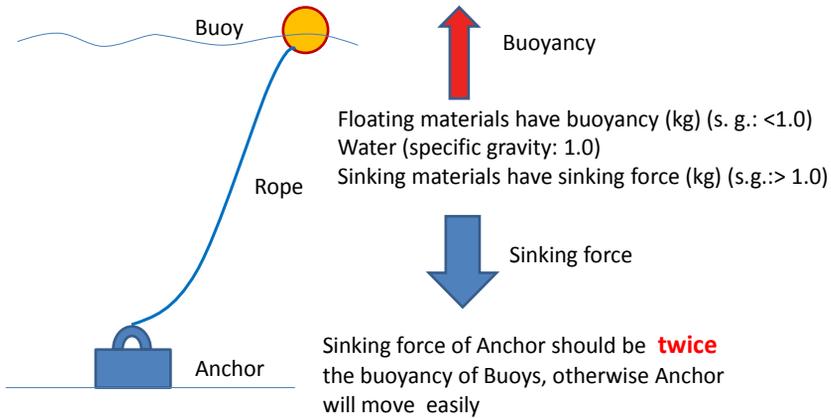


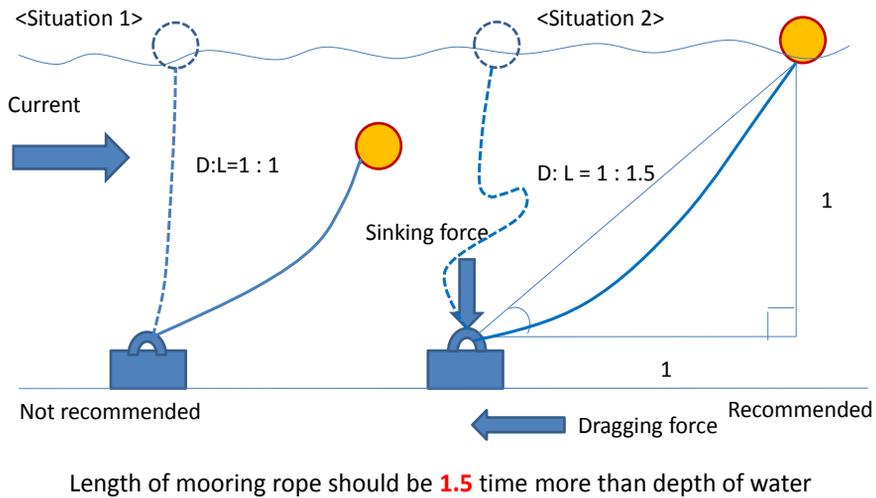
1. Basic knowledge of mooring (1)

Relation between buoyancy and sinking force



1. Basic knowledge of mooring (2)

Relation between depth of water (D) and length of mooring rope (L)



2. Basic knowledge of materials used (1)

(1) Type of buoy

Hard plastic buoy: Hard plastic buoys are normally water-resist, however depending on material and thickness, resistible pressure is different, and buoyancy is different depending on diameter

ABS resin (200~800m water resist), PE (50 - 100m water resist)

Example)

Diameter (cm): 17cm, 20cm, 23cm, 29cm, 34cm

Buoyancy (kg): 2.4kg, 3.9kg, 6.2kg, 11kg, 21kg

Soft sponge float (bullet buoy): Once soft sponge float are submerge, they will lose their buoyance, and become less than half of the surface buoyancy below 10m depth. These floats will be able to recover their buoyancy on surface again at the surface

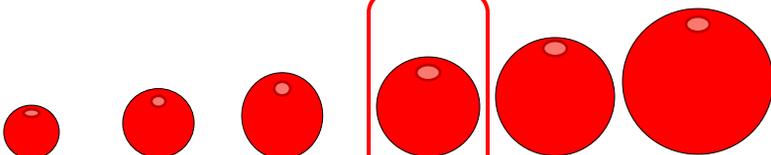
Poly Vinyl Chloride (PVC), Styroform

Inflatable buoy: Inflatable buoy is easy to handle, and large buoyancy buoy is available

Bamboo, Boir-flor wood: Natural materials, such as bamboo and light wood, might be local available materials, but they will lose their buoyancy after several month used. They must be replaces on regular base

