Seaplane Data Base

Author **Benedikt Mohr**
Joachim Schömann

Technische Universität München

Garching, Germany

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Institute for Aerospace Systems
Technische Universität München
Boltzmannstr. 15
85747 Garching
Germany

Author:
Benedikt Mohr
Phone: +49.89.28915990
Fax: +49.89.28915982
mohr@tum.de
www.fusetra.eu

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1.0	27/05/2010	Mohr	24	Initial write
1.1	31/05/2010	Mohr	24	Data update
1.2	19/08/2011	Schömann	60	Data update, inclusion of survey, seaports, fire fighting aircraft and emphasizing of most important aircraft
1.3	06/09/2011	Schömann	68	Data update

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FUSETRA	Future Seaplane Traffic
CA	Consortium Agreement
EU	European Union
EC	European Community
FP7	Framework Programme 7
URL	Uniform Resource Locator
WPL7	Leader of Work Package 7

1 Introduction

The objective of this document is to establish a database that represents the status quo in the following fields:

- Seaplane aircraft & manufacturers
- Seaplane operators
- Seaplane organizations
- Sea dromes

Used sources were the aircraft compendium Jane's All the World's Aircraft (Jane's Information Group, 2003) and several sources on the internet. Although there is considerable activity in the field of ultra-light seaplanes, the focus in this document is on transport aircraft.

The identification of the State-of-the-Art of seaplane operations worldwide is a critical part of WP1. Historical data about seaplane and amphibian aircraft and types of operation was found useless for investigations about the current transport system as aircraft models have mainly been designed for military purposes before and during World War II.

To get an overview about the current application of seaplanes and amphibians, a thorough investigation of active operators and aircraft used was undertaken using their internet presences as well as the national registration databases. Additionally an online survey has been created and made accessible to operators worldwide on the project website.

The following topics have been identified as subject of interest for the survey:

- General Information about Seaplane Operators
- Operational Issues
- Pilots, Regulations and Certification
- Infrastructure and Aircraft
- General issues and comments on the future development of the seaplane transport system.

Over 300 operators were asked to participate in the survey. It was unclear from the list, which of the companies are still operating especially as the invitations

were sent out in winter 2009, still in the wake of the world financial crisis. With 28 participants it is hence also unclear which percentage of the active operators was covered.

2 Aircraft

2.1 Aircraft Manufacturers

Table 1 gives an overview of the currently active manufacturers of seaplanes or amphibians. Also companies who have not yet started manufacturing or obtained a type certificate are included.

Name	**Country**	**URL**
Aztec Nomad	Canada	http://www.aztecnomad.com/
Viking Air	Canada	http://www.vikingair.com/
Dornier Seawings	Germany	http://dornierseastar.de/home.html
Dornier Aviation	Germany	http://www.do-sray.com/
ShinMaywa	Japan	http://www.shinmaywa.co.jp/
Beriev	Russia	http://www.beriev.com
Idea Aircraft	Hungary	http://www.ideaaircraft.com
Centaur Seaplane	United Kingdom	http://www.centaurseaplane.com/
Aviat	USA	http://www.aviataircraft.com/
Bombardier	USA	http://bombardier.com/
Cessna	USA	http://cessna.com/
Lake	USA	http://www.teamlake.com/
Progressive Aerodyne	USA	http://www.searey.com/
Quest Aircraft Company	USA	http://questaircraft.com/
Seawind	USA	http://www.seawind.net/

Table 1: List of aircraft manufacturers

Within the list of aircraft discussed in the following sections, it will be shown that the models of former Canadian manufacturers De Havilland Canada (DHC) and Canadair are among the most frequently used. The type certificates of the company are nowadays owned by Viking Air and Bombardier respectively. The general

impression given by the list of manufacturers clearly is that most manufacturers and especially manufacturers with high numbers of aircraft sold are situated in North America.

The situation is very similar for the float manufacturers that are listed in Table 2. Aircraft manufacturers that produce their own floats are excluded. Furthermore, manufacturers of floats for ultra-light or experimental aircraft were not included.

Name	**Country**	**URL**
Aerocet Floats	USA	http://www.aerocet.com
Aqua Floats	USA	http://www.aquafloat.com/
Baumann Floats	USA	http://www.baumannfloats.com/
Wipaire	USA	http://www.wipaire.com/
Zenair	USA	http://www.zenithair.com
Mead Floats	USA	http://meadfloats.com/
Edo Floats (Kenmore Air)	USA	http://www.kenmoreair.com/parts/EDOfloats/

Table 2: List of float manufacturers

2.2 Historic Aircraft

For the scope of this document, the term seaplane shall include all aircraft operating on water. The two possible configurations are flying boats, with a shaped fuselage and floatplanes with a conventional body and floats installed as a landing gear. Both configurations can also be equipped with a retractable wheeled landing gear, making the aircraft amphibious

Amphibious Floatplane	Floatplane	Amphibious Flying Boat	Flying Boat
			

Table 3: Types of seaplanes (Ontario Ministry of Natural resources, 2009) (de Havilland Canada DHC-6 Twin Otter, 2007) (www.luftfahrt.ch, 2004) (Dornier Wal, 2008)

In total, 254 aircraft types were found and added to the data base. The complete list of aircraft can be found in Appendix A.

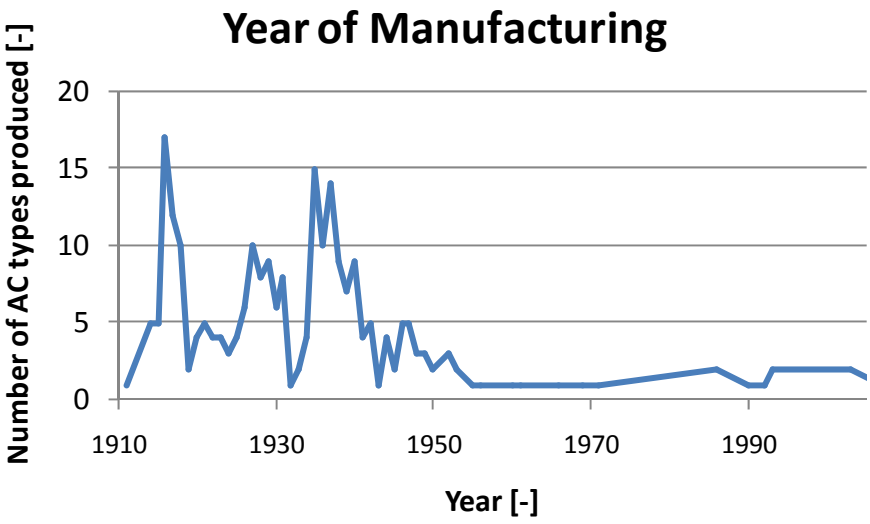

Figure 2-1: Seaplane manufacturing timeline

To evaluate the current situation of seaplane aviation, the first step of processing the data is to create a timeline of aircraft designed and manufactured. Figure 2-1 shows new seaplane designs per year, where the first flight marks the year. It is clearly to be seen, that the height of the seaplanes and amphibians was the pre-World War 2 era. Since then the number of new aircraft stays on a constant low level of one or two mostly very small two- to four-seater models per year. The peak beginning in the early nineteen thirties can be explained with the fact that neither tires for high loads nor a sufficient number of airports were available. Furthermore the missions of the aircraft of that era in the data base include specifically maritime military tasks like coastal defense, and combat with airships and submarines. Taking a look at all the operations performed, given in Figure 2-2, reconnaissance seems to be the most important one followed by passenger transport.

To get an impression of the size of the aircraft in the complete data base, Figure 2-3 shows the percentages if today's certification classes were applied. The bigger part is aircraft with takeoff mass higher than 5670kg that would nowadays be certified under CS-25. With the plain numbers for payload and takeoff mass given in Figure 2-4 and Figure 2-5 it can be seen that there was a tendency to use flying

boats for applications with higher payload and range. It can also be seen that the range of most of the models in the data base stays below 1000nm (1852km).

