering support is Port Bannatyne on Bute
Nearest dive shop support is Largs
The nearest CG is:

Belfast CG Operations
HM CG
Breganz House
Quay Street
Bangor
Co Down
BT20 5ED

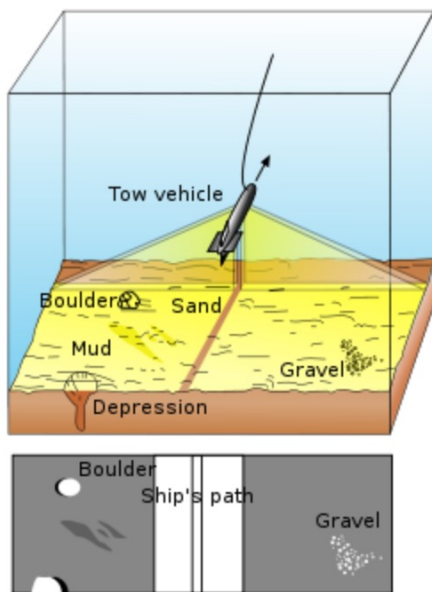
Tel 02891463933

SAR support is available from Prestwick Airport operated by Bristows. 2 Sikorsky S-92 helicopters.

Target finding

The initial task will be to side scan the areas of interest in blue in Fig 5. Side scan uses a sonar device that emits a fan shaped pulse to the sea floor across a wide angle perpendicular to the path of the sensor which is towed from the surface. The acoustic reflection from the sea floor is recorded in a series of cross track slices and stitched together along the direction of motion. Typical frequencies are 100-500kHz with a higher frequency giving a better resolution but less range. The side scan unit will be combined with a RTK (Real Time Kinematic) GPS unit which enhances the precision of position data by using the phase of the signal carrier wave providing cm levels of accuracy. This data capture will provide targets of interest which will be investigated by the ROV. Suitable targets will be dived using a simple circular search from the shotline. Appropriate targets will be filmed using Go Pro and surveyed.

Fig 6: Side scan operation



Side scan tow fish in operation.

Shotlines

Once a suitable target is identified a shotline will be deployed. The trapeze will be karabinered to the down line. A 2 kg weight attached to the transfer line will find its own level on the shot and provide the route to the trapeze. On descent each pair of divers will place their tag on the junction of the transfer/shotline. Once on the bottom each pair will attach a strobe to the shotline. These will be recovered on exit. Due to the absence of significant tidal streams the trapeze should not need releasing but can be from both ends of the transfer line. Once all divers are on the trapeze a red DSMB will be released to inform the boat cover that all divers are safe. N30 and N70 will be available on the trapeze and the safety divers are available to meet the ascending divers with N30.

Underwater task allocation

With 4 pairs available to dive each day dive tasks will be rotated, see Appendix 3. Depending on depth and size of target 1-4 pairs can be deployed. Small targets will be single pairs allowing 4 targets a day but deep bigger targets will be allocated 2 pairs allowing 2 targets a day.

Pair 1	Check shot position, start circular search, tie off distance line, deploy wash bag, commence survey.
Pair 2	Film target, complete survey, recover distance line

Emergencies

CG must be contacted on 16/DSC 70. CG will be appraised of plan each day. Helicopter rescue is an option and coxes must familiarise themselves with procedures beforehand. This will be covered as part of the EM briefing. Coxes must know how to use flares, O2, erect radar reflectors, use VHF and perform the small boat helicopter recovery.

Gas

Divers are free to choose own gasses but pairs should have similar mixes. Gas blending will be available on site. The expedition will purchase J cylinders of He and O2 from the BOC depot at Dunoon. The expedition will transport a compressor and mixing panel to site at a cost of £500 from Loch Fyne.

Nitrox and equipment support is also available from C&C Marine Services, Largs Marina, 01475 687180

Local Information

Emergency:

At sea VHF 16, land 999/112 ask for CG
Belfast CG 02891 463933

Decompression

Call DDRC 01752 209999 or 07831 151523 or Diver Helpline Scotland 0845 408 6008

Nearest chamber

Oban: Dunstaffnage Marine Laboratory PA37 1QA via Helpline above
Millport on Isle of Cumbrae closed.

Sea areas

Malin with Hebrides to north and Irish Sea to south.

Weather information

Met Office inshore forecast, Shipping forecast Malin, CG.

RHIBS

The expedition will use 2 RHIBs, Fyne Pioneer a 10m twin 200HP Humber and Topcat a 6m 140 HP Ribcraft. Both boats are petrol driven and are capable of 35 kts. Fuel planning will be based on economy speeds as the refuelling will need to be done via jerrycans. Fyne Pioneer burns 1 ltr a nm at 6kts but 4.5 ltrs a nm at 20 kts. Topcat is more efficient at 1 ltr per nm at 20 kts. Rule of thirds will be used for passage planning. Both boats will carry flares/smoke, radar reflectory, pumps, tools, fire extinguishers, first aid kits, AED, GPS, sounders, VHF.

Costs

The expedition will assemble at Glenstriven Estate on the edge of Loch Striven. Topcat will require towing from Macclesfield.