2. Basic knowledge of materials used (1)

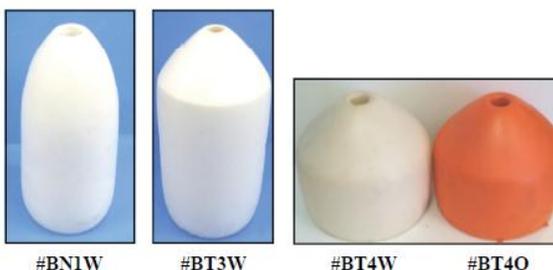
Table of High Pressure Buoys (ABS resin)



MODEL	6B-3	7B-2	8B-3	10B-8	12B-3	13B-2
MAX WATER DEPTH	300m	200m	300m	800m	300m	200m
HOLE DIAMETER	170 x 23	200 x 23	230 x 22	290 x 28	345 x 28	390 x 40
WEIGHT	375g	522g	843g	3.26kg	2.70kg	3.40kg
BUOYANCY	2.4kg	3.9kg	6.2kg	11kg	21kg	30kg

2. Basic knowledge of materials used (1)

Table of Bullet buoys

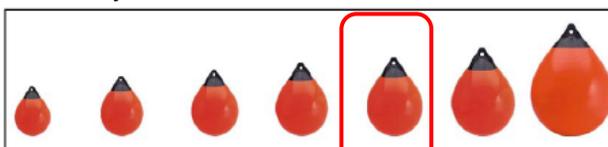


ITEM NUMBER	APPROX. DIMENSIONS	COLOR	HOLE SIZE	APPROX. BUOYANCY	PRICE 1-99
FLTBN2W	5" Dia 11" Long	White	3/4"	7 Lbs.	\$ 4.35
FLTBN1W	6" Dia 14" Long	White	1"	11 Lbs.	\$ 7.21
FLTBT4W	7" Dia 7" Long	White	3/4"	6 Lbs.	\$ 5.78
FLTBT4O	7" Dia 7" Long	Orange	3/4"	6 Lbs.	\$ 6.23
FLTBT3W	7" Dia 14" Long	White	1"	16 Lbs.	\$ 9.95
FLTBT3O	7" Dia 14" Long	Orange	1"	16 Lbs.	\$ 10.65
FLTBN3W	7" Dia 15" Long	White	1"	16 Lbs. 6 oz.	\$ 11.50
FLTBT5W	8" Dia 14" Long	White	1"	18 Lbs.	\$ 13.20
FLTBN15	9" Dia 15" Long	White	1 1/4"	27 Lbs.	\$ 15.95

2. Basic knowledge of materials used (1)

Table of Inflatable buoy

A
SERIES



SPECIFICATIONS	A-0	A-1	A-2	A-3	A-4	A-5	A-6
SIZE (diameter x length)	9" x 11.5" 23 x 29 cm	11.5" x 14.5" 29 x 37cm	15.5" x 19.5" 39 x 49 cm	18.5" x 23" 47 x 59 cm	21.5" x 28" 55 x 71 cm	27.5" x 30" 70 x 92cm	34.0" x 46.5" 86 x 118 cm
EYE DIAMETER	0.6" 1.6 cm	1.0" 2.5 cm	1.125" 2.8 cm	1.125" 2.8 cm	1.125" 2.8 cm	1.25" 3.0 cm	1.5" 3.8 cm
CIRCUMFERENCE	28.3" 72.2 cm	36.1" 91.1 cm	48.7" 122.5 cm	58.1" 147.6 cm	67.5" 172.7 cm	86.4" 219.8 cm	106.8" 270.0 cm
BUOYANCY (approximate)	13 lbs. 5.9 kg	28 lbs. 12.7 kg	65 lbs. 29.5 kg	115 lbs. 52 kg	178 lbs. 80.7 kg	378 lbs. 171.5 kg	754 lbs. 342 kg
VOLUME (gallons/liters)	1.6 gal. 5.9 L	3.5 gal. 13.2 L	8.2 gal. 30.8 L	14.5 gal. 54.9 L	22.5 gal. 84.8 L	47.6 gal. 179.6 L	95.1 gal. 359.2 L
PIECES PER BOX	20	10	10	10	10	5	3
ITEM NUMBER	FLTA0	FLTA1	FLTA2	FLTA3	FLTA4	FLTA5	FLTA6
PRICE EACH	\$ 19.99	\$ 26.83	\$ 34.10	\$ 46.42	\$ 64.75	\$ 162.53	\$ 298.14

