Water or Trees?

by

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If you fly long enough and often enough, sooner or later you'll face the prospect of having to put an airplane on the deck in a hurry. If you're lucky, it'll be due to just a sick passenger or maybe a rough engine. But it could just as well be a full-up-oil-on-the-windshield forced landing.

In the latter, you're confronted with the sudden and unavoidable question of where to put the thing down. Is a road the best choice? An open plowed field? Settling into a dense pine forest? A nice lake, near the shore?

Until recently, we thought we knew the answer: the water is by far the most survivable surface upon which to alight in an emergency. We said as much at an FAA accident prevention seminar we were asked to give by Bob Martens, the aviation safety counselor at the nearby Bradley FSDO. We had just completed extensive research on how aircraft fare during ditchings in water and concluded that the odds of survival during a ditching were greater than 90 percent, thus water was a better choice than trees for a power-out landing.

Not so fast, Martens said. As the occasional accident duty guy in heavily forested New England, he had seen plenty of airplanes go into the trees and his gut feel was that the majority of occupants walk away or at least survive.

Good point. We agreed to sweep through the accident database for another look. One thing's for sure: there are plenty of forced landings to pick from, most of them the depressing result of fuel exhaustion. It's not hard to find between 300 and 400 a year.

Crash or Forced Landing?

As with analyzing ditching accidents, you have to draw a distinction between a ditching and a crash in the water and a forced landing and a crash on land. From the NTSB's summaries, it's occasionally impossible to tell which is which. Some reading between the lines is necessary.

For our purposes, a ditching – and for that matter, a forced landing – means that there's strong evidence to suggest that the pilot attempted to touch down under control and that the aircraft didn't impact out of control at high speed. But there are degrees of control and lack thereof. The accident record shows that in many forced landings, pilots set up an approach that's too fast, too high and to a poorly chosen surface. They hit hard, bounce and roll over.

There's obviously *some* control being exercised, but no one would mistake the results for a spot-landing contest. Some forced landings seem to begin auspiciously, evolve into a hard landing then degrade into what the casual observer would certainly regard as a crash.

Another difficulty in this analysis is the dead-men-tell-no-tales syndrome. When the accident proves fatal for all occupants, there may not be anyone to offer an eyewitness account of what actually happened. Ground witnesses, if there were any, are often unqualified or unable to judge what they've seen. In some cases, this information can be gleaned from radio transmissions and witnesses, but not always.

With these caveats in mind, the data we have available to review is obviously flawed and thus we can draw only the broadest conclusions from analyzing it. In other words, our findings can't be considered airtight by any means.

We reviewed some 179 ditching accidents over an eight-year period and 216 forced landing incidents that occurred from 1995 to 1998. There's no magic to those years; we picked them at random.

Going Swimming

As we reported in the October 1999 issue of *Aviation Safety* (prepublished here), the survival rate in light aircraft ditching incidents is quite high, suggesting that when there's a choice, a body of water is a safe place to get out of an airplane.

That said, there are far fewer ditchings than forced landings on terra firma. Our review of accident stats reveals about 20 recorded ditchings in U.S. waters each year, compared to between 300 and 500 genuine forced or precautionary landings on land.

Our review of the records found 179 ditchings over the period we examined. Of that total, only 22, or 12 percent, involved fatalities.

But that figure needs clarification.

One of the distinctions between ditchings and forced landings is that the former may be more likely to require survival equipment than the latter. If the equipment isn't aboard, a successful ditching in which the occupants all exit the aircraft can turn into fatalities if any or all die of exposure or drowning.

While it's true that a forced landing in a remote area can have the same consequences, the accident record doesn't reveal many of those. In most forced landings, emergency personnel are on the scene quickly, even in remote areas.

To understand ditching survival odds, knowing the egress rate is important. In other words, how often do the occupants get out unscathed after a ditching? It turns out to be about 92 percent. That means that more than

nine out of 10 people get out of ditched aircraft without significant problems.

Pilots worry about such things as sinking to the bottom before the doors can be opened or flipping over and becoming too disoriented to get out. Yet these things don't seem to happen much.

Ditching survivors often can't recall if the airplane flipped on impact but even it does, the high egress rate speaks for itself. Whether upright or inverted, pilots and passengers somehow manage to get out of their airplanes.