Accommodation £1200 divided by 12 (£100 each)

Towing charge 270 miles each way (540 miles at 25 mpg) 22 gallons £140

Fuel costs based on 200nm for the week. 600ltrs for Fyne Pioneer and 200 ltrs for Topcat.

Total 800 ltrs £1100.

Movement of gas charging station £500

Gas costs at £45 a fill (8 dives each) £400 X 10 divers £4000

Food £120 per person £1440

Total £8380 (£700 per person with 12 on expedition)

The Lift (Full MOD permission granted)

The shallowest Highball will be raised using a large cargo net bag tied at the base of the Highball. A single one tonne lift bag will be used lifting from the bottom of the Highball so it 'falls into the bag'. A separate twinset (5000 ltrs) will be used for inflation, messangered down the shotline. A pipe will be used to inflate the bag allowing the diver to remain remote from the lift. Once on the surface the Highball will be dragged to Loch side and beached. The harness will be used to crane the Highball onto a flatbed vehicle for transportation. Only 2 divers will be involved in the lift and all normal lifting safety considerations will be undertaken. This system has been devised on advice and practiced. A full team lifting practice will occur on the planned training weekend.

Advice has been taken from Wessex Archaeology and the Royal Armouries re preservation. The Highball will be transported to East Cheshire Sub Aqua Club in Macclesfield where it will be immersed in fresh water in this container with the top cut off.



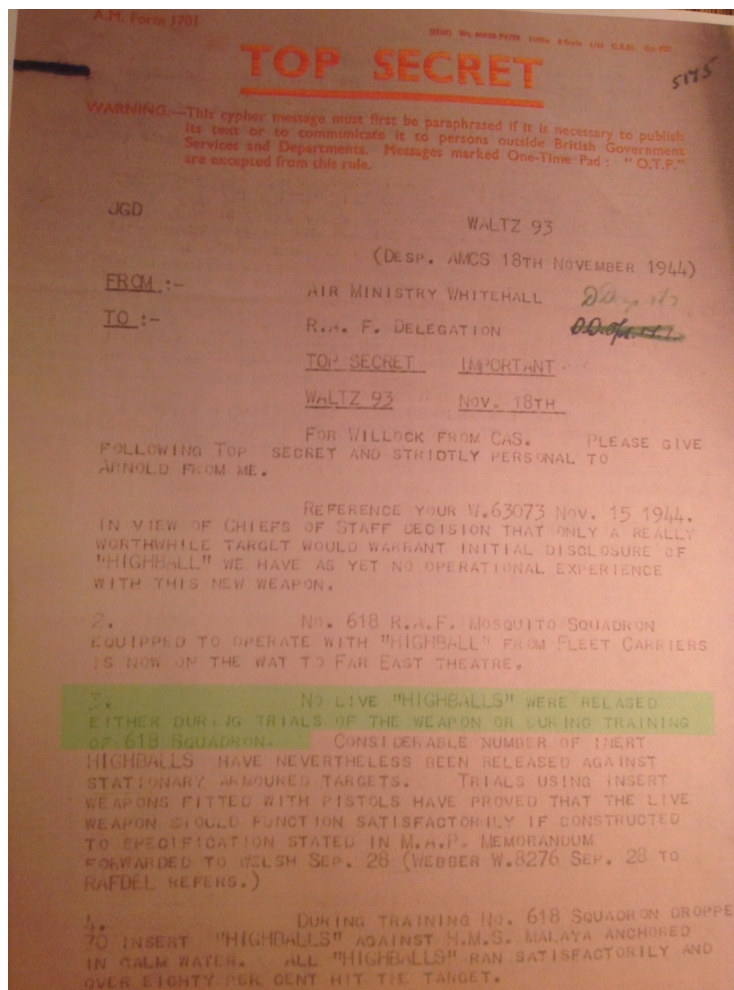
The water will be changed regularly and replaced with de ionised water. Once the salt is removed the Highball will be placed in a drying room with heater and thermostat. Once dry the steel casing can be painted. This process may take 12 months.