2. Basic knowledge of materials used (1)

Natural materials as buoys



Bamboo raft being
constructed in Castara,
Tobago, Dec 2003
<Source: Ellis 2003>



Boir-flor raft being constructed
in King's Bay, Tobago,
Dec 2003
<Source: Ellis 2003>

2. Basic knowledge of materials used (2)

(2) Type of anchor

Concrete barrel: Concrete barrel anchor with a steel bar is popular anchor, which is easy to get materials and make. $\frac{3}{4}$ barrel of concrete will be able to make 360kg anchor ($W=V \times C = \frac{3}{4} \times 200L \times 2.40$) in air, but 209kg in water (58%)

Engine block: Engine block is made from steel, so it is heavy material, but it is not easy to handle it. If a engine block has 500kg weight in air, it become 435kg in water (87%)

Sandbag: Sand bag, which made from special synthetic material, have long durability. A sandbag can contain 50 ~ 60 kg of sand. 20pc of sandbag (10pc x 2) will be able to make 1,200kg weight in air, 528kg weight in water (44%)

2. Basic knowledge of materials used (2)



550x870mm w 4m PP rope
For 50 – 60kg sand/bag

2. Basic knowledge of materials used (3)

(3) Type of mooring rope

1) Floating materials

PP (Polypropilen) <s.g.:0.91>

PE (Polyethylene) <s.g.:0.95>

*Note: Floating rope needs attachment of sinkers to prevent it from floating on surface and reduce the risk of damage by propeller

2) Sinking materials

Nylon (Polyamide) <s.g.:1.14>

Cement strap (Nylon strap)



Plastic bottles filling with
sand & sea water work as
sinkers

2. Basic knowledge of materials used (3)

Polysteel®

Nylon

		Polysteel®		Polypropylene		Rope Diameter		Minimum Breaking Strength		Safe Load (Safety Factor 12)		Weight	
Size (Dia.)		Approx. Weight of 1200 ft. Coil	Tensile Strength	Approx. Weight of 1200 ft. Coil	Tensile Strength	(in)	(mm)	(lb _f)	(kN)	(lb _f)	(kN)	(lb _w /ft)	(kg/m)
mm	inches	(Lbs)	(Lbs)	(Lbs)	(Lbs)								
6	1/4	18	1,650	15	1,011	3/16	5	880	3.91	73.3	0.326	0.009	0.013
8	5/16	24	2,820	22	1,483	1/4	6	1486	6.61	124	0.551	0.016	0.023
10	3/8	37	3,700	35	2,248	5/16	8	2295	10.2	191	0.851	0.025	0.036
11	7/16	47	4,400	45	3,100	3/8	10	3240	14.4	270	1.20	0.036	0.053
12	1/2	62	5,100	57	3,372	7/16	11	4320	19.2	360	1.60	0.048	0.071
14	5/8	77	6,300	73	4,490	1/2	12	5670	25.2	473	2.10	0.063	0.094
18	5/8	95	10,840	91	5,395	9/16	14	7200	32.0	600	2.67	0.080	0.119
18	3/4	138	13,570	141	7,982	5/8	16	8910	39.6	743	3.30	0.099	0.147
22	7/8	180	18,780	182	10,116	3/4	18	12780	56.8	1070	4.76	0.143	0.213
24	1	220	21,730	230	12,589	7/8	22	17280	76.9	1440	6.41	0.195	0.290
28	1-1/8	293	29,000	286	15,286	1	24	22230	98.9	1850	8.23	0.253	0.377
30	1-1/4	337	33,050	324	18,434	1 1/16	26	25200	112	2100	9.34	0.287	0.427
36	1-1/2	476	47,560	500	26,876	1 1/8	28	28260	126	2360	10.5	0.322	0.479
40	1-5/8	586	58,910	610	31,473	1 1/4	30	34830	155	2900	12.9	0.397	0.591
44	1-3/4	690	68,000	752	38,217	1 3/8	32	38250	170	3190	14.2	0.437	0.650
48	2	790	78,000	950	48,333	1 1/2	36	48600	216	4050	18.0	0.570	0.848
						1 5/8	40	57375	255	4780	21.3	0.673	1.00
						1 3/4	44	66150	294	5510	24.5	0.780	1.16
						2	48	84600	376	7050	31.4	1.00	1.49