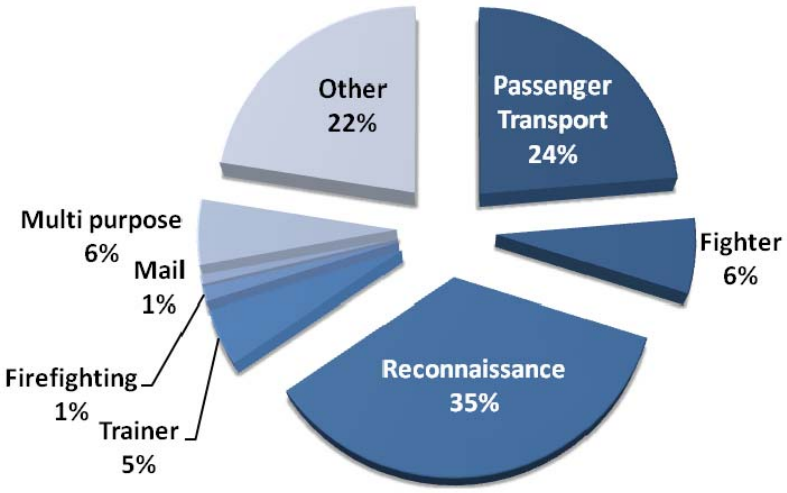

Figure 2-2: Seaplane mission types

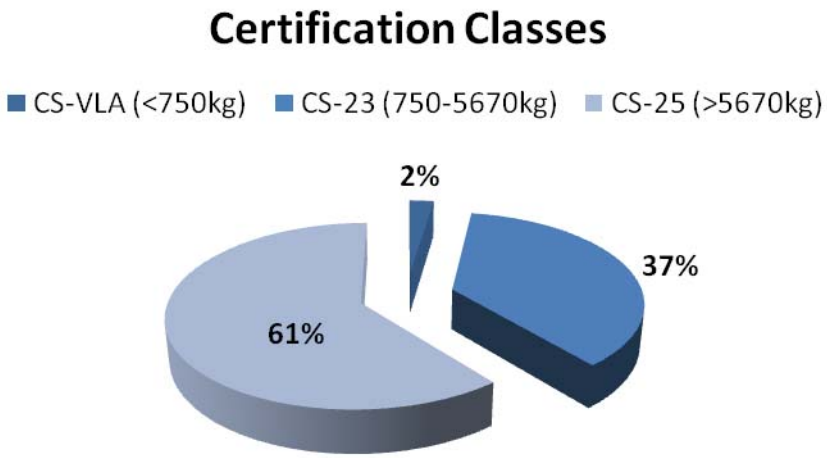

Figure 2-3: Seaplane certification classes

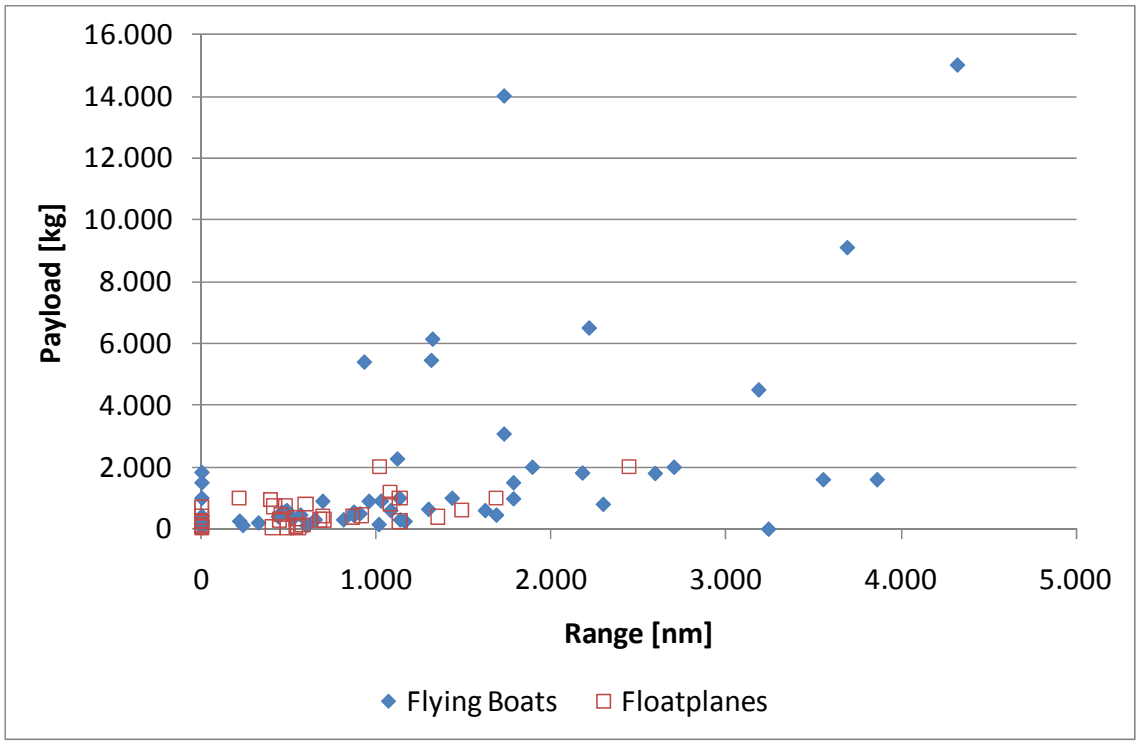

Figure 2-4: Payload and range for historical seaplanes

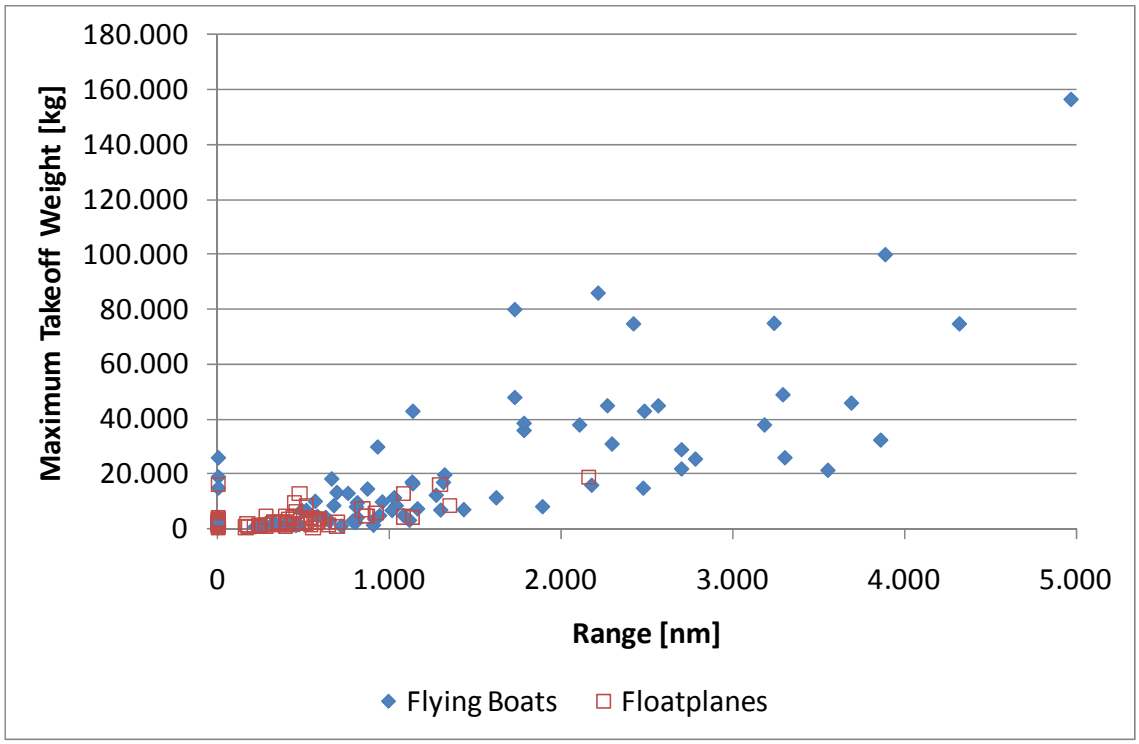

Figure 2-5: Maximum takeoff weight and range for historical seaplanes

2.3 Currently operated aircraft

From the historical data collected it is not possible to draw any conclusion about the seaplane transportation system of today. Therefore it has to be clarified which of the aircraft is still operated. This is done by an operator survey as well as with investigations within the national registration data bases and in the internet.

2.3.1 Operator survey

Figure 2-6 shows the types and amount of aircraft operated by the survey participants. Furthermore, the fleets of relevant other commercial operators were incorporated into this and the following figures of this section. The overall number of aircraft comprised is 136. The absolute numbers for each aircraft are given in Table 4. It can be seen that distribution of used aircraft is very uneven. For a big part of the models there is only one reported to be in operation. The models of Cessna and especially De Havilland Canada are by far the most popular with the participating operators.

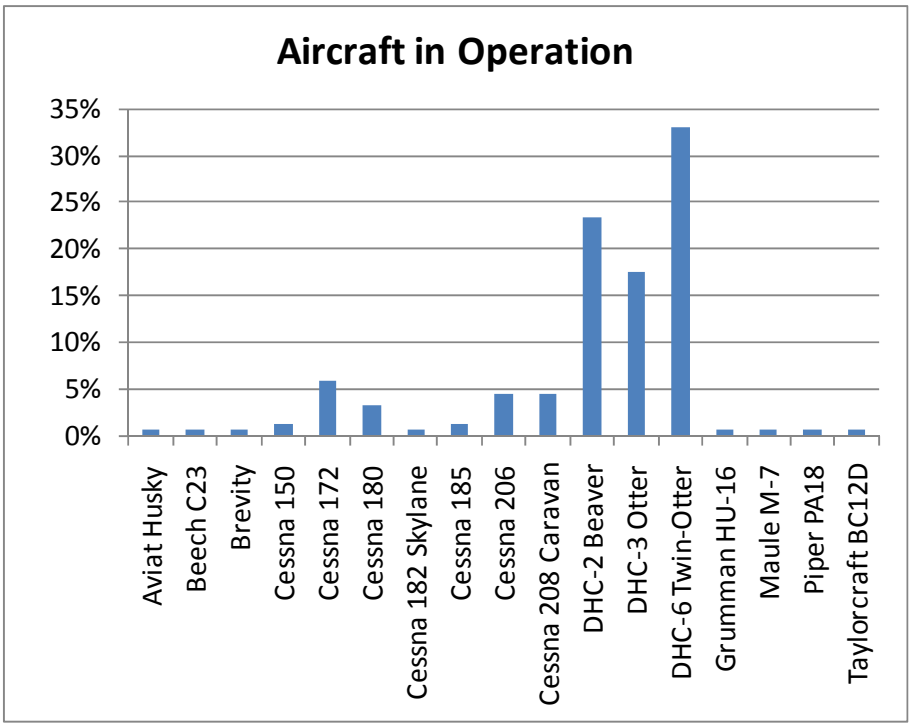

Figure 2-6: Aircraft in Operation

Relating the used aircraft with their passenger capacities given in Table 4 leads to the percentages of different sizes of aircraft given in Figure 2-7. Contrary to the statement on size given in Figure 2-3, all used aircraft could be certified under CS-

23. The biggest percentage of aircraft is in the range from seven to nineteen passengers.

	Amount	PAX
Aviat Husky	1	1
Beech C23	1	3
Brevity	1	5
Cessna 150	2	1
Cessna 172	9	3
Cessna 180	5	4
Cessna 182 Skylane	1	3
Cessna 185	2	5
Cessna 206	7	5
Cessna 208 Caravan	7	9
DHC-2 Beaver	36	7
DHC-3 Otter	27	11
DHC-6 Twin-Otter	52	19
Grumman HU-16	1	19
Maule M-7	1	3
Piper PA18	1	1
Taylorcraft BC12D	1	1

Table 4: Aircraft capacities and amount in use by survey participants

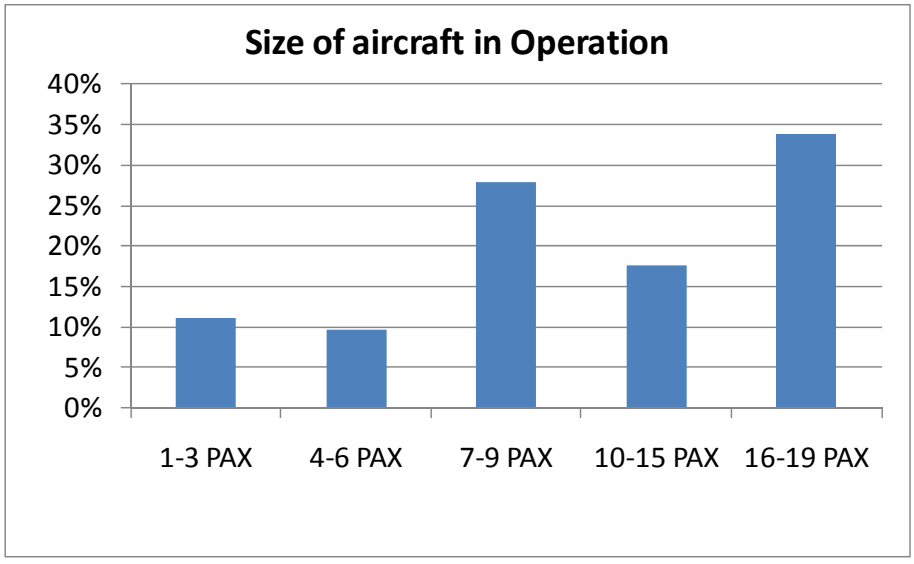

Figure 2-7: Size of aircraft in operation

For all the aircraft collected, the percentages of the used type of undercarriage or seaplane type are shown in Figure 2-8. It can be seen that the floatplane is almost the only relevant type of seaplane currently operated. The one percent of flying boats solely consists of the historic Grumman HU-16 used for the scenic flights and the portion of conventional landing gears is included because operators mixed seaplane/landplane fleet included all aircraft in the survey.

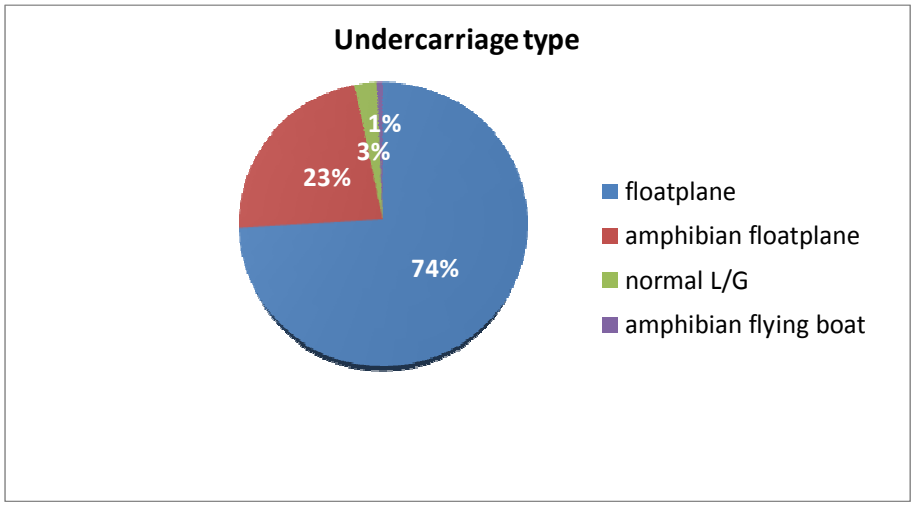

Figure 2-8: Undercarriage types

2.3.2 Restrictions because of availability of suitable aircraft

Operators were asked if they see the growth of a future seaplane transport system being restricted by the availability of suitable aircraft. At least 41% answered YES to this question. The year of first manufacturing of most seaplanes in operation has been several decades ago and the wish for efficient new aircraft is rising. Operators indicate the will to participate in the definition of requirements towards new aircraft in future FUSETRA surveys.

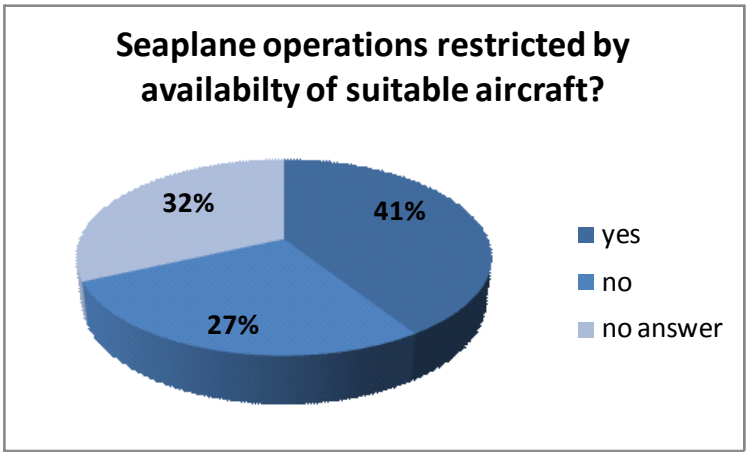

Figure 2-9 Restrictions by available aircraft

2.3.3 Future Aircraft Requirements

The main requirements towards future aircraft have been asked, too. The requested payload lies between 250kg and 1500kg for the greatest part of operators. Only few requested larger payloads over 4 tons.

Payload Requirement [kg]	**% of operators**
<500 kilograms	29%
500-1000 kilograms	29%
1000-1500 kilograms	29%
>1500kg (i.e. 4800kg, 5600kg)	14%

Table 5 Payload requirements

The range requirements are more uniform and show that characteristic stage lengths are far below conventional commercial operations.

Range Requirement [nm]	**% of operators**
< 250 nautical miles	30%
250- 450 nautical miles	30%
450- 650 nautical miles	20%
650- 850 nautical miles	20%
> 850 nautical miles	0%

Table 6 Range requirements

The required speed for future seaplanes is ranging from 140-180 knots.

Additional comments on features which should be considered in aircraft development in future:

- Capable of operating in open / rough water (good sea state capability)

- High wing
- Amphibian
- IFR capable (Instrument Flight Rules)
- Engine designed to cope with very short cycles in the area of 5/hr
- Hot salt water tolerant resistance
- Good visibility for passengers
- Suitable for use in confined areas
- Suitable for working with boats
- Low operating costs

2.4 Registration data base

Registration databases of the National Aviation Authorities (NAA) theoretically offer the possibility to get an overview of the seaplanes currently registered. As stated in 2.3.1, all relevant seaplanes are floatplanes which in all cases means, that there is also a landplane version available. In most of the registration databases unfortunately it is impossible to distinguish between land- and seaplane. Therefore, the most important aircraft described in 2.5 are derived from those that operators identified use. With the importance of online presence nowadays it is very improbable that the internet recherche missed any relevant operators hence any aircraft important for today's seaplane operation.

What is possible with the registration data base is to identify the amount of registered flying boats.

	USA	**Canada**
Grumman G-21 "Goose"	62	0
Bombardier CL-215/ CL-415	5	58
PBY Catalina	14	0

Table 7: Most numerous flying boats registered in the US and Canada (FAA Registry, 2011) (Canadian Civil Aircraft Register, 2011)

The Grumman G-21 and the PBY Catalina are mostly operated by private persons or in very small commercial airlines. The Bombardier CL-215 is a water bomber and almost exclusively registered to governmental organizations related with fire fighting. For the determination of the most important aircraft for aerial firefighting anyway not only the results from registration databases are used but also information on aircraft used by the responsible institutions responsible for firefighting, that are listed in 3.1.

2.5 Main characteristics of the most important aircraft

2.5.1 Commercial Transport

The most important aircraft in current seaplane operation are displayed in Table 8.