Appendix 1: Tidal Streams

5610-11		Tidal Streams referred to HW at GREENOCK									
Hours	Geographical Position	A 55°39'90N 5 25 27W	B 55°45'00N 5 13 37W	C 55°43'50N 4 59 17W	D 55°48'90N 4 58 17W	E 55°43'00N 4 55 67W	F 55°44'60N 4 54 07W	G 55°38'48N 4 50 01W			
Before High Water	Directions of streams (degrees)	040 0-3 0-2	Tidal streams are irregular and very weak. Rate not exceeding 0.25 knots.	072 0-3 0-2	000 0-1 0-1	233 0-1 0-1	052 0-8 0-5	Tidal streams are weak. Rate not exceeding 0.25 knots.	-6		
		030 0-3 0-2		046 0-6 0-4	027 0-2 0-1	343 0-2 0-1	048 1-1 0-7		-5		
		017 0-3 0-2		026 0-7 0-4	054 0-2 0-1	027 0-2 0-1	044 1-0 0-6		-4		
		330 0-3 0-2		044 0-6 0-4	030 0-2 0-1	027 0-4 0-2	052 0-8 0-6		-3		
		297 0-3 0-2		037 0-4 0-3	024 0-1 0-1	023 0-4 0-3	053 0-8 0-5		-2		
		243 0-3 0-2		016 0-3 0-2	120 0-1 0-1	017 0-4 0-2	050 0-6 0-4		-1		
High Water	Rates at spring tides (knots)	225 0-4 0-3	018 0-2 0-1	139 0-1 0-1	009 0-3 0-2	035 0-1 0-1	0				
		Rates at neap tides (knots)	215 0-5 0-3	257 0-4 0-3	257 0-1 0-1	0-0 0-0	231 0-6 0-4	+1			
			205 0-4 0-3	235 0-9 0-5	279 0-2 0-1	193 0-3 0-2	237 1-3 0-8	+2			
			194 0-3 0-2	215 0-9 0-6	217 0-2 0-1	198 0-3 0-2	229 1-4 0-9	+3			
			121 0-1 0-1	209 0-8 0-5	265 0-4 0-2	196 0-5 0-3	229 1-3 0-8	+4			
			062 0-2 0-1	152 0-4 0-2	272 0-2 0-1	196 0-7 0-4	230 0-8 0-5	+5			
After High Water	Directions of streams (degrees)		044 0-3 0-2	085 0-2 0-1	0-0 0-0	204 0-2 0-1	119 0-6 0-4	+6			

Closest Tidal Diamond to Loch Striven is D so tidal streams not a factor for expedition

Copy of declassified document stating Highballs are inert.



Appendix 2: Risk Assessment

Hazard	Risk	Chance	Control Measure
Road traffic	Injury en route	Low	Allow adequate journey time
Manual handling	Injury to diver	Medium	Minimise loads. Use trollies. Assist each other. Dekit in water
Trip hazards	Injury to diver Falling in water	Low	Drysuits or life jackets on site
MOB	Loss of diver	Medium	Divers to wear drysuits zipped on RHIBs. MOB to be practiced day 1.
Sea state	Not as forecast	Low	Daily weather update Liaise with CG Limits for expedition Sheltered location
Deteriorating weather	Increasing sea state	Low	Daily weather updates Monitor weather
Surface traffic	Collision risk	Low	Boat cover CH13 A flag
Poor visibility	Unable to find shotline	High	Pathfinder strobes Distance line DSMB ascent if required
DCI	Injury to diver	Low/medium	O2 on RHIBs Extra in water deco of 10 mins over planned. Ascent via shot and trapeze. In water gas available. CG evac if required.
VHF range	Unable to contact CG in event of emergency	Low	Relay through other vessels or shore
Cold water	Hypothermia/free flow	Low	Summertime. Drysuits and under suits. Maintained equipment
Gas loss	Unable to complete deco. Panic	Low	Extra gas in water. AS. Rule of 1/2s
Diver separation	Lost diver, hypothermia	Medium	Shotline and trapeze AIS, EPIRB, location aids
Wreck	Entanglement/injury	Medium	Cutters, no penetration
Gas problems	O2 toxicity, CO2 toxicity	Medium	Analysis/labelling/ Reduced PO2/low work rate
Engine trouble	Drifting at sea	Low	2 boats, tow bridle

Appendix 3: Expedition member schedule

Cox (C)	Support Diver (SD)	Dive (D)	Cylinder fills (CF)
Fuel, passage plan, MET, CG, monitor weather and shipping	Navigator, aid kitting up, deploy and cover trapeze, slate, in water support, prepare breakfast /lunch	Dive as planned	Fill cylinders Prepare dinner

Team Members and Teams

Loz Broome C	Advanced Diver	ECSAC	OC MG/fuel manager
Ken Burrows B	Advanced Diver	ECSAC	OC
Cameron Cromwell C	Advanced Diver	Richmond SAC	OC MG
Simon Exley E	FCD	Chorley SAC	OC MG/side scan
David Ketteringham A	Advanced Diver	Brize Norton SAC	RB/lift manager/gas blender
Louise Ketteringham A	Advanced Diver	Swindon SAC	RB/records
Mark Paisey F	FCD	ECSAC	RB Exped Manager/ Exped plan and report/ Marine Scotland
Kevin Phillips F	Advanced Diver	ECSAC	OC MG/data manager/ BEGS application
Tim Porter B	Dive Leader	ECSAC	OC Catering manager
Simon Smith E	FCD	Tyne SAC	RB/ MOD and Navy liaison
Dafydd Thomas D	Dive Leader	ECSAC	OC MG
Gemma Thomas D	Dive Leader	ECSAC	OC MG

Team	Task	16/7	17/7	18/7	19/7	20/7	21/7	22/7
A		D/CF	D	C	D	D	SD	D/CF
B		SD	D/CF	D	C	D	D	SD
C		D	SD	D/CF	D	C	D	D
D		D	D	SD	D/CF	D	C	D
E		C	D	D	SD	D/CF	D	C
F		D	C	D	D	SD	D/CF	D