Tensile Strengths are averages for new ropes tested under laboratory conditions and may vary by 10%.
Weights are average and may vary by 5%. Polypropylene specifications are based on the closest equivalent Canadian Standards (40-GP-13M)

2. Basic knowledge of materials used (4)

- Type of appendage

Tarpaulin

Old net

Old rope



3. Issues of existing FAD

1) FAD submersion problem under strong current



Reduction of operation days

2) Loss of FAD by vessel propeller's cutting, or
by strong current



More cost required for replacement

Reduction of operation days



Reduction of productivity of FAD fishery

4. Ideas for improvement (1)

“How to make a FAD non submergible, economically and effectively”



- By increasing buoyancy and sinking force safely and economically
- By increasing length of mooring rope effectively and economically



<Suggestions>

- **Sandbag anchors**: to increase sinking (anchoring) force easier and safer
- **Attachment of mid-water buoy**: to straight mooring rope from anchors to mid-water buoy (100~200m below surface) as much as possible
- **Additional length (3times x 200m) of mooring rope in upper- side of mid-water buoy**: to give enough sag of rope to prevent FAD from submerging

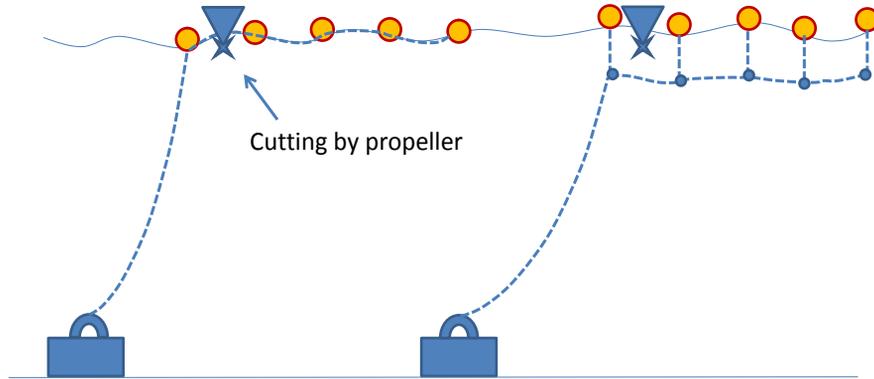
<Effect of suspension rope from buoy>

Suspension rope from buoy: to prevent buoy rope from cutting by propeller of boats passing between buoys