	PAX	Year of first flight	Time of production
Cessna 172 “Skyhawk“	3	1955	1955 - today
Cessna 180	4	1952	1953 - 1981
Cessna 185 “Skywagon II”	5	1960	1961 - 1985
Cessna 206 “Stationair”	5	1964	1965 - today
Cessna 208 “Caravan”	9	1982	1983 - today
DHC-2 “Beaver”	7	1947	1947 - 1967
DHC-3 “Otter”	11	1951	1951 - 1967
DHC-6 “Twin-Otter”	19	1965	1965 – 1998; 2008 - today
Quest Kodiak	10	2004	2007 - today

Table 8: Most important transport aircraft

All the listed aircraft are floatplanes. None of the floats are retractable which means that a lot of performance losses are created due to the additional undercarriage drag. Also it has to be noted that the newest of the aircraft is the Cessna 208 which is already 30 years old. Although updates with new turbine engines or parts of the aircraft made out of composite materials exist, especially the fact that the biggest part of the aircraft is made of metal is a very big problem for waterborne operation. Protection from corrosion requires a maintenance effort incomparably higher than for landplanes.

	Cessna 172	**Cessna 180**	**Cessna 185**	**Cessna 206**	**Cessna 208**
MTOW [kg]	1.111	1.270	1.520	1,632	3.792
Empty Weight [kg]	745	771	793	206H: 987 T206H: 1034	2.598
Span [m]	11,0	10,9	10,9	11,0	15,9
Wing area [m^2]	16,17	16,2	16,2	16,3	26,0
Propulsion	1 x piston engine (119 kW)	1 x piston engine (170 kW)	1 x piston engine (220 kW)	206: 1 x piston engine (224 kW) T206: 1 x supercharged piston engine (231 kW)	1 x turboprop (503 kW)
Cruise Speed [km/h]	226	274	269	206H: 263 T206H: 304	282
Range [km]	1074	1.650	1330	206H: 1352 T206H: 1281	1.519

Table 9: Technical data of Cessna aircraft (Jane's Information Group, 2003)

	DHC-2	DHC-3	DHC-6
MTOW [kg]	2.313	3.629	5.670
Empty Weight [kg]	1.361	2.010	3.200
Span [m]	14,6	17,7	19,8
Wing area [m^2]	23,2	34,8	39,0
Propulsion	DHC-2: 1 x radial engine (336 kW) DHC-2T: 1 x turboprop engine	DHC-3: 1 x radial engine (448 kW) DHC-3T: 1 x turboprop engine	-100 to -300: 2 x radial engine (507 kW each) -400: 2x turboprop engine (559 kW each)
Cruise Speed [km/h]	143	195	278
Range [km]	732	1.520	1.690

Table 10: Technical data of DeHavilland or Viking Air aircraft (Jane's Information Group, 2003)

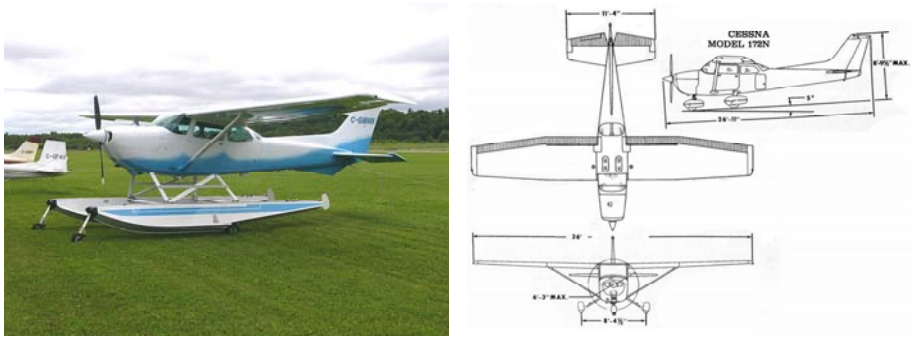

Figure 2-10: Photo and 3-view of the Cessna 172 (Cessna 172, 2008) (Cessna 172,n.d.)

Figure 2-11: Photo and 3-view of the Cessna 185 (Cessna 185, 2006) (3 View Aircraft –Index Directrory, n.d.)

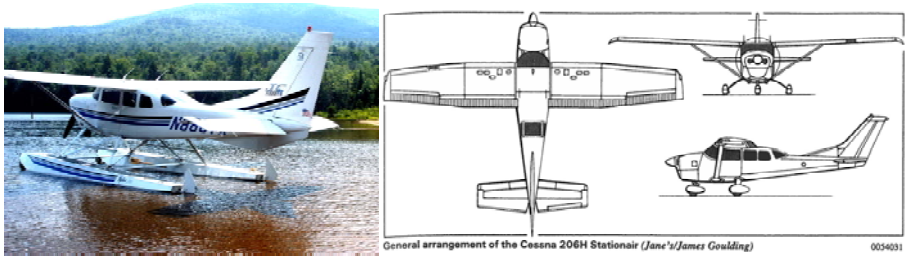

Figure 2-12: Photo and 3-view of the Cessna 206 (Cessna 206, 2007)

Figure 2-13: Photo and 3-view of the Cessna 208 (Cessna 208, 2005) (Caravan Amphibian, 2009)

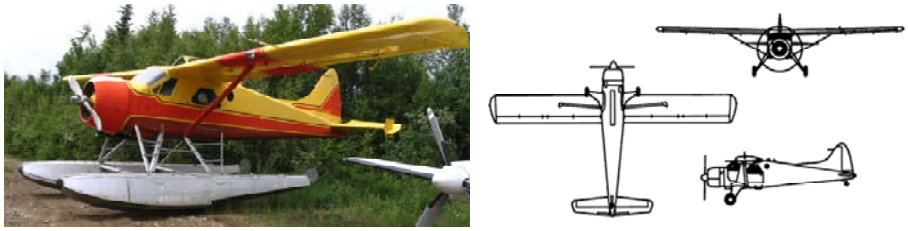

Figure 2-14: Photo and 3-view of the DHC-2 (de Havilland Canada DHC-2 Beaver, 2007)

Figure 2-15: Photo and 3-view of the DHC-3 (de Havilland Canada DHC-3 Otter, 2007)

Figure 2-16: Photo and 3-view of the DHC-6 (de Havilland Canada DHC-6 Twin Otter, 2007)

Reliable detailed data on the aircraft performance is very difficult to obtain, because most are not manufactured anymore. Therefore the losses due to the float installation shall be shown with the example of the Cessna 208. The manufacturer offers payload range diagrams for both the amphibian and the land version that can be seen in Figure 2-17. When comparing the two versions, it is important to know that the landplane version also does not have a retractable landing gear, so performance losses are less obvious than in comparison to an ideal aircraft. From the data of float manufacturers it can be stated that the addition of straight floats adds 439 kg to the aircrafts weight while straight floats only account for 334 kg. The fact that in Figure 2-17 the difference in payload is lower than the weight penalty for the undercarriage installation can be explained with the higher takeoff weight of the amphibian version.

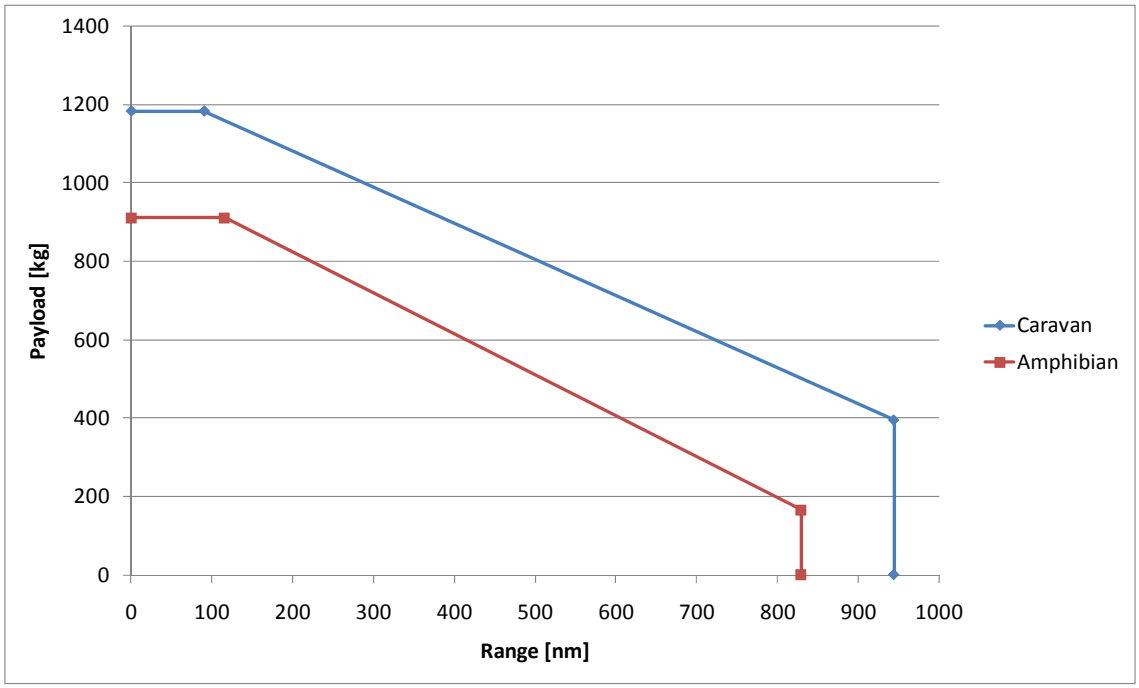

Figure 2-17: Payload-Range diagram for the Cessna 208 version Caravan and Amphibian (Caravan Amphibian, 2009)

Another index to compare the performance of both versions is the cost per mile and hour given by the manufacturer and in Table 11. "The value represents costs for fuel, parts, airframe maintenance, and powerplant maintenance. A fuel cost of $5.00 per gallon and a shop Rate of $85.00 per hour is assumed. Actual operating cost will vary according to mission profiles flown, maintenance practices, and utilization."

	Caravan Amphibian	**Caravan 675**
Base Price	$1,886,548	$1,886,548
Typically-Equipped Price	$2,357,368	$2,114,168
Estimated Direct Operating Costs		
Cost per Nautical Mile	$2.78	$2.40
Cost per Hour	$417.40	$422.40

Table 11: Cost of the Cessna 208 amphibian and landplane version (Caravan Amphibian, 2009)

2.5.2 Firefighting

Aircraft mostly operated for aerial firefighting include the Bombardier (former Canadair) CL-215 and its successor the CL-415, the smaller Air Tractor AT-802 Fireboss, and the bigger Beriev Be-200. Their key data is given in Table 12 and Table 13.

	Capacity in [L]	**Year of first flight**
Bombardier CL-215	4.900	1967
Bombardier CL-415	6.140	1993
Air Tractor AT-802	3.050	1990
Beriev Be-200	11.800	1998

Table 12: Most important aircraft for aerial firefighting (Jane's Information Group, 2003) (Jane's Information Group, 1993)

As to be seen from the data of the firefighting entities given in Table 17, the Bombardier models are by far most widely spread. Contrary to the commercial transport aircraft, the so called water bombers are mostly flying boats, an exception is the Air Tractor AT-802.

Figure 2-18: Air Tractor AT-802 (top left), Beriev Be-200 (top right), Bombardier CL-215 (bottom left) and CL-415 (bottom right) (Air Tractor AT-802, 2009) (Beriev Be-200, 2008) (Canadair CL-215, 2007) (Bombardier 415, 2006)

	CL-215	CL-415	AT-802	Be-200
MTOW [kg]	17.100 (from water) 19.730 (from land)	17.170 (from water) 19.890 (from land)	7.257	37.900 (from water) 41.000 (from land)
Empty Weight [kg]	12.065	12.880	2.951	27.600
Span [m]	28,6	28,6	18,1	32,8
Wing area [m^2]	100,3	100	37,25	117,4
Propulsion	2 radial engines (1.566 kW each)	2 turboprop engines (1.775 kW each)	1 turboprop (1.007 kW)	2 turbofans (16.534 lbf each)
Cruise Speed [km/h]	192	333	356	560
Range [km]	2.260	2.443	1.289	2.100

Table 13: Technical data for firefighting seaplanes (Jane's Information Group, 2003) (Jane's Information Group, 1993)

2.6 Aircraft currently in development

There are two strategies for providing future seaplanes followed by the manufacturers: Updating of existing models and developing of new ones. Viking Air is the certificate holder for the DHC-2, -2T, -3, -6, -4, -5 and -7 aircraft. They manufacture the DHC-2T and DHC-6-400, where the latter is described as "all new" (Twin Otter – Series 400, n.d.)

Developments that are new from sketch are presented by Dornier Aviation and Centaur seaplane. Both chose the flying boat concept to optimize performance and both are made of composite materials. Dornier has planned an aircraft family called S-Ray. The 2-seater S-Ray 007 has already been flight tested excessively. The transport aircraft S-Ray 008 (8 Pax) and S-Ray 009 (up to 18 Pax) are future

projects. Their data is given in Table 14. In order to give the aircraft high sea stage capability the concept of the Sponsen is used. This design traditionally used by Dornier is a wing stub at low fuselage height. The actual wing is designed as high wing.

	S-Ray 007	**S-Ray 008**	**S-Ray 009**
Wing Span [m]	9	17	20
Length [m]	6,9	15,9	16,3
Height [m]	2,2	5,3	5,4
Propulsion	Limbach 2400 DT 100 kW Propeller Sensenich 3 blade	2x Austro Diesel Engine 300 kW each	2x PT6A-65B 820 kW each
Take off distance [m]	120	TBD	840
Landing distance [m]	120	TBD	587
MTOW [kg]	800	4500	8368
Empty weight [kg]	500	1700	4974
Payload [kg]	50	1500	1750 (with 2800 kg fuel)
Operating Speed [km/h]	180	TBD	Max Speed: 358,2
Range	TBD	6 PAX : 2222 Full PL: 1389	Empty: 3189 Full PL: 998

Table 14: Preliminary data of the Dornier S-Ray aircraft family (Wagner, 2010)

The design by Centaur Seaplanes comprises a low stub wing platform with floats at their tips. They planned versions are the Centaur 2 with 2 seats and the Centaur 6

with six or seven seats. For the Centaur 6 there is no data yet. The concept for the Centaur 2 was not yet proven in flight but there is preliminary data available that is available on the company's homepage (Centaur 2 Specifications, 2011)

Figure 2-19: Dornier S-Ray 007 during the flight test campaign (Dornier S-Ray 007,n.d.)

