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AERIAL FISH SPOTTING IN THE UNITED STATES COMMERCIAL FISHERIES

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SUMMARY

About 70 aircraft are used by the United States commercial fisheries to locate concentrations of schooling fish and to assist the fishing fleet in their capture. Use of spotter aircraft has enabled the fishing fleet to increase its efficiency by reducing the amount of search time required to locate concentrations of fish.

One of the primary reasons for successful aerial fish-spotting operations since the World War II period was the development of reliable light aircraft engines and electronic equipment.

Each commercial species requires a specialized spotting technique. In some fisheries operations may be conducted only during daylight hours, or at the hours of dusk, or at night only during periods when there is no moonlight. The skill of the spotter pilot is dependent upon good visual acuity and the ability to "recognize" schooling fish and to determine species from aerial observations.

Altitudes of operation may vary from 300 to over 2,000 feet.

Tuna, sardines, salmon, mackerel, anchovies, barracuda, menhaden, bonito, and Atlantic herring are some of the species that are fished using aerial spotting as an aid.

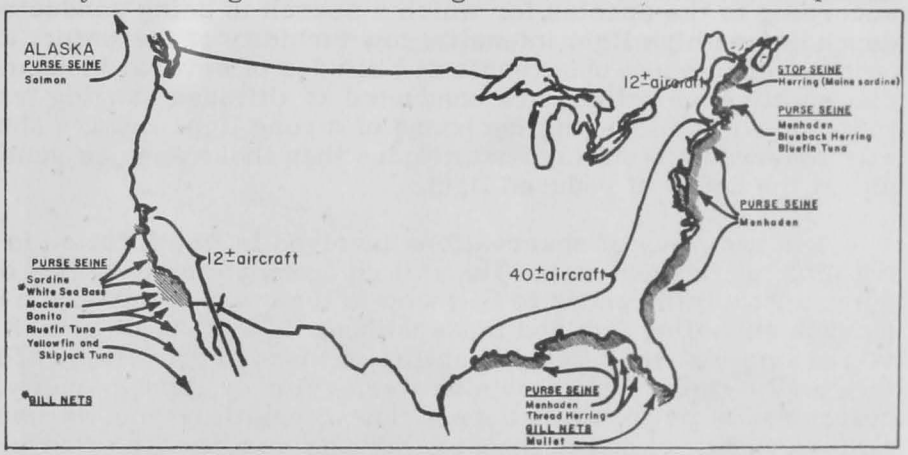

Fig. 1 - Commercial fishing areas using aircraft.

One of the hazards of aerial fish spotting is mid-air collisions. Seven fatalities have been attributed to mid-air collisions between fish spotter aircraft in the past five years. Cooperative regulations have been developed by fish-spotter pilots to reduce the chance of mid-air collisions.

The exact value of aerial fish spotting to the commercial fishing industry is not known but is considered to be substantial. Some fishing vessels are at times reluctant to journey to the fishing grounds unless an aerial reconnaissance of the grounds has been made.

Charges for the fish-spotting service varies from one area to another--both the rate and method of computing payment.

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The use of aircraft for fish spotting will increase in the future and light aircraft now used in some fisheries will undoubtedly be replaced by one-man helicopters, when the development of that aircraft has reached a point of dependability and its initial cost reduced.

BACKGROUND

The search for methods to develop the efficiency of commercial fishing has resulted in an increased use of light aircraft in many domestic and foreign fisheries during the past decade. Approximately 70 aircraft are now in use throughout the United States during the various fishing seasons for the purpose of scouting for concentrations of schooling fish and directing fishing operations of the commercial fleet.

The first use of aircraft for scouting concentrations of schooling fish was reported to be in 1920 for menhaden in the Atlantic. Several attempts to use aircraft and blimps for fish spotting were recorded for the period before and during World War II. Since World War II, by using aircraft to aid in spotting surface schooling fish, fishing vessels have been able to reduce the amount of search time. This is due to the aircraft's ability to search a tremendously greater area during a given period of time, to observe schooling fish when below the surface, and assist the fishing vessel in selecting the fish school with the approximate desired tonnage. In some instances aircraft have enabled vessels to fish during daylight hours where previously night fishing during the dark phase of the moon's cycle was the only conventional method, thereby increasing the productive efficiency of the fishing fleet.

One of the principle factors that has resulted in the widespread use of private commercial aircraft for fish spotting was the development of reliable light aircraft engines, and dependable radio equipment.