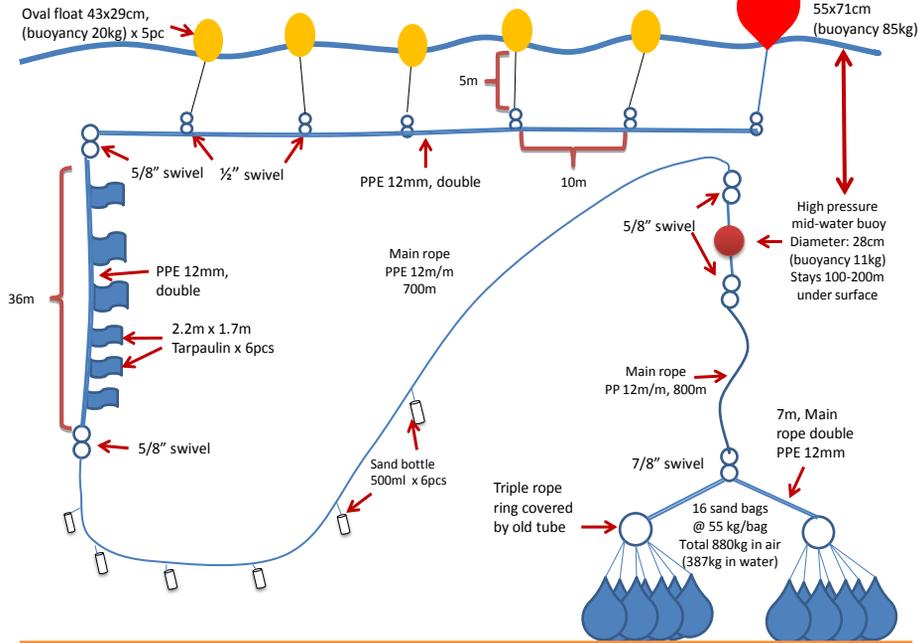
<Scenario1>

Boat passing between buoys

<Scenario2>



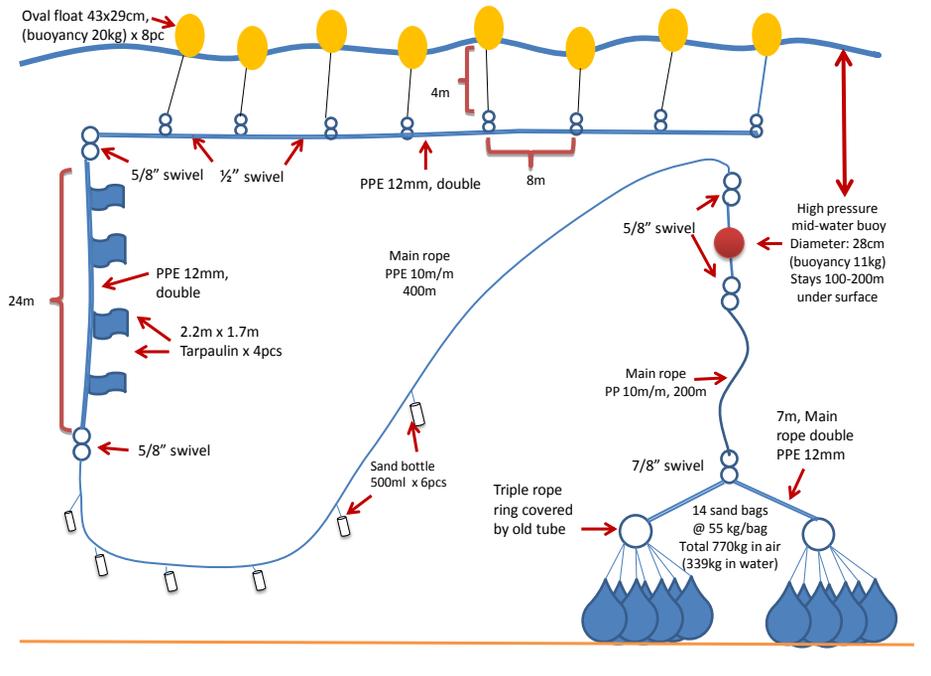
5. Improved FAD design for 1,000m depth (1)



Material List for FAD in 1,000m depth (1)