Russian manufacturer Beriev Company has presented plans to extend its range of amphibian aircraft by two models larger than those presented in this section. Both the Be-112 and the Be-114 are intended to be used for passenger and cargo transport, search and rescue and rescue activities and emergency services.

	Be-112	**Be-114**
Takeoff weight [kg]	11.000	22.000
Payload [kg]	2.350	6.000
Passengers	Up to 27	Up to 44
Propulsion	2 Deagel TVD-1500 turboprop, each 1062 kW	2 Klimov TV7-117 turboprop, each 2088 kW
Maximum speed at an altitude of 3000m [km/h]	420	530
Range [km]	1000	1000
Field length required [m]	850	1300

Table 15: Preliminary data of future Beriev designs (Anon., 2010)

3 Operators

3.1 Internet recherche

From an internet recherche, a list of 327 seaplane operators worldwide was gathered. The information in the complete list that is available electronically contains the complete postal address, the web address, phone, fax and email contact data as well as GPS coordinates for the headquarters. An excerpt can be found in Appendix B – Seaplane operators worldwide.

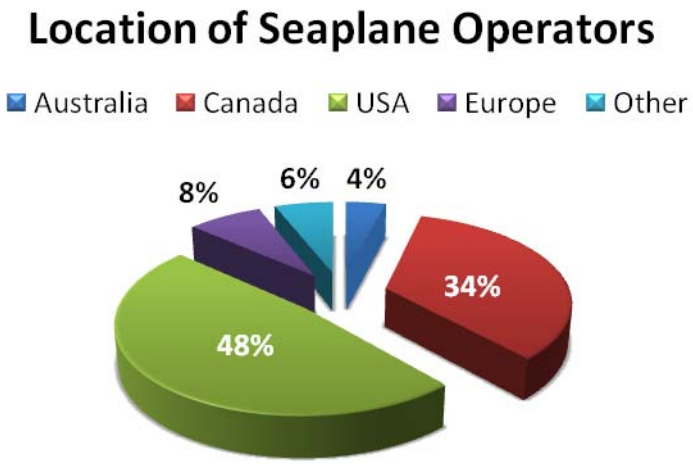

Figure 3-1: Location of seaplane operators

The worldwide distribution of seaplane operators in the list, given in Figure 3-1, very impressively shows the dominance of North America. Almost half of all operators are based in the United States, together with Canada it's even bigger than 80%.

The picture is similar when focusing on the biggest operators given in Table 16. Besides two Canadian carriers, including the biggest seaplane operator Harbour Air, there are two Australian companies, two in the USA and two Maldivian carries. Maldivian Air Taxi is the second biggest seaplane operator worldwide. Of the four European operators given, only Harbour Air Malta offers scheduled flights. The sole connection offered is between Valetta on main island Malta to Mgarr on the island Gozo, takes 10min and costs 50€ for an adult one-way ticket. The other operators in Europe, but Harbour Air Malta as well, offer scenic or charter flights. All the operators in Table 16 are commercial. Other seaplane operators like flying clubs, flying schools or private enthusiasts, do not own a relevant number of

aircraft. Exceptions are companies for aerial firefighting. Firefighting also is the task for which public institutions own larger seaplane fleets. From country to country these are the local governments (USA, Canada), the airforce (Croatia, Spain, Greece) or the civil protection or emergency agencies (Italy, Russia, and France). An overview of the entities responsible for aerial firefighting is given in Table 17.

As an example of a bigger commercial seaplane network, the destinations of Harbour Air are given in Figure 3-2. None of the connections offered covers a distance of more than 54 nm (100km). Seaplane operation in this area is that well established, that Kenmore Air and Tofino Air are operating there or in the direct vicinity as well. The concept of Maldivian Air Taxi and Trans Maldivian Aviation is different, as mainly holiday resorts on the different islands are destinations.

There is no information on the use of seaplanes for cargo operations. The allowed luggage varies from operator to operator. For flights with Harbour Air for example, the weight of the luggage is dependent on the connection chosen, but it is never lower than 11,5kg.

	Country of origin	**Cessna 172**	**Cessna 180**	**Cessna 185**	**Cessna 206**	**Cessna 208**	**DHC-2**	**DHC-3**	**DHC-6**	**Sum**
Harbour Air Malta	M							1		1
Sydney Seaplanes	AUS					1	3			4
Air Whitsunday Seaplanes	AUS					3	3			6
Fonnafly AS	N				3	1				4
Clipper-Aviation	D	1					1			3
Harbour Air Ltd.	CDN			1			14	18	6	39
Kenmore Air	USA		2				10	6		18
Seaborne Airlines	USA								3	3
Tofino Air	CDN		3				4	1		8
Maldivian Air Taxi	MV								24	24
Loch Lomond	GB				1	1				2
Trans Maldivian Aviation	MV								18	18

Table 16: Most important and European seaplane operators

Figure 3-2: Harbour Air network (Harbour Air Seaplanes, 2011)

Country	Firefighting Entity	Bombardier CL-215	Bombardier CL-415	Air Tractor AT-802	Beriev Be-200
Canada	Conair Group	4		10	
Canada	Buffalo Airways	6			
Canada	Forest Protection Limited			7	
Canada	Government Air Services (Manitoba)	7	4		
Canada	Ministry of Natural Resources (Ontario)	9	9		
Canada	Ministry of Natural Resources and	6	8		
Canada	Department of Natural Resources	6	4		
Canada	Ministry of the Environment	6			

Country	Firefighting Entity	Bombardier CL-215	Bombardier CL-415	Air Tractor AT-802	Beriev Be-200
France	Sécurité Civile		12		
Greece	Hellenic Air Force	13	8		
Italy	Societa Ricerche Esperienze	5	15		
Italy	Protezione Civile			10	
Portugal	Operated by SoREM	2			
Spain	Spanish Air Force - 43 Grupo	14	3		
Spain	Ministry of Environment (CEGISA)	5		3	
Spain	Avilsa			30	
United States	Aero Flite, Kingman, Arizona			n/a	
United States	Division of Forest Resources, North	n/a			
United States	Department of Natural Resources,	n/a			
United States	Los Angeles County Fire Department		2		
United States	San Diego County		2		
Croatia	Croatian Air Force			5	
Russia	Ministry of Emergency Situations				15

Table 17: Entities responsible for firefighting and aircraft in service (Jane's Information Group, 2003)

3.2 Operator survey

3.2.1 General Information about Seaplane Operators

3.2.1.1 Participants' origin

The distribution of survey participants, given in Figure 3-3 and Figure 3-4, shows that around one half them was European, more than one third North American and the rest from India and Australia. The European participants are equally distributed over the continent with slightly more participation in France and the United Kingdom. In Figure 3-4 10% equals one participant. Surprisingly operators from countries with long coast lines, for example from the Iberian Peninsula, the Spanish Isles or Scandinavia (except Norway) did not participate. There are

neither participants from Russia, which is home to a very active seaplane industry and has a lot of inland waterways.

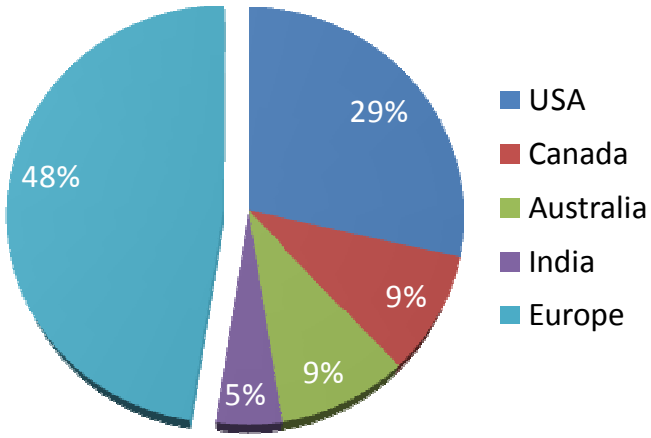

Figure 3-3: Origin of survey participants

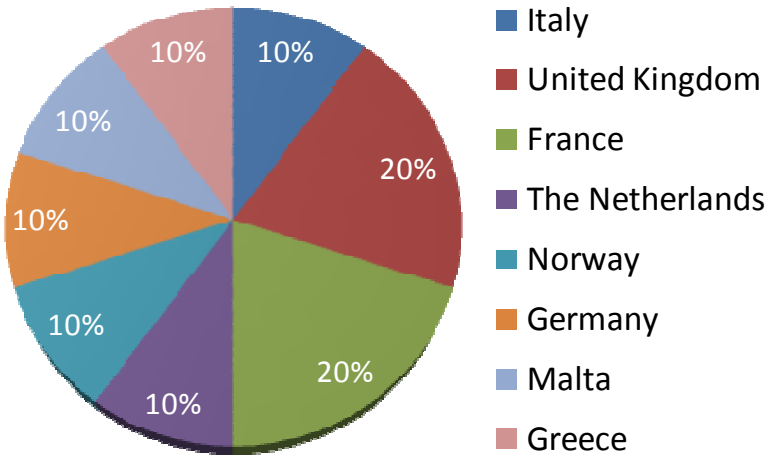

Figure 3-4: Origin of European survey participants

3.2.1.2 Participants' field of service

The participants' companies or clubs were founded from 1930 to now. Almost two thirds of them were founded in the current decade as to be seen in Figure 3-5. This result strengthens the assumption that a long-lasting seaplane business is very difficult to establish and maintained, but without proven information of former operators it only stays an assumption.

Concerning the services offered by the participants, a general statement has to be made, that most of them offer more than one. The activities are divided into those given in the following list and the results are shown in Figure 3-6.

- Commercial airline
- Commercial airline aspirant (or former commercial airline)
- Flight training
- Flying club
- Manufacturer
- Charter
- Tourist
- Consultant

Popular combinations of services are flying schools that offer charter flights, generally the combination of charter and scenic flights and former commercial airline or aspirants that offer their services as consultants. The manufacturers that participated just provided data about the availability on pilots. Commercial airline aspirants are either working on obtaining their Air Operator Certificate (AOC) or already abandoned this plan.

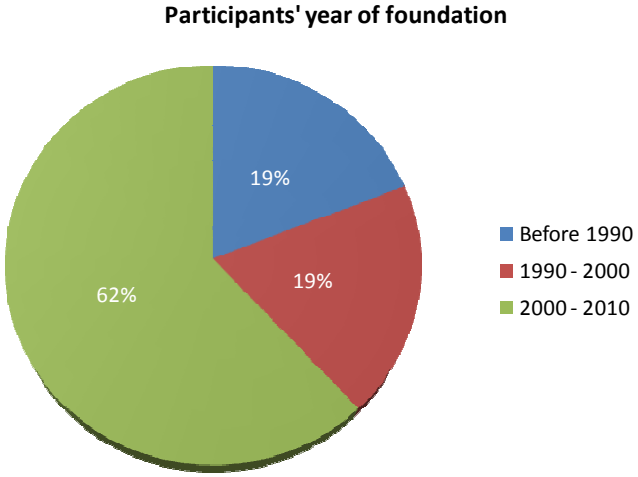

Figure 3-5: Participants' year of foundation

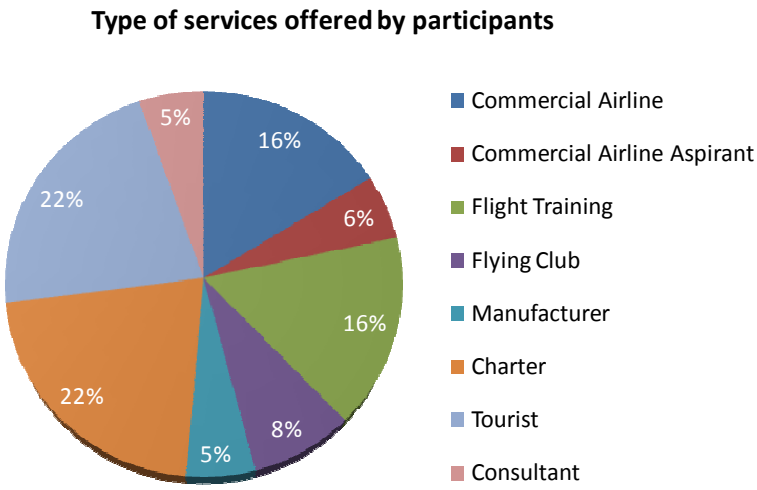

Figure 3-6: Type of services offered by participants

3.2.2 Seaplane operations

3.2.2.1 Operational key figures

To get a picture of the actual all-day performance of the seaplanes in operation, we asked the participants to state on the number of flights per year, the average flight time and distance as well as the average load factor. The results are shown from Figure 3-7 to Figure 3-10. The percentage of participants that provided this type of data is 41%. The numbers gathered for the amount of flights per year unfortunately doesn't allow a clear statement, as the distribution is almost equal. Furthermore there are commercial airlines with a very high number of flight movements, but also those with a very low number. The same phenomenon can be seen for the participants offering flight training, charter and scenic flights. Some have around 40 flights per year while others are above 1200 movements. The highest amount registered is 5000 movements per year.