TECHNIQUES OF OPERATION

The various United States fisheries have independent methods of search and spotting techniques developed for the species that are of direct concern. Search altitudes may vary according to the species for which a search is being conducted. Under certain conditions, depending on high light intensity, low turbidity of the water, and surface schooling, concentrations of fish are observable at altitudes of several thousand feet. However, most commercial spotting operations are conducted at altitudes ranging from 500 to 1,500 feet. Species that are available during the hours of strong light and are abundant in large schools are usually observable from higher altitudes than those species generally occurring in small schools and at the hours of reduced light.

The accuracy of observations involved in fish location is a function of the pilot's ability, training, and experience. The skilled fish-spotter pilot has developed an ability to distinguish subtle differences to be found in the color composition of water masses containing near-surface schooling fish and those without fish. Proficient fish spotting is dependent on the visual acuity of the pilot, his ability to discern gradations of luminosity emitted from the surface and to then discriminate between color or light intensity. He then, "recognizes" or perceives some distinctive inherent characteristic associated with a fish-school target. The fish-spotter pilot has developed, through many hours of observing, a background of training and experience which provides the associations necessary for the determination or recognition of targets of schooling fish. When persons inexperienced in observing schooling fish are taken on a fish-spotting mission, they usually fail to observe concentrations of fish even though they may be quite obvious to the trained observer. However, most persons with good visual acuity are able to distinguish schooling fish with a short period of instruction.

The second phase of the recognition process, and one of great importance to the commercial fishery, is the determination of species. Determination of species may be on the basis of color, shape, behavior, or other differences and may be a combination of two or more factors. If operations are in areas where one species predominates, the problem of species recognition is reduced. However, in areas such as southern California where several species--sardines, anchovies, bonito, barracuda, and mackerel--are selectively sought by the commercial fleet, there is a need for further refinement of identification methods, as

schools of those species may appear to be indistinguishable from one another. The more skilled fish spotters have developed observation techniques to determine the differences between the commercial species.

AREAS OF OPERATION

Aircraft are now being used in the following areas for fish spotting: Alaska: salmon; Pacific West Coast: sardine, mackerel, bonito, sea bass, barracuda, anchovy, and tuna; Gulf of Mexico: menhaden, and thread herring; Atlantic Coast: menhaden, Atlantic herring (Maine sardine), blueback herring, swordfish, and bluefin tuna (see fig. 1).

Menhaden, tuna, sardines, salmon, sea bass, mackerel, swordfish, and anchovies are some species that are at times available and easily observed from the air, and are fished under conditions of bright sunlight (see figures 2a and 2b, and figure 3).

In contrast to such species is the Atlantic herring (Maine sardine); which is usually observable only under conditions of reduced light, during one to two hours from dusk till darkness. At this time the herring rise from the bottom and migrate toward the inshore areas. Commercial fish spotting for Atlantic herring is sometimes conducted at altitudes down to 300 feet to better identify small schools that may be confused with the rocky bottom and submerged kelp areas that are common to the coast of Maine. Aircraft are sometimes used to examine the stop-seined area for the results of the previous night's fishing, to determine if the quantity of fish caught is worth moving into a seine pocket for holding.

Figs. 2a and 2b - Anchovy schools near shore, north of San Quintin, Baja California, Mexico. Altitude 150 feet (2a), 700 feet (2b). Concentrations extended for $2\frac{1}{2}$ miles in the immediate offshore area.

Aerial fish-spotting operations are conducted during the day, and at night off southern California during periods of the dark cycle of the moon. Sardines and other pelagic schooling species have been located at night by the luminescence of planktonic organisms, commonly called by fishermen as, "fire in the water." This is the result of the "plankton" being agitated by the schooling fish and is a phenomena that is observable only during the dark period of the moon's cycle. This luminescence is observable from the air and is used by the aerial spotter to locate schools, as it is by the surface fisherman.

Night aerial spotting operations have been a common practice in California for the past five years. Night-and-day operations ranging 125 miles or more into the offshore areas are conducted using single-engine light aircraft. Such planes used primarily for tuna spotting, either off southern California or off the southern end of Baja California, Mexico, are capable of flights of 12 hours or more. Flights of extended duration occur during the moon's cycle of full darkness and the fish spotter aircraft may remain in the air from dusk till dawn.

Fig. 3 - Concentrations of anchovies off Coronado Strand, Calif.