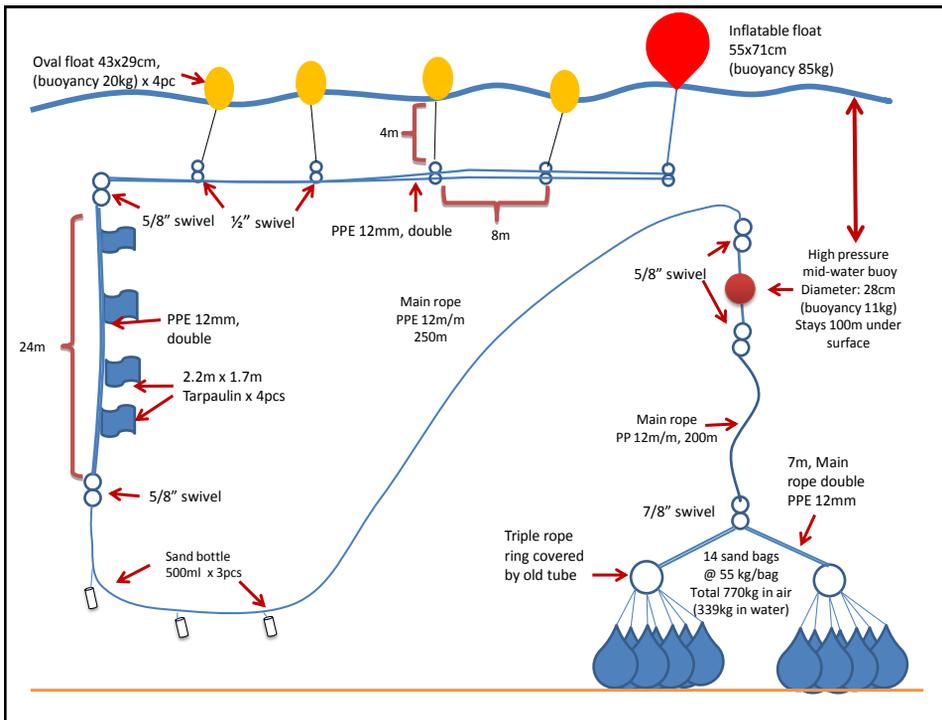
No.	Item	Description	QTY	Unit price	Price(US\$)	Remarks	Buoyancy	Sinking force
1	Polyform float	A-4, 55x71cm, buoyancy 85kg (red)	1	75	75	Inflatable buoy	85kg	
2	Oval float	30G-2 ABS 200m, 437mmx290mm+40mmHole, buoyancy 20kg (yellow)	5	28.6	143	Head parts	100kg (20x5)	
3	Swivel	Galvanized Eye&eye swivel 1/2", 0.64kg/pc	6	13.5	81	for floats		3.3kg (0.64x6x0.87)
4	Tarpaulin	2.2mx1.7m	7	10	70	appendages		
5	Duradan PPE rope	12mm/dia x 250m/coil, 16.5kg/coil, breaking load 2,654kg (green)	1,000	0.37	370	main rope for FAD, 4coils	3.6kg [16.5x(1/0.93-1)x3]	
6	Sand bottle	500ml plastic bottle with sand	6	0	0	sinkers for rope		1.3kg (0.5x6x0.44)
7	Duradan PPE rope	12mm/dia x 250m/coil, 11.9kg/coil, breaking load 2,654kg (green)	750	0.37	277.5	main rope for FAD, 3coils	3.6kg [16.5x(1/0.93-1)x3]	
8	Swivel	Galvanized Eyw&eye swivel 5/8", 1.2kg/pc	4	21	84	for appendages & mid-water buoy		4.1kg (1.2x4x0.87)
9	Pressure float	ABS float, 10h-8, dia x hole: 290 x 28mm, buoyancy 11,000g, water resist 800m	1	96	96	High pressure type, mid-water buoy for FAD	11kg	
10	Swivel	Galvanized Eye&eye swivel 7/8", 2.9kg/pc	1	42	42	for anchor part		2.5kg (2.9x1x0.87)
11	Sand bag	Synthetic bag 550x850mm (for 60kg)	16	3.5	56	55kg sand/bag as FAD anchor		387kg (55x16x0.44)
						Total	202.3kg	398.2kg
	Duradan PPE rope	4mm/dia x 500m/coil, breaking load 338kg (green)	250	0.06	15	working rope	1/2coil	
	Garden hose		20		0	for rope reinforcement		
	Tyre tube		2		0	for rope reinforcement		
					US\$ 1309.5			