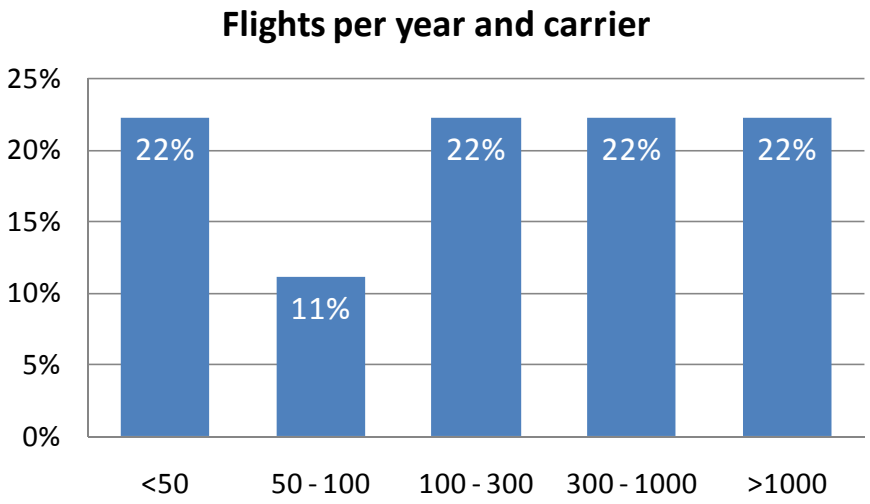

Figure 3-7: Flights per year and carrier

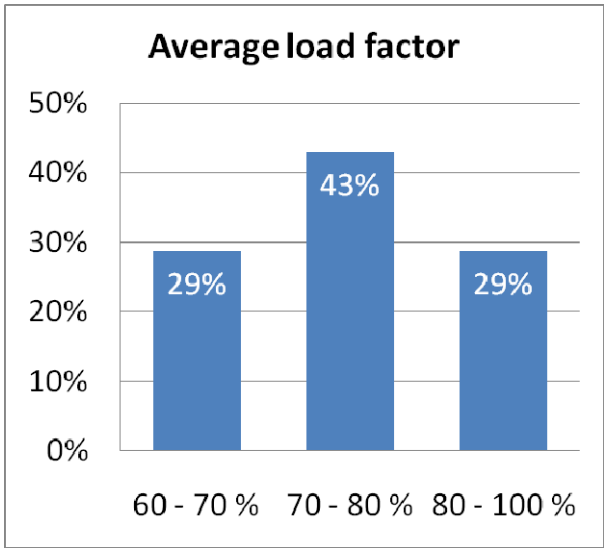

Figure 3-8: Average load factor

The average load factor worldwide for passenger aviation is around 75%. The average taken from the survey is only slightly higher at 79%. Here a clear tendency can be seen that the load factors of the commercial airlines with fixed schedules are slightly below the average and those of flying schools and for charter and scenic flights are mostly above. This tendency is also to be seen in passenger aviation in general and is easy to be understood from an entrepreneurial view.

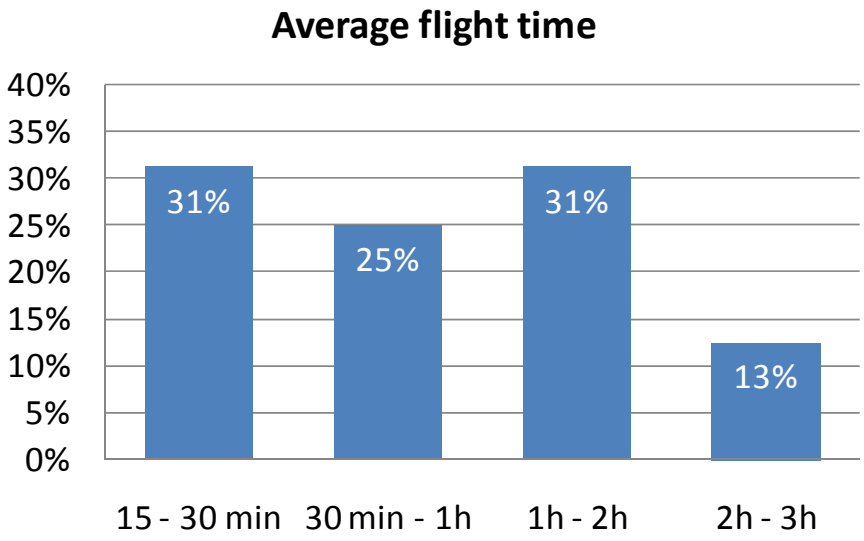

Figure 3-9: Average flight time

When comparing the flight times given in Figure 3-9, the only clear result is that the endurance is seldom more than two hours. Again, no clear separation of commercial airlines and the other participants can be done by the flight times.

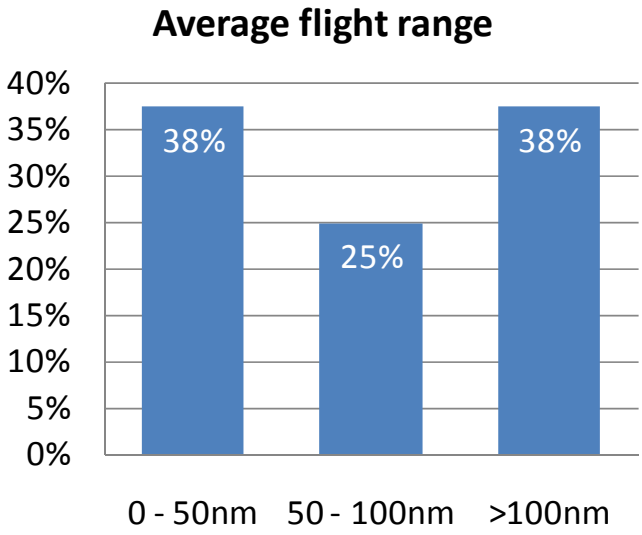

Figure 3-10: Average flight range

The maximum flight range registered is 120nm. The highest values are reported by flying clubs and flying schools, while the average distances of the commercial airlines move between 30 – 70nm. The absolute average is 68nm.

3.2.2.2 Connections and flight plans

Figure 3-11 shows that one quarter of the participants do not operate in winter. Those are mostly those that offer charter and scenic flights, but the main aspect of winter operation is of course the geographic location.

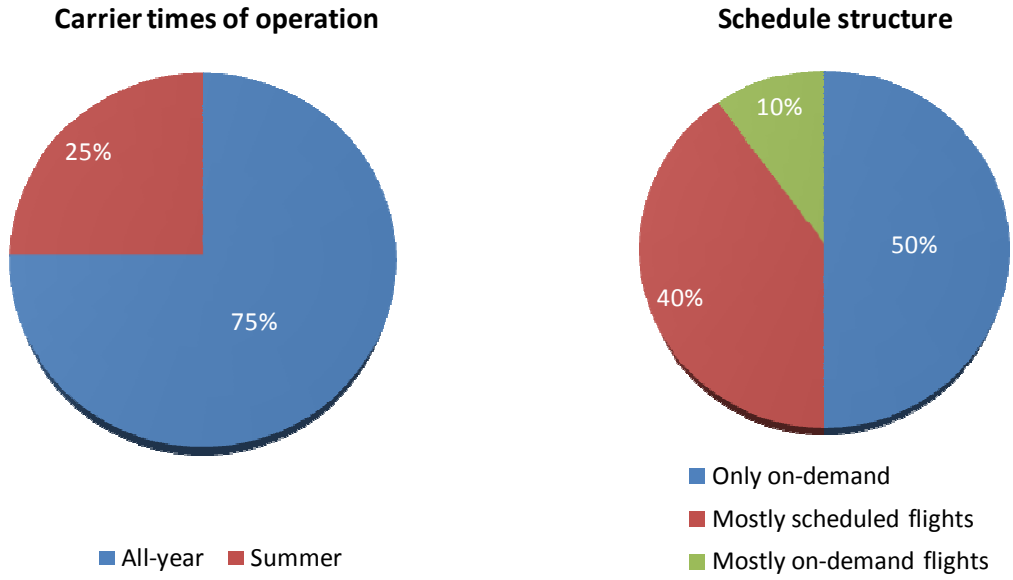

Figure 3-11: Participants' times of operation and schedule structure

Half of the carriers fly only on-demand, 60% mostly. With respect to the flight movements stated, the percentage of on-demand flights is 76%. The scheduled flights are, other than expected, mostly scenic flights. Only one quarter of the participating commercial airlines have a fixed schedule.

The purpose of the flights, with respect to the participants is mostly passenger transportation (including scenic flights), but as to be seen in Figure 3-12, a remarkable portion is declared as other flight. From the services the participants offer, it can be assumed that this is mostly flight training or leisure flights in flying clubs. Fire fighting and cargo transport were offered as flight types in the survey but are only performed by a very low percentage of the participants. Only one participant based in Canada uses his aircraft for firefighting (15% of all flights). Two of the commercial airlines have a very low percentage of cargo transport.

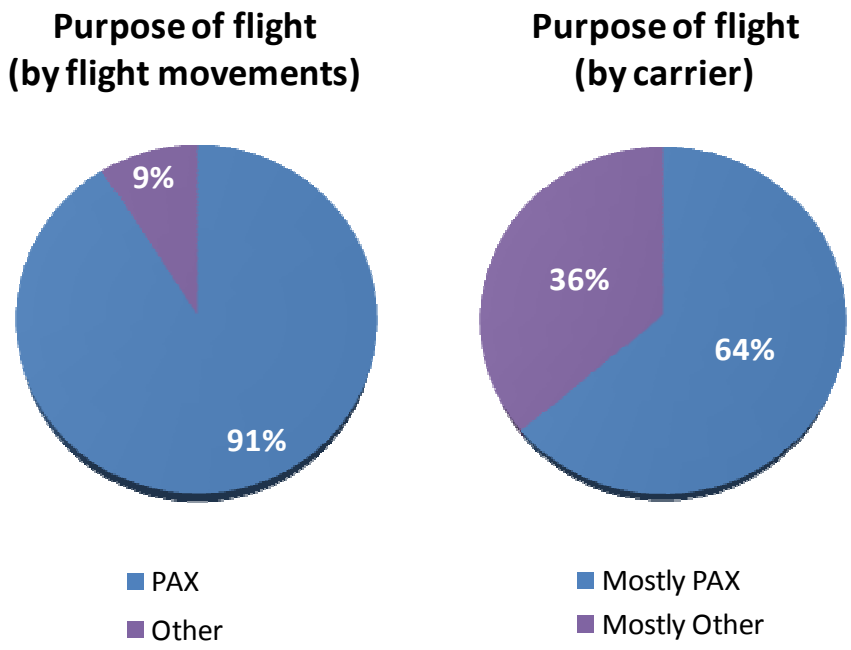

Figure 3-12: Purpose of flight

The results on the question whether the connections are from water to water, from water to land or land connections can be seen in Figure 3-13. When watching them with respect to the participants, more than half are connecting mostly water sites, and this impression is even stronger when relating the results to the number of flights. Then over 80% of all flights are water-to-water connections.

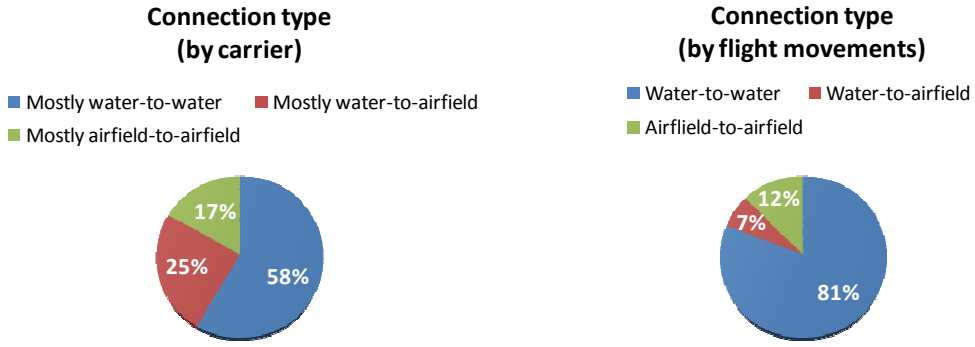

Figure 3-13: Connection type

3.2.3 Certification

3.2.3.1 Pilots

The comments on the availability of pilots with seaplane rating are shown in Figure 3-14. The general situation when summarizing all results is not alarming. Almost three quarter of the participants do not characterize the situation as critical. Dividing up the continents shows that in North America the availability of pilots is unproblematic for over 85%, while for two-thirds of the European participants it is critical and challenging for the remaining one-third. In Asia and Australia the situation is generally characterized as challenging.

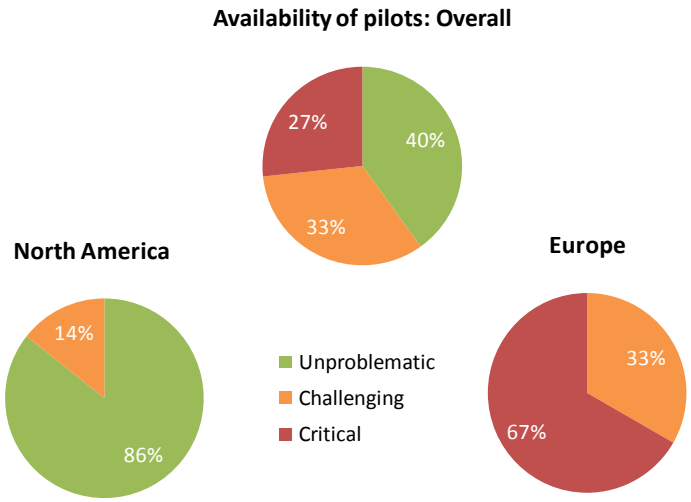

Figure 3-14: Availability of pilots

It was further asked where the pilots employed with an operator received their original flying license. Without exception it was issued in the country the operator is based in. Free comments on the situation included that mostly North American pilots are available. It was also remarked that even if a pilots are rated for seaplane operation, a big amount lacks sufficient open water experience. A specific problem in the northeast US seems to be that seaplane pilots are only employed seasonally.

3.2.3.2 Operators

All of the participants that answered to the following section of the survey own the aircraft operator certificate (AOC), except for the US based flying schools and the commercial airline aspirants. In all cases it was issued by the national aviation authorities (NAA) of the country the operator is based in. When looking at the participants' description of the certification process in Figure 3-15 it clearly to be

seen that only in a minor number of cases it was considered unproblematic. All these cases are North American companies. The Canadian Department of Transport is explicitly mentioned for an uncomplicated working relationship. In Europe the process is mostly seen as critical. Several statements from participants worldwide say that there is a lack of understanding and sensibility for seaplane operations in the NAA.