Operating procedures between the fishing vessel and the spotter aircraft may vary greatly. In some areas the aircraft is is used to guide the seine vessel to an area where schooling fish are found to be abundant; and the seine vessel will then proceed with the fishing procedure, using surface observations as a guide. In other cases, the aircraft spotter who is proficient in seining procedures will direct the setting of the purse seine, or stop seine, by radio contact with the captain of the fishing vessel. When the schooling fish are not close to the surface and therefore not visable from the fishing vessel it is still possible for the aircraft spotter to locate the school and direct the positioning and setting of the seine.

Fig. 4 - Herring in a seine pocket, and the results of a night's stop-off in the large seine-enclosed area. On the right, the seine twine is "ballooned" by the incoming tide. Location, north side of Great Mark Island, Casco Bay, Maine.

TYPES OF AIRCRAFT AND EQUIPMENT

The type of aircraft most preferred and used in aerial scouting work is the light aircraft of high-wing monoplane design with a tandem seating arrangement, allowing observation from either side of the aircraft. The aircraft are powered by a 4 or 6 cylinder opposed-piston engine having a horsepower range of 65 to 150. Several commercial aircraft designs have certain important features that lend themselves to fish spotting. In general, they are, low-stalling speed, inherent stability, good visibility, and relatively low maintenance and cost of operation.

The cost of light aircraft now in use by the commercial fish spotter may range from $2,000 to $12,000 depending on the age and condition of the engine and airframe, and if new or used. A new aircraft of the type described in the following specifications, equipped with floats, radio communications, and navigational equipment, would cost about $12,000.

Helicopters have been used experimentally for commercial fish spotting; however, the helicopter's high initial and operating costs have discouraged its use in most commercial fishing operations. The continued development of the helicopter will in the future result in construction of an economical machine, probably of the one-man type, that will see widespread use by the commercial fishing fleet. A small helicopter of the one-man type could be operated from the fishing vessel and would be very useful in oceanic fisheries that range long distances from shore-based aircraft.

In recent years, reliable radio communication equipment has been developed allowing direct contact between the fishing vessel and the aircraft. This is in contrast with communications systems experimented with in the earlier days of fish spotting. Such methods as wig-wagging the wings and heading the aircraft in the direction of the fish school; flying low over the fishing vessel, cutting the engine, and yelling directions; diving on the school; dropping empty milk cartons or floats on the school; signaling with a system of colored lights--these have been replaced with an efficient plane-to-boat electronic communications system. Radio frequencies in the high frequencies and very-high frequencies (VHF) are most commonly used. Equipment may range from elaborate VHF communications systems between the shore plant, fishing vessels, and spotter aircraft, to simple systems between the plane and vessel using the marine frequencies of 2738 kilocycles. Citizen band units on a frequency of 27 megacycles are in use, and though range is limited, it does provide a near-private means of giving fishing information.

Most aircraft used in over-water fish spotting operations are equipped with wheels and can be operated only from a land airport. Land-based aircraft are easier to maintain than are float-equipped aircraft operating from a salt-water base, because of the elimination of the corrosion problem. Also, in most areas service facilities for land-based aircraft are common but seaplane service facilities are almost non-existent. Float-equipped aircraft are commonly found in the Gulf of Mexico menhaden fishery and the Maine herring fishery (see fig. 5). The cost of float-equipped aircraft is about $2,800 more than that of wheel-equipped aircraft. However, the ability to make a forced landing on water with float aircraft, versus a landing on water with a wheel-equipped type is a factor that must be evaluated by the personnel who

Fig. 5 - Float-equipped aircraft of a type used in fish spotting.

fly the aircraft. In most cases, wheel landing on water will result in overturn of the aircraft, damage, and usually complete loss by sinking.

Typical specifications of light aircraft used in fish spotting are:

Design - High-wing monoplane, two-place (tandem seating).
Engine - 4-cylinder opposed, 150 B. hp. @ 2,700 r.p.m. engines may range from 65 to 160 B. hp.
Gross weight - 1,750 lbs.
Empty weight - 930 lbs.
Useful load - 820 lbs.
Wing span - 35 ft.
Cruising speed - 113 m.p.h. (75% power).
Stalling speed - 45 m.p.h. (flaps extended).
Fuel capacity - 36 U. S. gallons.
Fuel consumption - 9 U. S. gals./hr. (75% power).
Cruising range - 460 miles (75% power).