5. Improved FAD design for 400m depth (2)



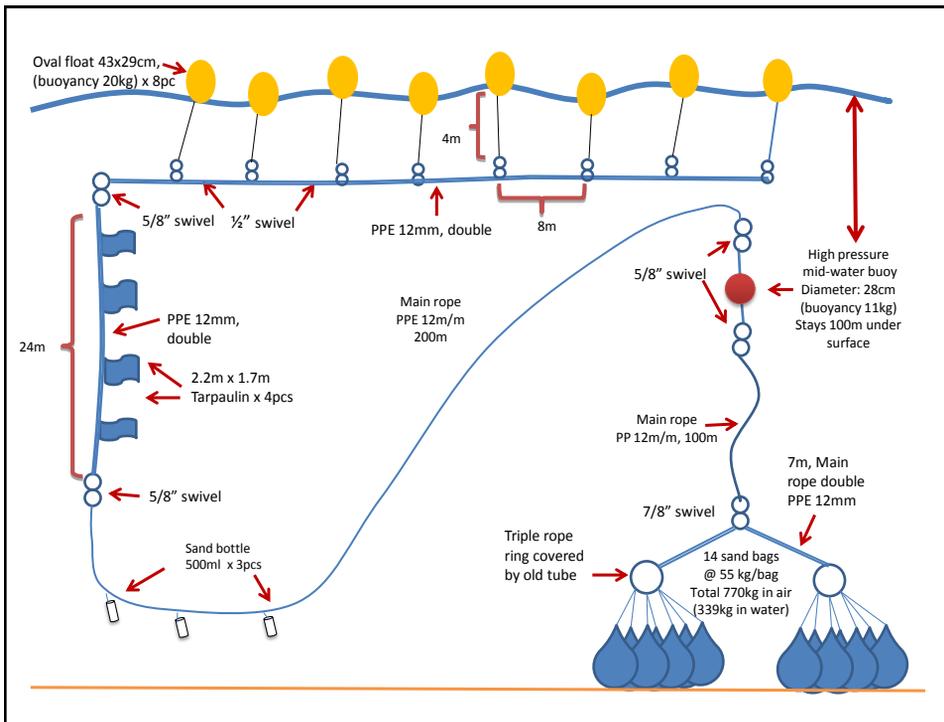
Material List for FAD in 400m depth (2)

No.	Item	Description	QTY	Unit price	Price(US\$)	Remarks	Buoyancy	Sinking force
1	Oval float	30G-2 ABS 200m, 437mmx290mm+40mmHole 20kg buoyancy (yellow)	8	28.6	228.8	Head parts	160kg (20x8)	
2	Swivel	Galvanized Eye&eye swivel 1/2", 0.64kg/pc	8	13.5	108	for oval floats		4.5kg (0.64x8x0.87)
3	Tarpaulin	2.2mx1.7m	4	10	40	appendages		
4	Duradan PPE rope	12mm/dia x 250m/coil, 16.5kg/coil breaking load 2654kg (green)	250	0.37	92.5	buoy & anchor extention rope	1.2kg [16.5x(1/0.93-1)]	
5	Sand bottle	500ml plastic bottle with sand	6	0	0	sinkers for rope		1.3kg (0.5x6x0.44)
6	Duradan PPE rope	10mm/dia x 250m/coil, 11.9kg/coil, breaking load 1908kg (green)	750	0.26	195	main rope for FAD 3coils	2.7kg [11.9x(1/0.93-1)x3]	
7	Swivel	Galvanized Eyw&eye swivel 5/8"	4	21	84	for appendages & mid-water buoy		4.1kg (1.2x4x0.87)
8	Pressure float	ABS float, 10b-8, dia x hole: 290 x 28mm, buoyancy 11,000g, water resist 800m	1	96	96	High pressure type, mid-water buoy for FAD	11kg	
9	Swivel	Galvanized Eye&eye swivel 7/8"	1	42	42	for anchor part		2.5kg (2.9x1x0.87)
10	Sand bag	Synthetic bag 550x850mm (for 60kg)	14	3.5	49	55kg/bag as FAD anchor		339kg (55x14x0.44)
						Total	175kg	351.4kg
	Duradan PPE rope	4mm/dia x 500m/coil, breaking load 338kg (green)	250	0.06	15	working rope	1/2coil	
	Garden hose		20			for rope reinforcement		
	Tyre tube		2			for rope reinforcement		
					US\$ 950.3			



Material List for FAD in 300m depth (3)