Where you ditch matters, too. Survival rates for ocean areas are lower than for lakes and rivers. In blue water ocean, for example, the survival rate is 82 percent, versus 93 percent for rivers.

How About Land?

So much for the water. How do pilots fare when the only choice is rough terrain, trees or other airplane inhospitable surfaces? In a nutshell, about the same or a bit better, although the prospect of injury is somewhat higher. First, some comments on the data and the basis of comparison.

Working through the NTSB database, the only forced landings likely to be reported are those that result in accidents, and we're quite certain that not all of them make it into the database, either. We're confident that most do but know enough of how this system works to have few illusions about either its completeness or accuracy. That said, comparing known reported forced landings on water against those that occur on land is still an apples-to-apples comparison.

We can't comment on accident rates, of course, but we can compare the aftermath. We examined 216 dry-land forced landing accidents that occurred in 1995, 1997 and 1998. These were picked at random from the NTSB files. The results of this search proved interesting.

First, the percentage of these accidents that resulted in fatalities was an encouragingly low 3 percent, meaning the survival rate for forced landings in all kinds of terrain where an accident occurs is 97 percent overall, or a bit better than it is for landings in water.

Further, even in cases where there were fatalities, in many cases, some occupants in these aircraft survived the forced landing gone bad.

When you consider injuries sustained by pilots and passengers during forced landings, the picture isn't quite so rosy. In 16 percent of the 216 accidents studied, pilots and/or pax suffered serious injuries. In 20 percent of the cases, minor injuries were reported.

In water landings, only 10 percent received serious injuries but 33 percent reported minor injuries. The typical “minor” injury in a ditching accident is a bumped head from impact or abrasions during a hurried exit.

The picture is grimmer if you consider the type of surface or terrain in which the forced landing is attempted. When trees are the touchdown area, serious injuries occur about 35 percent of the time while injuries of some kind happen about 60 percent of the time.

If this record is at all accurate, mushing one into the trees means your chances of suffering an injury of

some kind are about even. In other words, the odds of the tree landing hurting a little are greater than if you had gone into the water.

However, the good news is that your chances of coming out of the controlled crash alive are quite good. In fact, they're the same as surviving a ditching. Only 6 percent of the tree landings we reviewed resulted in fatalities.

Logically, pilots and pax should expect to do better when the airplane is landed in open fields or in fields obstructed with minor obstacles. And that appears to indeed be the case. When an open field is the landing area, the serious injury rate drops to 14 percent, while the overall injury rate is about 35 percent. Those are better odds than going into the trees. Out of 65 accidents in which the airplane was landed in what was described as an open field, we could find only one fatality.

Again, worth noting is that what the NTSB describes as an attempted forced landing may in fact have been an out-of-control crash. Sometimes, there's simply not enough information in the reports to split these kinds of hairs.

Roads are another popular forced landing site. When an accident occurs, pilots and pax fare a little worse on roads than in open fields, with serious injuries occurring 40 percent of the time and minor injuries about 22 percent of the time. We found no fatalities in some 27 attempted forced landings on roads.

Conclusions

Clearly, our FAA friend was correct. The fatal accident rate for tree landings is essentially the same as for water. The analysis suggests that either kind of landing, if done correctly and under control, puts your chances of surviving at nine out of 10. But that doesn't mean you'll necessarily walk – or swim – away.

The chances of sustaining an injury of any kind are somewhat higher when you go into the trees than when you ditch in the water and the chances of a serious injury are quite a bit higher in the trees. This seems logical and the data we assembled – however flawed – seems to bear out the theory.

So when there's no open field available and the choice is either trees or water, the choice isn't the lead pipe cinch we once thought it was. **The overall survival rate between the two appears to be about the same, but the injury rate is higher if you go for the trees.**