Conventional light aircraft are sometimes modified to carry large quantities of fuel giving 12 or more hours of flight duration.

Radio equipment usually includes a marine-band transmitter-receiver, a citizen-band set, or both, and an aircraft VHF navigation-communications set capable of omni-reception. An A.D.F. (automatic direction finder) may be included in some cases.

Instrumentation, in addition to the basic flight and engine instruments, may consist of a full panel allowing operation of the aircraft under I.F.R. (instrument flight rules) conditions. Aircraft operating in the offshore areas, and at night, are usually so equipped.

HAZARDS OF OPERATION

Aside from the hazard of power failure, which would result in a forced landing, there is the hazard of mid-air collision. During the past five years, records indicate that in the Middle Atlantic and New England areas there have been at least seven fatalities resulting from mid-air collisions between aircraft conducting fish-spotting operations. A mid-air collision between a fish-spotter aircraft and a military jet in North Carolina, and off southern California a missing aircraft and an unexplained crash into the sea, has resulted in additional fatalities.

Aerial fish spotting requires the concentration of the pilot, not only upon flying the aircraft but in searching below and to the side of the aircraft for signs of schooling fish. Once the fish are found, it is of necessity that the pilot closely observe the fish during a circling procedure while waiting for the seiner to arrive at the proper position before setting the net, and when setting the net. The attention required of the pilot to search and direct the fishing vessel reduces the amount of attention that the pilot can give to other air traffic.

In an effort to eliminate or cut down on the hazard of mid-air collision, the commercial fishing industry has, in areas where fatalities have occurred, developed safety rules for fish-spotting operations. These rules are agreed upon by the companies and pilots involved, and operate successfully only through the cooperation of the pilots. In 1959, as a result of a mid-air collision accounting for three fatalities in 1958, companies and pilots in the Gloucester, Mass., area, in cooperation with the U. S. Bureau of Commercial Fisheries developed the following voluntary rules. These rules were in part based on those developed by companies and spotter pilots in the Chesapeake Bay area after a fatal accident in 1956. The cooperative safety rules are:

1. Working altitudes as specified will be adhered to: 0 - 1,500 feet, Company A, Gloucester, Mass., 2,000 feet plus, Company B, Gloucester, Mass.; or at ceilings below 2,000 feet a minimum altitude separation of 300 feet will be maintained between aircraft.

2. All fish-spotter pilots will set their altimeters to the barometric pressure (altimeter setting) each morning at time of take-off.

3. No formation or acrobatic flying over the fishing areas.

I certify and agree that the foregoing rules have been accepted by the companies and pilots involved in aerial fish-spotting operations and that the boat captains operating in cooperation with the pilots have been made aware of these rules and that all conditions set forth herein will be complied with. I further agree that the acceptance of these rules does not in any manner alleviate the pilot for compliance with all pertinent Federal Air Regulations.

(signed by company representatives and pilots)

VALUE TO THE INDUSTRY

The fish spotter's value to those commercial fisheries dependent upon seining pelagic schooling fish... is well established and, in many cases, fishing vessel operators are reluctant to venture to the fishing grounds unless an aircraft has scouted the area and can give current information on the location of schooling fish. Fish-spotting pilots contend that unless fish are spotted from the air, it is useless for commercial fishing vessels to attempt scouting. But weather conditions resulting in low ceilings and poor visability is one of the few times when surface observations from a fishing boat is the only way to spot schooling fish. The resulting increase in fishing efficiency from the use of aircraft has not been fully appreciated by the commercial fishing industry in general, as aircraft are not usually thought of as having an important part in commercial fishing. In southern California it has been estimated by one of the more experienced fish-spotting pilots that each active fish-spotting aircraft is responsible for directing fishing operations resulting in the catch of at least 20,000 tons of sardines, mackerel, and other species during a season. Aircraft used in fish spotting are sometimes owned by the fishing vessel or processor, and pilots are hired on a monthly or seasonal basis at a flat rate. In other cases, the aircraft are independently-owned and spot for the commercial fishing vessels on a share basis, or for a company on a fixed rate. For example, in the southern California purse-seine fishery, it is reported that the fee for the spotting service is five percent of the gross ex-vessel sale of the catch on a long-term contract, or seven percent of the individual catch when not under contract. In other areas, fees have been reported to be 1 to $1\frac{1}{2}$ shares of the vessel's gross stock. The number of fishing vessels that can be properly serviced by one spotter aircraft is 4 to 5.

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