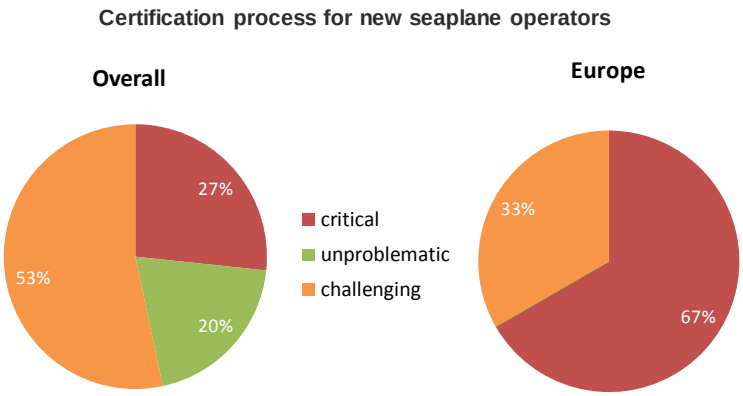

Figure 3-15: Certification process for new seaplane operators

When asked if they were assisted with the licensing process by their NAA, North American participants generally answered that they were not, but the process was feasible and known. A Canadian operator was assisted when looking for a new aerodrome. European participants complain about the unclear regulations and a missing point of contact within EASA. Expanding the question to the expectations they have for a central certification process governed by EASA or a central institution, and which points should be included, various points were mentioned. A specific European concern is to modify EU-OPS, so that for international business, it is not necessary to study the varying national laws. Furthermore a seaplane licence rating and standardisation in issuing landing sites was prompted. One European operator wished for a distinction between commercial and private operations with respect to the level of experience.

North American participants would like to include a clear regulation about the availability of waterways. They recommend that the assessment of landing sites is done analogue to those on land with a rating for the environmental impact and designated flight and noise abatement areas. One participant states that maritime regulations should be applied for the movements on the water while aviation regulations should become effective when the aircraft becomes airborne.

Further questions were addressing specific points of contact with authorities. As to be seen in Figure 3-16, 40% of the participants are having problems with environmental authorities or residents. The reason is almost exclusively noise. In some cases in North America, participants are operating in or close to national parks.

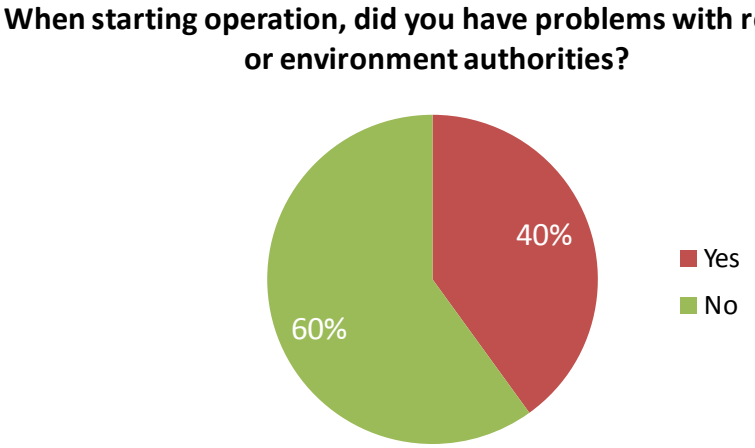

Figure 3-16: Problems with residents or environmental authorities

More than half of the operators are affected by special regional regulations concerning the use of waterways. Besides the mentioned national parks, they face generally restricted areas, excessive diffusion of water plants or are restricted to coastal regions, as reported from Norway or the United Kingdom. One operator complains that the designated permitted areas are too small and in the wrong location for typical conditions.

When asked if the compliance with both, maritime and aviation regulations leads to a conflict, one-third thought that they do. It was stated that maritime regulations do not consider the lack of manoeuvrability and ability to come to a sudden stop when compared to a boat. In one case in Australia, the port authorities require seaplane pilots to have a recreational boat license for their commercial operations. A participant from the United Kingdom reported that the restrictions to operations the maritime authorities imposed to guarantee safety of maritime traffic were not improving the latter but reducing aviation safety.

4 Seaplane Organizations

Seaplane organizations are mostly associations of pilots. Although Europe is poorly represented within manufacturers and operators, there are seaplane organizations throughout the continent.

Name	**City**	**Country**	**URL**
Norwegian Ski- & Seaplane Association	Oslo	Norway	www.nak.no/sea
Swedish Seaplane Association	Färetuna	Sweden	www.sjoflyg.com/
Finnish Sea- & Skiplane Association	Helsinki	Finland	www.vesilento.com
Seaplane Pilots Association Germany	Niedernberg	Germany	www.wasserflieger.com
Seaplane Pilots Association Switzerland	Eglisau	Swiss	www.seaplanes.ch
Seaplane Pilots Association France	Biscarrosse	France	www.francehydravion.org
Seaplane Pilots Association España	Barcelona	Spain	
Seaplane Pilots Association Italy	Como	Italy	www.aeroclubcomo.com
Hellenic Seaplane Association	Athens	Greece	www.seaplane.org.gr
UK Seaplane Association	Kilmarnock	Scotland	www.seaplaneassociation.org.uk
Seaplane Pilots Association	Lakeland	USA	www.seaplanes.org
Canadian Owners and Pilots Association	Ottawa	Canada	www.copanational.org/

Table 18: Seaplane organisations

5 Sea Dromes

5.1 General

There are two main categories of sea dromes. The first category is a sea port, where the aircraft stays seaborne. This type of sea drome usually realized with moorings, very similar to those used for sea vessels. As an example, the installation of Harbour Air in Vancouver can be seen in Figure 5-1. This kind of sea drome limits accessibility to the aircraft but allows using existing seaport infrastructure. As the aircraft does not need to be moved out of the water, very short turnaround times can be realized.

Figure 5-1: Harbour Air seadrome in Vancouver Harbour

The second category is the land-based sea port. While amphibious aircraft can leave the water autonomously on a ramp, straight seaplanes require a type of lifting mechanism. Having the aircraft turned around on land offers to integrate it into conventional processes. Also it is easily accessible and can be freed from salt water during every turnaround. Getting it out of the water anyway requires additional time and energy.

Figure 5-2: Hydroport in Gelendzhik (Anon., 2010)

5.2 Survey

5.2.1 Seaport Management

Operators were asked if they manage their seaport themselves or if their seaport is managed by other institutions. 55% of the participating seaplane/ amphibian operators were managing theirs seaports on their own. However, no link could be made between business size (number of aircraft operated) and seaport management. If an operator has to manage the seaport on its own seems to be dependent on the availability or the obligation to use managing services and/or special regulations varying from country to country.

5.2.2 Seaport License & Seaport Approval

Operators were asked which institutions issued their seaport license and/or approval. The following information could be gathered in the survey:

	Seaport License	**Seaport Approval**
USA	FAA, DOT (State department)	
Canada	Transport Canada	
Malta		DCA Malta
Australia	State Maritime Authority	

Table 19: Seaport Licensing Institutions

5.2.3 Configuration of seaside landing site

The following table gives an overview about installations currently used by seaplane operators. The use of moorings, pontoons and respective foot bridges is commonly part of a seaport. Amphibian operators need not rely on seaside infrastructure and can used land bound landing strips, of course. The use of own maintenance hangars, offices and fuel stations is also not related to business size (or aircraft operated). Additionally, the use of emergency equipment seems not to be regulated differently from country to country.

Installation item	**Operators using installation [%]**
Moorings / Pontoons	50%
Foot bridges	41%
Navigation lights	5%
Maintenance site/ Hangar	18%
Office	36%
Fuel Station	32%
Emergency / Fire Services	14%

Table 20: Landing site installations

Other items mentioned apart from the above list were safety boats, fuel barges and navigation marks.

5.2.4 Maintenance concept

According to the use of own maintenance sites/ hangars about a third of the operators use external maintenance concepts.

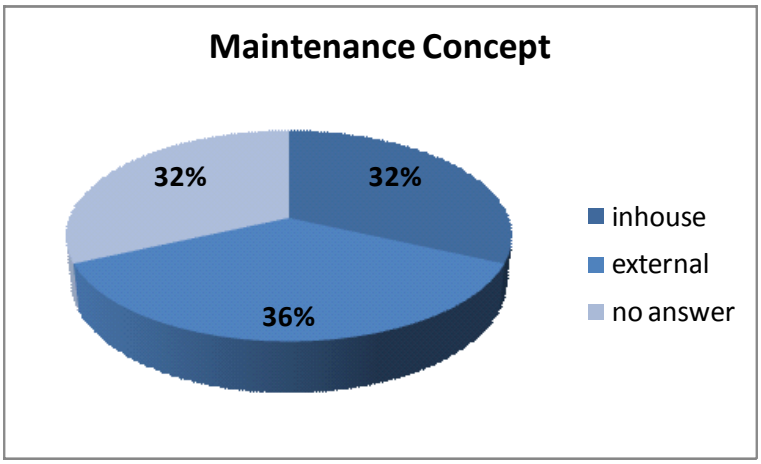

Figure 5-3: Maintenance concept

It was asked how many days per month the average aircraft is out of service due to maintenance. The number of days ranges from one to six days of maintenance per month. Astonishingly, aircraft which are used commonly (DHC-2 and Cessna 208) have the largest necessity for maintenance with 5 to 6 days per month not in operation. (Note: these numbers are results from the online survey and are not checked for plausibility e.g. from OEM maintenance instructions.)

5.2.5 Connectivity of seaports to landside infrastructure

Table 21 shows that most operators are connected to some kind of street/ motorway infrastructure but no seaplane operator is connected to larger airports. Main business is leisure travel for most seaplane operators. Still, the option of feeding traffic into larger hub airports by amphibian aircraft is possible but not executed. About a quarter of all participating operators rely on existing seaport or airport infrastructure. However, most businesses seem to be remote locations not closely coupled to other means of transport.

Connection	**% of operators**
Landing site connected to roads / motorways	91%
Landing site connected to long distance railroad system	5%
Landing site connected to public metropolitan and suburban	14%
Landing site integrated in seaport	23%
Landing site connected to local airfield	23%
Landing site connected to international airport	0%

Table 21: Landside connectivity

6 Summary

Summarizing the results, it seems to be clear that seaplane operation and manufacturing is well established in North America. In Europe the seaplane transport system seems to be sustained by enthusiasts. The reasons for this will be investigated in the FUSETRA project.

With the data obtained by evaluating the results of the survey as well as off the internet and the registration database, it was possible to determine the most important aircraft for seaplane transportation and how and by whom they are operated. Furthermore, information on the ground infrastructure and possible concepts for sea dromes was gathered. This is the necessary starting point for the evaluation of strengths, weaknesses, opportunities and threats to a European seaplane transportation system.

The survey provided operational data and the comments on required aircraft and necessary changes to regulations. Together with the data of the major operators this is a basis is given for the improvement of European regulation as well as for the formulation of requirements for future seaplanes.

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Appendix A – Seaplane models worldwide

Only the most important categories are displayed in the following table to keep this document clearly arranged. The complete data base contains – where available - the following information on each model:

Attribute	**Attribute description**
Name	Name of the aircraft
Manufacturer	Name of the manufacturer
Manufacturer Country	Country of the manufacturer
Link	URL of a photo of the aircraft
Usage	Type of mission the aircraft is mainly used for
Floats	Seplane/Flying boat, number of floats/outriggers
Wing Arrangement	High wing, low wing, mid wing, biplane
Tail	Form of the tailplane
Retractable Landing Gear	yes / no
Year of Manufacture	
Units built	
Price ($)	
Crew	Number of crew members
Length (m)	
Span (m)	
Height (m)	
Wing Area (m^2)	
MWE (kg)	Manufacturer empty weight
Payload (kg)	
MZFW (kg)	Maximum zero fuel weight
MTOW (kg)	Maximum takeoff weight
Passengers	Maximum number of passengers
Engines	Number of engines
Engine Arrangement	
Installed Power (hp)	
V_max (km/h)	Maximum Speed
V_cruise (km/h)	Cruise speed
Range (km)	
Flight Duration(h)	
Cruise Ceiling (m)	
Climb Rate (m/min)	
Power/Weight (hp/kg)	
Weight/Wing area (kg/m^2)	
Mean Aerodynamic Chord (m)	
Aspect Ratio [-]	
Fuselage width (m)	
Engine Weight (kg)	

Manufacturer	Name	Span (m)	MTOW (kg)	V_max (km/h)
Aeromarine	39	14,32	1136	117
Aeromarine	40	14,80	1175	114
Aeromarine	AS	11,43	1466	209
Aichi	E11A	14,49	3297	217
Aichi	E13A	14,50	4000	375
Aichi	H9A	24,00	7500	315
Aichi	M6A	12,26	4445	474
Air Department	FlyingBoat	15,34	1618	160
Air Department	Seaplane Type 1000	35,10	12700	135
Airspeed Limited	Queen Wasp	9,45	1588	277
Albatros	W.4	9,50	1070	160
Arado	W 2	17,40	1995	145
Arado	Ar 95	12,50	3560	310
Arado	Ar 196	15,10	3720	311
Arado	Ar 231	10,18		170
Aviat	Husky	35'6'	998	90
Avro	Type D	9,45	230	78
Beriev	MBR-2	19,00	4245	275
Beriev	Be-2	11,00	2686	245
Beriev	Be-8	19,00		266
Beriev	Be-6	33,00	29000	414
Beriev	Be-12	29,84	36000	530
Beriev	Be-10	28,60	48000	912
Beriev	A-40	41,62	86000	760
Beriev	Be-103	12,50	2270	240
Beriev	Be-200	31,80	43000	710
Blackburn	T.B.	18,45	1591	138
Blackburn	Velos	14,78	2812	172
Blackburn	Iris	29,60	13405	190
Blackburn	Perth	29,57	17237	213
Blackburn	B-20	25,00	16000	490
Blanchard	Brd. 1	19,00	3930	170
Bleriot	5190	26,00	22000	210
Blohm & Voss	BV 138	27,00		275
Blohm & Voss	Ha 139	27,00		307
Blohm & Voss	BV 222	46,00	49000	390
Blohm & Voss	BV 238	60,17	100000	425
Boeing	Model 1	15,86	1270	121
Boeing	Model 3	13,36	1086	117
Boeing	314 Clipper	46,36	38000	340
Boeing	344 XPBB Sea Ranger	42,59	45968	345
Boeing	451 L-15 Scout	12,20		180
Bombardier	CL 415	28,60	19848	377
Breguet	521	35,18	16600	243
Breguet	730	40,37		330
Breguet	731	40,37		330
CAMS	33	17,62	4000	175
CAMS	37	14,50	3000	185
CAMS	46	12,00	1350	185