No.	Item	Description	QTY	Unit price	Price(US\$)	Remarks	Buoyancy	Sinking force
1	Polyform float	A-4, 55x71cm, buoyancy 85kg (red)	1	75	75	Inflatable buoy	85kg	
2	Oval float	30G-2 ABS 200m, 437mmx290mm+40mmHole, buoyancy 20kg (yellow)	4	28.6	114	Head parts	80kg (20x4)	
3	Swivel	Galvanized Eye&eye swivel 1/2", 0.64kg/pc	4	13.5	54	for floats		2.2kg (0.64x4x0.87)
4	Tarpaulin	2.2mx1.7m	4	10	40	appendages		
5	Duradan PPE rope	12mm/dia x 250m/coil, 16.5kg/coil, breaking load 2,654kg (green)	250	0.37	92.5	main rope for FAD, 4coils	1.2kg [16.5x(1/0.93-1)x1]	
6	Sand bottle	500ml plastic bottle with sand	3	0	0	sinkers for rope		0.66kg (0.5x3x0.44)
7	Duradan PPE rope	12mm/dia x 250m/coil, 11.9kg/coil, breaking load 2,654kg (green)	200	0.37	74	main rope for FAD, 3coils	1.2kg [16.5x(1/0.93-1)x1]	
8	Swivel	Galvanized Eyw&eye swivel 5/8", 1.2kg/pc	4	21	84	for appendages & mid-water buoy		4.1kg (1.2x4x0.87)
9	Pressure float	ABS float, 10h-8, dia x hole: 290 x 28mm, buoyancy 11,000g, water resist 800m	1	96	96	High pressure type, mid-water buoy for FAD	11kg	
10	Swivel	Galvanized Eye&eye swivel 7/8", 2.9kg/pc	1	42	42	for anchor part		2.5kg (2.9x1x0.87)
11	Sand bag	Synthetic bag 550x850mm (for 60kg)	14	3.5	49	55kg sand/bag as FAD anchor		339kg (55x14x0.44)
						Total	178.4kg	348.5kg
	Duradan PPE rope	4mm/dia x 500m/coil, breaking load 338kg (green)	250	0.06	15	working rope	1/2coil	
	Garden hose		20		0	for rope reinforcement		
	Tyre tube		2		0	for rope reinforcement		
					US\$	735.5		



Material List for FAD in 200m depth (4)

No.	Item	Description	QTY	Unit price	Price(US\$)	Remarks	Buoyancy	Sinking force
1	Oval float	30G-2 ABS 200m, 437mmx290mm+40mmHole 20kg buoyancy (yellow)	8	28.6	228.8	Head parts	160kg (20x8)	
2	Swivel	Galvanized Eye&eye swivel 1/2", 0.64kg/pc	8	13.5	108	for oval floats		4.5kg (0.64x8x0.87)
3	Tarpaulin	2.2mx1.7m	4	10	40	appendages		
4	Duradan PPE rope	12mm/dia x 250m/coil, 16.5kg/coil breaking load 2654kg (green)	200	0.37	74	buoy & anchor extention rope	1.2kg [16.5x(1/0.93-1) x]	
5	Sand bottle	500ml plastic bottle with sand	6	0	0	sinkers for rope		1.3kg (0.5x6x0.44)
6	Duradan PPE rope	10mm/dia x 250m/coil, 11.9kg/coil, breaking load 1908kg (green)	100	0.26	26	main rope for FAD 3coils	0.5kg [11.9x(1/0.93-1) x2/5]	
7	Swivel	Galvanized Eyw&eye swivel 5/8"	4	21	84	for appendages & mid-water buoy		4.1kg (1.2x4x0.87)
8	Pressure float	ABS float, 10b-8, dia x hole: 290 x 28mm, buoyancy 11,000g, water resist 800m	1	96	96	High pressure type, mid-water buoy for FAD	11kg	
9	Swivel	Galvanized Eye&eye swivel 7/8"	1	42	42	for anchor part		2.5kg (2.9x1x0.87)
10	Sand bag	Synthetic bag 550x850mm (for 60kg)	14	3.5	49	55kg/bag as FAD anchor		339kg (55x14x0.44)
						Total	175kg	351.4kg
	Duradan PPE rope	4mm/dia x 500m/coil, breaking load 338kg (green)	250	0.06	15	working rope	1/2coil	
	Garden hose		20			for rope reinforcement		
	Tyre tube		2			for rope reinforcement		
					US\$ 762.8			

6. References

1. Troll fishing & Fish Aggregation Device (FAD) : Regional Fisheries Training Project in Trinidad, JICA/CFTDI 2001
2. FAD fishing digital textbook 1~4: Study on Formulation of Master Plan on Sustainable Use of Fisheries Resources for Coastal Community Development in the Caribbean, CRFM/JICA, 2010
3. Baseline survey report: Project for Promotion of Grace of the Seas for Coastal Villages in Vanuatu, Phase 2, Vanuatu Fisheries Department / JICA 2012