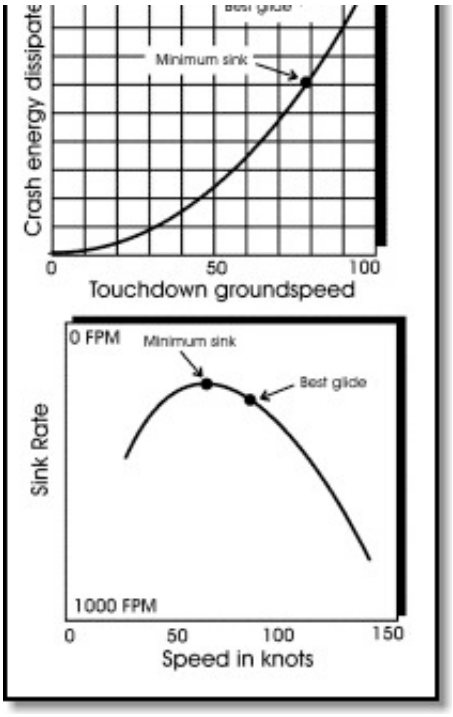
One thing is relatively certain: Whichever you pick, the airplane will probably be a write off, so trying to save or minimize damage shouldn't figure into your decision. In fact, whenever you're confronted with *any* emergency in which survival is at question, the airplane should be considered nothing but an expendable collection of aluminum, steel, rubber and fluids.

That's the way the insurance company will look at it, and that's why you pay them that hefty annual premium.

Speed Kills (At Least It Hurts)

One question we can't answer is how many forced landings happen with no damage to the airplane and no injuries. We

would guess quite a few but there's no reliable data on this.



But we can say why many of them go bad: speed, usually. Too much of it. You can't blame a pilot under duress for getting a little over-amped and flying an approach that's too fast. On the other hand, we are talking survival here and an accurate touchdown at the slowest possible speed may be the difference between life and death or walking away or being carried away from the wreckage.

Interestingly, among the 216 accidents we examined, only two involved stalls or mushes but many – dozens, in fact – involved too-fast touchdowns in which the aircraft bounced and slithered its way across a too-short landing area only to pile up in the rocks and trees at one end.

In fully 44 percent of the open-field landings, the aircraft nosed over and came to rest inverted. A fair number of these occurred in snowy fields or soft, plowed surfaces which tend to snag the gear.

Nonetheless, it's also true that if the touchdown is slow enough, they're less likely to happen or, if they do happen, the speeds will be slow enough to cause less injury.

Speaking of speed, the less you have of it, the better. This is especially true of tree landings where control is minimal or non-existent once the branches start slapping the wings and fuselage.

The accompanying graphic shows how touchdown groundspeed affects the dissipation of crash energy (click on graphic for larger image). Note that the relationship between speed and energy is logarithmic, not flat. The slower you can go and still maintain control, the less it'll hurt when you sink into the trees.

The best way to become proficient at accurate, slow touchdowns is to practice emergency landings regularly with an emphasis on flying them as slowly as possible and definitely more slowly than you fly your standard approach.

Furthermore, you probably fly your standard approach too fast, too.

Every normal landing is an opportunity to learn the art of the slow, precise power-off approaches that are a must for survivable forced landings in less-than-ideal areas.

Then, of course, there's the issue of avoiding what caused the forced landing in the first place. Sad to say, most are the result of fuel exhaustion, not mechanical failures. More than a handful are caused by carb icing which, of course, melts when the airplane lands, removing all the evidence. (“I swear it … the engine quit … I swear it did!”)

On the issue of fuel exhaustion, we have written numerous articles on this subject and tried to

jolly the pilot community along with human factors psychobabble and warm entreaties that aircraft fuel gauges really are defective. Enough of that. Absent a leak or other mechanical fault, if you run an airplane out of gas, you are an idiot and you deserve what befalls you. With any luck, both you and your passengers will survive.

Slower is better, especially when it comes to forced landings. As the top graph shows, reducing from best glide speed to minimum sink speed substantially cuts the amount of energy the airplane brings to the ground. The bottom graph shows that sink rate is more at best glide speed than at minimum sink speed. For most airplanes, minimum sink speed is just about the glide speed with full nose-up trim, further reducing workload at a crucial time.

FORCED LANDING CHECKLIST

- To avoid landing downwind, especially in IMC, compare the GPS groundspeed to true airspeed. (You *did* calculate that, right?)
- Compare GPS heading with compass/DG to find crosswind direction and strength.
- The closest airport may be behind you.
- Find an airport, field or deserted road if possible.
- Seat belts as tight as you can stand.
- Stow loose objects.
- Once landing area is made, slow to minimum sink speed. It's close to maximum endurance speed and roughly 1.2 times clean stall speed.
- Give accurate position report to ATC, including GPS coordinates if you can.
- Flaps to full.
- Landing gear is a toss-up. Make your best call.
- Try to relax.
- Electrics, fuel off and doors cracked open before impact.
- Cushion face with pillow or folded jacket or blanket.

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