Manufacturer	Name	Span (m)	MTOW (kg)	V_max (km/h)
CAMS	53	20,40	6900	212
CAMS	55	20,40	6900	195
CAMS	58	24,30	8450	200
Canadair	CL 215	28,60	17100	290
Canadian Vickers	Vedette	12,80	4000	153
Canadian Vickers	Varuna	16,84		130
Canadian Vickers	Vanessa	10,74	1543	166
Canadian Vickers	Vancouver	16,76		151
CANT	Z.501	22,50	7050	245
CANT	Z.506	26,50	12705	350
CANT	Z.509	28,32	15965	
CANT	Z.511	39,86		424
Caproni	Ca.310	16,20		365
Caproni	Ca.316	15,87	4804	328
Chetverikov	MDR-6	19,40	7200	360
Colonial	Skimmer	10,36	975	201
Consolidated	P2Y	30,48	11460	240
Consolidated	Commodore	30,48	11460	224
Consolidated	PBY Catalina	31,70	16066	314
Consolidated	PB2Y Coronado	35,00	30000	310
Convair	F2Y Sea Dart	10,30	9750	1325
Convair	R3Y Tradewind	44,42	74800	624
Curtiss-Wright	HS	22,60	2918	137
Curtiss-Wright	NC	38,40	12422	152
Curtiss-Wright	Model 71 / SOC Seagull	10,98	2466	266
Curtiss-Wright	Model 97 / SC Seahawk	12,50	4082	504
Dayton-Wright	FP.2	15,67		193
De Havilland Canada	DHC-2 Beaver	14,63		255
De Havilland Canada	DHC-3 Otter	17,70		258
De Havilland Canada	DHC-6 Twin Otter	19,80	5670	338
Dornier Seawings	Delphin III	19,60	3900	180
Dornier Seawings	Seastar	17,74	5000	335
Douglas	DT	15,80		160
Douglas	DWC	15,24		161
Douglas	T2D	17,37	4773	201
Douglas	Dolphin	18,29	4323	217
English Electric	P. Kingston	26,06	6403	175
Fairchild	91	17,07	4763	269
Fairchild	F-11 Husky	32,97		206
Fairey Aviation	Fairey III	13,95		192
Fairey Aviation	Pintail	12,20		201
Fairey Aviation	Flycatcher	8,84		214
Fairey Aviation	Seafox	12,20		200
Farman	F.51	23,35		140
Felixstowe	F5L	31,62		
Fiat	RS.14	19,54	8470	390
Fleet Aircraft	Fleet 50	13,72	3777	241
Fleet Aircraft	Fleet Canuck	10,30	671	
Fleetwings	Seabird	12,33	1702	

Manufacturer	Name	Span (m)	MTOW (kg)	V_max (km/h)
Flexistowe	Porte Baby	37,80		148
Flexistowe	F.2	29,14		153
Flexistowe	F.3	31,10		147
Flexistowe	F.5	31,60		142
Flexistowe	Fury	37,50		156
Fokker	T.IV	26,20	7200	260
Fokker	C.VII-W	12,90	1700	160
Fokker	C.VIII-W	18,10	2750	195
Fokker	C.XI-W	13,00	2545	280
Fokker	C.XIV-W	12,05	1945	230
Fokker	T.VIII-W	18,00		285
Franco-British Aviation Company	FBA 310	12,00	970	145
Franco-British Aviation Company	FBA 290	13,10	4360	176
Friedrichshafen	FF.29	16,30	1400	
Friedrichshafen	FF.33	16,60	1550	110
Friedrichshafen	FF.31	16,85	1400	98
Friedrichshafen	FF.34	18,40	2305	145
Friedrichshafen	FF.35	23,74	3543	114
Friedrichshafen	FF.40	21,00	2539	125
Friedrichshafen	FF.43	9,92	1078	163
Friedrichshafen	FF.44	18,40	2305	145
Friedrichshafen	FF.41	21,96	3670	120
Friedrichshafen	FF.48	16,25	2215	163
Friedrichshafen	FF.49	17,15	2135	140
Gloster	III	6,09		362
Gloster	VI	7,90	1670	565
Goodyear	GA-2 Duck	10,97	1043	201
Gourdou-Leseurre	GL-832 HY	13,00	1696	196
Grigorovich	M-5	13,62	960	105
Grigorovich	M-9	16,00	1610	110
Grigorovich	M-11	8,75	926	148
Grigorovich	M-16	18,00	1450	120
Grigorovich	M-15	11,90	1320	125
Grumman	J2F Duck	11,90		304
Grumman	G-21 Goose	14,90	3720	296
Grumman	G-44 Widgeon	12,19	2500	257
Grumman	G-73 Mallard	20,30		
Grumman	HU-16 Albatross	24,40	15000	380
Hanriot	HD.2	8,51	700	182
Hansa-Brandenburg	W	16,50	1650	90
Hansa-Brandenburg	CC	9,30		175
Hansa-Brandenburg	W.12	11,20		160
Hansa-Brandenburg	W.19	13,80		150
Hansa-Brandenburg	W.29	13,50		175
Hansa-Brandenburg	W.33	15,85	2124	160
Harbin	SH 5	36,00	45000	556
Heinkel	He 42	13,50		185

Manufacturer	Name	Span (m)	MTOW (kg)	V_max (km/h)
Heinkel	He 55	14,00	2270	194
Heinkel	He 56	11,10	1600	197
Heinkel	He 60	13,50		240
Heinkel	He 59	23,70		235
Heinkel	He 119	15,90		590
Heinkel	He 115	22,20		349
Hughes	H-4 Hercules	97,54		
Kawanishi	E7K	14,00	3300	275
Kawanishi	H6K	40,00	21500	331
Kawanishi	H8K	38,00	32500	465
Kawanishi	H3K	31,05		225
Lake	Buccaneer	11,58	1220	
Latécoère	521	49,31	37993	247
Latécoère	298	15,50	3793	300
Latécoère	611	40,56	31065	349
Latécoère	631	57,43	75000	417
Latham	47	25,20	6886	170
Lohner	L	16,20	1700	105
Loire	102	34,00	19100	
Loire	70	30,00	11500	235
Loire	130	16,00		225
Loire	210	11,79	2100	229
Macchi	MC.72	9,48	3031	709
Macchi	MC:94	22,79	8200	292
Macchi	MC.100	26,71	13100	310
Martin	M-130	39,70	25590	290
Martin	PBM Mariner	36,00		330
Martin	JRM Mars	60,96	74800	356
Martin	P5M Marlin	35,70	38600	404
Martin	P6M SeaMaster	31,37	80000	1010
Mithsubishi	F1M	11,00	2856	368
Nakajima	E2N	13,52		172
Nakajima	E4N	10,98		232
Nakajima	E8N	10,98	1900	301
Naval Aircraft Factory	PN	22,21		184
Naval Aircraft Factory	TF	18,00		153
Naval Aircraft Factory	TS	7,62		198
Norman Thompson	N.T.4	23,96		153
Northrop	N-3PB	14,91	4808	414
Piaggio	P.6	13,50	2360	195
Piaggio	P.136	13,53	2995	335
Potez-CAMS	142	41,01	26055	320
Progressive Aerodyne	SeaRey	9,39	622	
Republic	RC-3 Seabee	11,48	1429	238
Rohrbach	Ro V Rocco	26,00	9710	220
Rohrbach	Ro X Romar	36,90	19000	210
Saunders-Roe	A.17 Cutty Sark	13,72		172
Saunders-Roe	A.19 Cloud	19,51		190
Saunders-Roe	A.27 London	24,40	9980	249

Manufacturer	Name	Span (m)	MTOW (kg)	V_max (km/h)
Saunders-Roe	A.36 Lerwick	24,70	15060	344
Saunders-Roe	SR.A/1	14,02	8633	824
Saunders-Roe	SR.45 Princess	66,90	156500	579
Savoia-Marchetti	S.56	10,72	975	178
Savoia-Marchetti	S.55	24,00	8260	279
Savoia-Marchetti	S.59	15,50	2950	200
Savoia-Marchetti	SM.62	16,66	5030	220
SCAN	20	15,00	2500	220
Seawind	300C	10,67	1542	322
Shavrov	Sh-2	13,00	937	140
ShinMaywa	US-1A	33,15	45000	495
ShinMaywa	US-2	33,15	43000	580
Short Brothers	S.74	17,35		105
Short Brothers	Type 827	16,43	1542	100
Short Brothers	Type 184	19,36	2433	142
Short Brothers	Crusader	8,07	1227	435
Short Brothers	S.8 Calcutta	28,40	10200	190
Short Brothers	S.8/8 Rangoon	28,35		185
Short Brothers	S.17 Kent	34,44		220
Short Brothers	S.14 Sarafand	36,60		246
Short Brothers	S.19 Singapore	27,43	14692	219
Short Brothers	S.22 Scion Senior	16,76	2610	225
Short Brothers	S.23 Empire	34,75	18370	322
Short Brothers	S.25 Sunderland	34,39		336
Short Brothers	S.45 Seaford	34,37		389
Short Brothers	Solent	34,30		440
Short Brothers	SA.6 Sealand	18,00	4130	300
SIAI	S.8	12,77	1375	89
SIAI	S.9	13,20	1740	140
SIAI	S.12	11,72	2360	222
SIAI-Marchetti	FN.333 Riviera	10,40	1485	285
Sikorsky	S-38	21,85		192
Sikorsky	S-40	34,76		217
Sikorsky	S-42	36,03		300
Sikorsky	S-43	26,21	8662	306
Sikorsky	VS-44	37,79	26082	257
Supermarine	Sea King	8,75		201
Supermarine	Seagull	14,91		130
Supermarine	Seal	14,02		
Supermarine	Sea Eagle	14,00		150
Supermarine	S.4	9,33		385
Supermarine	Southampton	22,86		153
Supermarine	Swan	20,90		175
Supermarine	S.5	8,15		514
Supermarine	S.6	9,14		529
Supermarine	Air Yacht	28,00		
Supermarine	Scapa	22,85		229
Supermarine	Walrus	14,00		215
Supermarine	Stranraer	25,90		265

Manufacturer	Name	Span (m)	MTOW (kg)	V_max (km/h)
Supermarine	Sea Otter	14,00		262
Supermarine	Seagull 381	16,00		418
Vickers	Viking	15,24		164
Vought	OS2U Kingfisher	10,95	2721	264
Watanabe	E9W	9,91	1253	232
Wight	Converted Seaplane	19,97	2525	135

Appendix B – Seaplane operators worldwide

Name	City	Country
Acadian Seaplanes		
Adlair Aviation		Canada
Adventure Seaplanes	Lino Lakes	USA
Aeroclub Como	Como	Italy
Ahoy Plane-Sailing Seaplanes	Cooktown	Australia
Air Cab	Coal Harbour, Vancouver Island	Canada
Air Cochrane		Canada
Air Dale Flying Services	Wawa,	Canada
Air Excursions	Gustavus	USA
Air Hart	Kelowna	Canada
Air Malta	Floriana	Malta
Air Melancon	Sainte-Anne-du-Lac	Canada
Air Nookta	Gold river	Canada
Air Saguenay	Jonquiere	Canada
Air Sitka	Sitka	USA
Air Tamarac	Saint-Hyacinthe	Canada
Air Tindi	Yellowknife	Canada
Air Whitsunday	Airlie Beach	Australia
Airlink	Waterville	USA
Airlink LLC.	Waterville	USA
Alaska Air Taxi LLC	Anchorage	USA
Alaska bush floatplane service	Talkeetna	USA
Alaska Floats & Skis	Talkeetna	USA
Alaska Fly 'n' Fish Charters LLC	Juneau	USA
Alaska Lakeside Lodge	Wasilla	USA
Alaska Rainbow Lodge	King Salmon	USA
Alaska Seaplane Tours	Ketchikan	USA
Alaska Seaplanes	Juneau	USA
Alaska Sportsmans Lodge	King Salmon	USA
Alaska West Air	Nikiski	USA
All Alaska Outdoors Lodge	Soldotna	USA
Alligator Airways	Kununurra Airport	Australia
Amphibious flying club	Fermanagh	Ireland
Andrew Airways	Kodiak	USA
Andy Aviation	Old Town	USA
Aniak Air Guides	Aniak	USA
Antilles Seaplanes	Graham	USA
Aquatica Aviation	Watermill	USA
Argo Airways	Volos	Greece
Argo Airways	Volos	Greece
Atlantic Aircraft Salvage Ltd.	Enfield	Canada
Atlantic Aircraft Salvage Ltd.	Dubai Airport	Dubai UAE
Atleo Air	Tofino	Canada
Aviat Aircarft Inc.	Afton	USA
Bakers Narrow Air Service	Flin Flon	Canada
Bald Mountain Air Service	Homer	USA

Name	City	Country
Bay Air Alaska	Dillingham	USA
Bay City Sea Planes	Geelong	Australia
Bel Air Aviation	Lac-à-la-Tortue	Canada
Bettles Air Service	Fairbanks	USA
Big River Camps INC.	Pasadena	Canada
Bigfoot Air,LLC	Napa	USA
Birch Lake Lodge	Red Lake	Canada
Birds Seaplane Service	Inlet	USA
Boois	Red Lake	Canada
Borek Air	Calgary	Canada
Branch River Air June - September	King Salmon	USA
Branch River Air October-May	Anchorage	USA
Bristol Bay Lodge	Ellensburg	USA
Bristol Bay Sports Fishing June-Sept.	Iliamna	USA
Bristol Bay Sports Fishing October-May	Grants Pass	USA
Brooks Range Aviation	Bettles	USA
Bush Flight	Derby	Australia
Cairns Seaplanes	Cairns	Australia
Caledonian Seaplanes Ltd.	St Fillans on Lochearn	Scotland
Caledonian seaplanes training school	Pitlochry	UK
Cambrian aero – training	Powys	UK
Cameron Air Service Inc.	Toronto	Canada
Campbell´s Cabins	Crane Lake	USA
Campbell´s Cabins	Fort Frances	Canada
Canadian Airventures Ltd.	Chapleau	Canada
Canadian Flying Fishing	Ranier	Canada
Canoe Canada Outfitters	Atikokan	Canada
Cat Island Lodge	Ear Falls	Canada
Chelan Sea Planes		
Chelatna Lake Lodge		USA
Chesapeake Seaplanes	Dameron	USA
Cloud Air	Port Carling	Canada
Cloud9Seaplanes	Gold Coast	Australia
Coastal Sea Planes	Seattle	USA
Copper Valley Air	Glennallen	USA
Coral Air		Fiji Islands
Coril Air	Campbell River	Canada
Courtenay Flight Center	Courtenay	Canada
Crystal Creek Lodge	Wasilla	USA
Currier's Flying Service, Inc.	Greenville Junction	USA
Denali Flying Service	Willow	USA
Destination Air	Aumphur Talang	Thailand
Dornier Sea Plane	Punta Gorda	USA
Dove Island Lodge	Sitka	USA
Dragonfly Aero	Homer	USA
Drive and Fly	Föhren	Germany
Due North	Thunder Bay	Canada
EADS Irkut Sea Plane	Blagnac	France
EADS Irkut Seaplane	Blagnac	France
Eagle Landing Resort		

Name	City	Country
EDO Floats , Kenmo Air	Kenmore	USA
El Capitan Lodge	Craig	USA
Ellison Air	Anchorage	USA
Emerson Aviation	Gilford	USA
Enchanted Lake Lodge June - October	King Salmon	USA
Enchanted Lake Lodge October-June	Anchorage	USA
Euro plane Services Limited	Bershire	UK
European coastal seaplanes	Zagreb	Croatia
European Nature Flyers		Finland
Excellent Adventures	Ear Falls	Canada
Expedition North Summer	Hornepayne	Canada
Expedition North Winter	Ada	USA
Family Air Tours	Ketchikan	USA
Fiji Sea Planes	Nadi Airport	Fiji Islands
Fishing Lodge	Chapleau	Canada
Float Plane Alaska	Homer	USA
Float Plane Lodge	Homer	USA
Float plane training	Dalarna	Sweden
Float Safety		
Fly Denali	Talkeetna	USA
Fly Float Planes	Altamonte Springs	USA
Flying Boat		Australia
Flying the Fish	Sun Valley	South Africa
Fonnafly	Bergen	Norway
Found Aircraft Alaska Sales	Anchorage	USA
Found Aircraft Australasia Sales	Nadi Airport	Fiji Islands
Found Aircraft Canadian Sales	Englehart	Canada
Found Aircraft International Sales	Parry Sound	Canada
Found Aircraft Sales and Service Centre	Gravenhurst	Canada
Found Aircraft Western U.S.Sales	Caldwell	USA
Freshwater Adventures Inc.	Dillingham	USA
Georgian Bay Airways	Parry Sound	Canada
Graf Air Sweden	Bromma	Sweden
Graf Air USA	Vero Beach	USA
Grand Sea Planes	Broken Arrow	USA
Green Flying	Red Lake	Canada
Hakan Osanmaz Charters		Turkey
Halley´s Camps	Minaki	Canada
Harbour Air Seaplanes	Richmond	Canada
Harris Air Craft	Sitka	USA
Harvey Flying Service	Kodiak	USA
Havasu Seaplane Adventures		
Hawk Air		
Helms Aero Service	Long Lake	USA
High Adventure Air	Soldotna	USA
Howe Sound Sea Planes	Victoria	Canada
Hughes Float Plane Service Inc.	Homer	USA
Huron Air and Outfitters Inc.	Armstrong	Canada
Hyack Air	Victoria	Canada
Hydravion Aventure		Canada

Name	City	Country
Hydravion Canada	St-Hippolyte	Canada
Ignace Outposts	Ignace	Canada
Iliamna Air	Iliamna	USA
Island Air		Canada
Island Coastal Aviation	Pitt Meadows	Canada
Island Sea Plane Tours of Honolulu	Honolulu	USA
Island Wings	Ketchikan	USA
Jack Browns´s Seaplane School	Winter Haven	USA
Kabeelo Lodge Summer	Ear Falls	Canada
Kabeelo Lodge Winter	Prior Lake	Canada
Kachemak Air Service, Inc.	Homer	USA
Kashabowie Outposts Ltd.	Atikokan	Canada
Katahdin Air Service	Millinocket	USA
Katmai Air Service	Anchorage	USA
Kay Air Serice	Ear Falls	Canada
Kenai Float Plane Svc	Kenai	USA
Kenai Lake Air Service.	Naknek	USA
Kenmore Air	Kenmore	USA
Kenora Air Service Ltd.	Kenora	Canada
Kimberley Extreme	Cable Beach	Australia
King Fisher Aviation	Kodiak	USA
Klahanie Air LTD	Mission	Canada
Knobby´s Fly-in Lodge & Outposts	Sioux Lookout	Canada
Kupreanof Flying Service	Petersburg	USA
La Placa Flying Service	Lake Havasu City	USA
Lake Amphibian	Gilford	USA
Lake Clark Air	Port Alsworth	USA
Lake Clark Inn & Air ,LLC	Port Alsworth	USA
Lake Havasu Seaplane	Lake Havasu City	USA
Lakeshore Aviation	Manitowoc	USA
Larsen Bay Lodge	Kodiak	USA
Lauzon Aviation	Blind River	Canada
Leuenberger Air Service	Nakina	Canada
Libby Camps	Ashland	USA
Loch Lomond seaplanes	Argyll and Bute	UK
Lockhart Air	Sioux Lookout	Canada
Mackinac Seaplanes	Sault Ste. Marie	USA
MAF Bangladesh	Dhaka	Bangladesh
Martin Mars	Port Alberni	Canada
Mattice Lake Outfitters	Armstrong	Canada
Melbourne Seaplanes	Williamstown	Australia
Minnesota Seaplanes Aerocet Floats	Priest River	USA
Minnesota Seaplanes Aqua Floats	Brandon	USA
Minnesota Seaplanes Baumann Floats	New Richmond	USA
Minnesota Seaplanes Clamar Floats	Denfield	Canada
Minnesota Seaplanes EDO Floats	Kenmore	USA
Minnesota Seaplanes PK Floats	Old Town	USA
Minnesota Seaplanes Wipline Floats	So. St. Paul	USA
Mirabella Aviation	Fort Pierce	USA
Mission Lodge	Marathon	USA

Name	City	Country
Misty Fiords Air	Ketchikan	USA
Moose Lake Lodge	Anahim Lake	Canada
Moosehead Lake Region Chamber of Commerce	Greenville	USA
Multi Engine Seaplane Rating	Bartow	USA
Naples Seaplane Service, Inc.	Naples	USA
Neil's seaplanes limited	Lochearnhead	UK
Nestor Falls	Nestor Falls	Canada
Norcal Seaplanes	San Andreas	USA
North Air	Perham	USA
North Aire	Prescott	USA
North Pacific Seaplanes	Rupert	Canada
North Star Aero	Fairbanks	USA
North West Seaplanes	Renton	USA
North Wind Aviation Ltd.	Happy Valley - Goose Bay	USA
Northern Rockies Vacations	Muncho Lake	Canada
Northern Wilderness	Fort Frances	Canada
Northwest Flying Inc.	Nestor Falls	Canada
Ocean Air	Victoria	Canada
OFF Training and Charter	Kingston	Canada
On-Track Aviation Limited	Wellesbourne	UK
Pa Pa Bear Adventures	Bethel	USA
Pacific Airways	Ketchikan	USA
Pacific Coastal	Richmond	Canada
Pat Bay Air Floatplane Training	North Saanich	Canada
Pavco Flight Center	Gig Harbor	USA
Paynes Air Service	Inlet	USA
Pickerel Arm Camp Summer (May 1-October 31)	Sioux Lookout	Canada
Pickerel Arm Camp Winter (November 1-April 30)	Janesville	USA
Pickle Lake Outposts	Pickle Lake	Canada
Pipestone Fly-In Outposts Summer	Emo	Canada
Pipestone Fly-In Outposts Winter	Baudette	USA
PK Floats	Lincoln	USA
Prince of Wales Air Taxi	Craig	USA
Promech Air	Ketchikan	USA
Quetico Air Service, Ltd. Canada	Fort Frances	Canada
Quetico Air Service, Ltd. USA	Crane Lake	USA
Rapids Camp Lodge Corporate Office	Dallas	USA
Rapids Camp Lodge Lodge	King Salmon	USA
Regal Air	Anchorage	USA
Reliance Airways Ltd.	Fort Smith	Canada
River Clyde seaplane service	Glasgow	Scotland
Royal Air Service	Duluth	USA
Royal Wolf Lodge	Anchorage	USA
Rust Myers	Fort Frances	Canada
Rust's Flying Service	Anchorage	USA
Ryan Aviation Seaplane Base, Inc.	Palm Coast	USA
Safari Seaplanes	Nassau	Bahamas

Name	City	Country
Saltsprin Air	Salt Spring Island	Canada
Scenic Mountain Air	Moose Pass	USA
Sea Hawk Air	Kodiak	USA
Sea Plane Services	Lino Lakes	USA
Sea Plane Türkiye	Istanbul	Turkey
Sea Planes in Paradise	Phoenix	USA
Sea Wind Aviation	Ketchikan	USA
Seaborne Airlines	Christiansted	US Virgin Islands
Seair Seaplanes Nanaimo	Nanaimo	Canada
Seair Seaplanes Vancouver	Richmond	Canada
Sealand Aviation	Campbell River	Canada
Seaplane Academy	Nanaimo	Canada
SeaPlane Operations, LLC	Zephyr Cove	USA
Seaplane Pilots Association Australia	North Rydw	Australia
Seaplanes of Key West Florida		
Seaplanes West	Sherwood Park	Canada
Seattle Seaplanes	Seattle	USA
Seawings.UAE	Dubai	United Arab Emirates
Servant Air	Kodiak	USA
Sharp Wings Ltd.	Williams Lake	Canada
Sheble Aviation	Fort Mohave	USA
Showalter's Fly-In Camps	Ear Falls	Canada
Sitka Air		
Sky Trekking Alaska	Wasilla	USA
Slate Falls Air	Sioux Lookout	Canada
Snake Falls Camp	Red Lake	Canada
Soloy	Olympia	USA
Southeast Aviation	Ketchikan	USA
Southern Seaplane, Inc.	Belle Chasse	USA
Southland Air Service	Gladstone	New Zealand
Sportsman's Guide and Air Service	Anchorage	USA
Stanton Air	Orillia	Canada
Subic Seaplane, Inc.	Magellan´s Landing	Philippines
Sudbury Aviation Ltd.	Azilda	Canada
Sunlight Aviation	Anchorage	USA
Sunrise Aviation	Wrangell	USA
Sydney by Seaplane	Newport Beach	Australia
Sydney Seaplanes Pty Ltd	Rose Bay	Australia
Täby Seaplane Club		Sweden
Talon Air Service	Soldotna	USA
Tartan Air	Murray River	Canada
Taupo's Floatplanes	Taupo	New Zealand
Texas Seaplanes	McKinney	USA
Tofino Air Gabriola Island	Gabriola Island	Canada
Tofino Air Sechelt	Sechelt	Canada
Tofino Air Tofino	Tofino	Canada
Trail Ridge Air	Anchorage	USA
Trans Maldivian	Male International Airport	Republic of Maledives
Traverse Air	Traverse City	USA
Travira Air	Kuningan	Indonesia

Name	City	Country
Trophy King Lodge	Homer	USA
Turtle Air Ways Fiji	Nadi Airport	Fiji Islands
Turtle Air Ways North America	Vancouver	USA
Tweedsmuir Air Services (May-October)	Nimpo Lake	Canada
Tweedsmuir Air Services (November-April)	Kelowna	Canada
Tyax Air (May-September)	Goldbridge	Canada
Tyax Air (October-April)	Whistler	Canada
UK Seaplane Association		
Ulster Seaplane Association Ltd	Coleraine	Ireland
Valhalla Lodge	Anchorage	USA
Vancouver Island Air	Campbell River	Canada
Vanuatu Sea Planes	Port Vila	Vanuatu
Venture Air	Thompson	Canada
Venture Travel, LLC dba Taquan Air	Ketchikan	USA
Viking Air Ltd.	Sidney	Canada
Viking Island Lodge and Outposts	Red Lake	Canada
Voyage Air Alberta	Fort McMurray	Canada
Voyage Air Saskatchewan	Buffalo Narrows	Canada
Walsten Outposts	Kenora	Canada
Ward Air Inc.	Juneau	USA
WaterWings Flight Training Center: Lake Martin, AL	Equality	USA
West Coast Air	Vancouver	Canada
WestCoast Air	Vancouver	Canada
WestCoast Wild Adventures	Ucluelet	Canada
Whistler Air	Whistler	Canada
Wilderness Air	Vermilion Bay	Canada
Wilderness North	Thunder Bay	Canada
Willow Air	Willow	USA
Wings Airways and Taku Glacier Lodge	Juneau	USA
Wings Over Kississing	Flin Flon	Canada
Wipaire	St.Paul	USA
Yakutat Coastal Airlines	Yakutat	USA
Yes Bay Lodge	Ketchikan	USA