SSF Soaring Safety Foundation

# Improving Soaring Safety by Mining Data

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# Spoilers

- Data collection relies on community participation
- Some significant pieces of Data are not available
- New sources of data and analysis techniques may provide new insights
- Modern Safety Management programs can help
- Turning analysis products into actionable programs is an ongoing challenge

# Data Collection and Analysis

- Collecting and analyzing data can:
  - Uncover long and short term threats and safety trends
  - Identify how effective mitigation strategies and techniques can be created and used
- To be effective collection and analysis techniques must be:
  - Anonymous: identifying problems not individuals
  - Actionable: mitigation strategies and practices must be implementable by a large portion of the soaring community

# Sources of Data

- Direct requests
  - SSF annual request for anonymous flight data
  - FAA pilot/aircraft annual survey
- Databases
  - NTSB Aviation Accident Database (CAROL)
  - NASA Aviation Safety Reporting System
  - SSF Incident Database
- Flight logs
  - SSA sanctioned contest flight logs
  - OLC and other soaring collection web sites

# What Data is Available Now?

- National Transportation Safety Board (NTSB)
- General Aviation Joint Safety Committee (GAJSC)
- AOPA Nall Report
- FAA annual Survey
- SSF Flight Survey

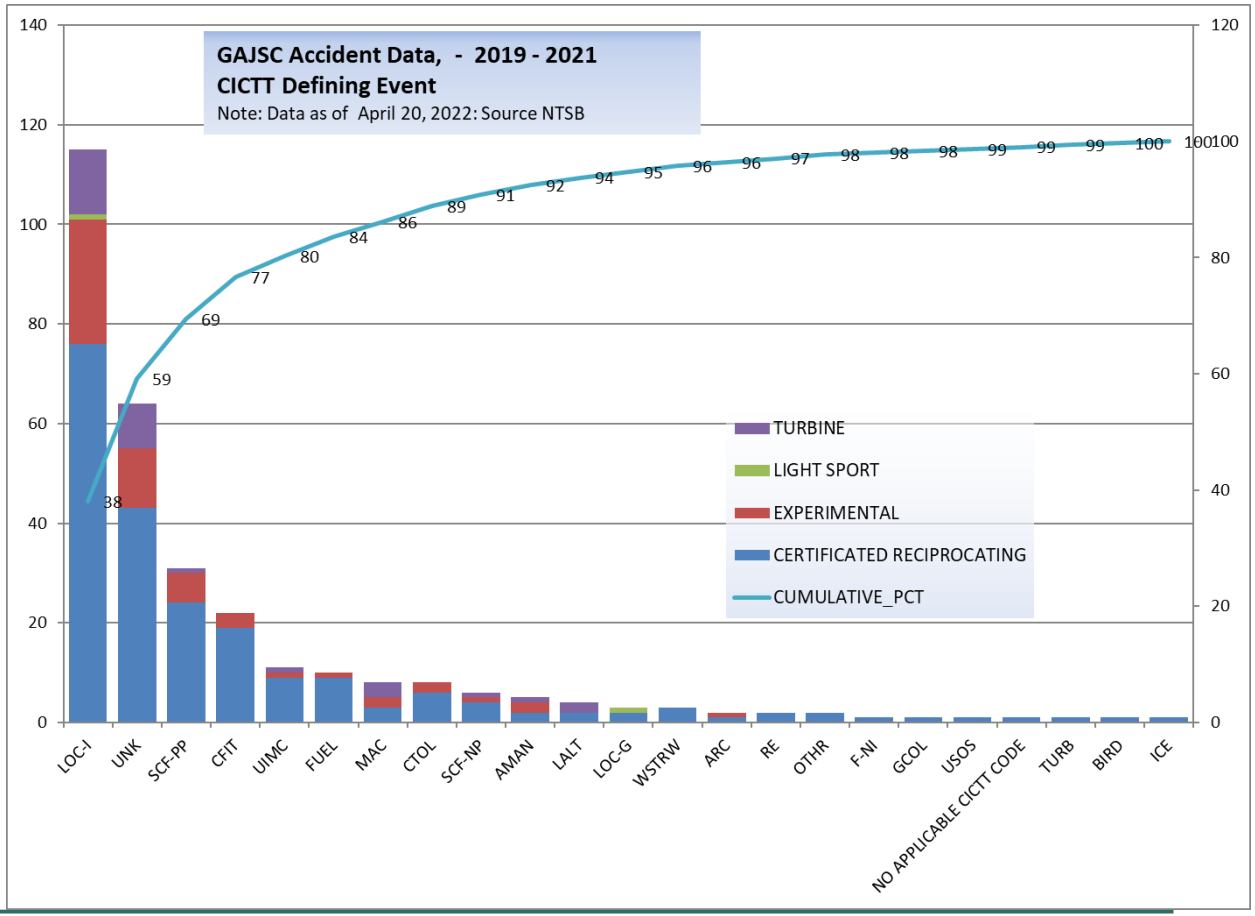
# GAJSC Accident Categories

GAJSC codes defined in Occurrence Category Definitions PDF document

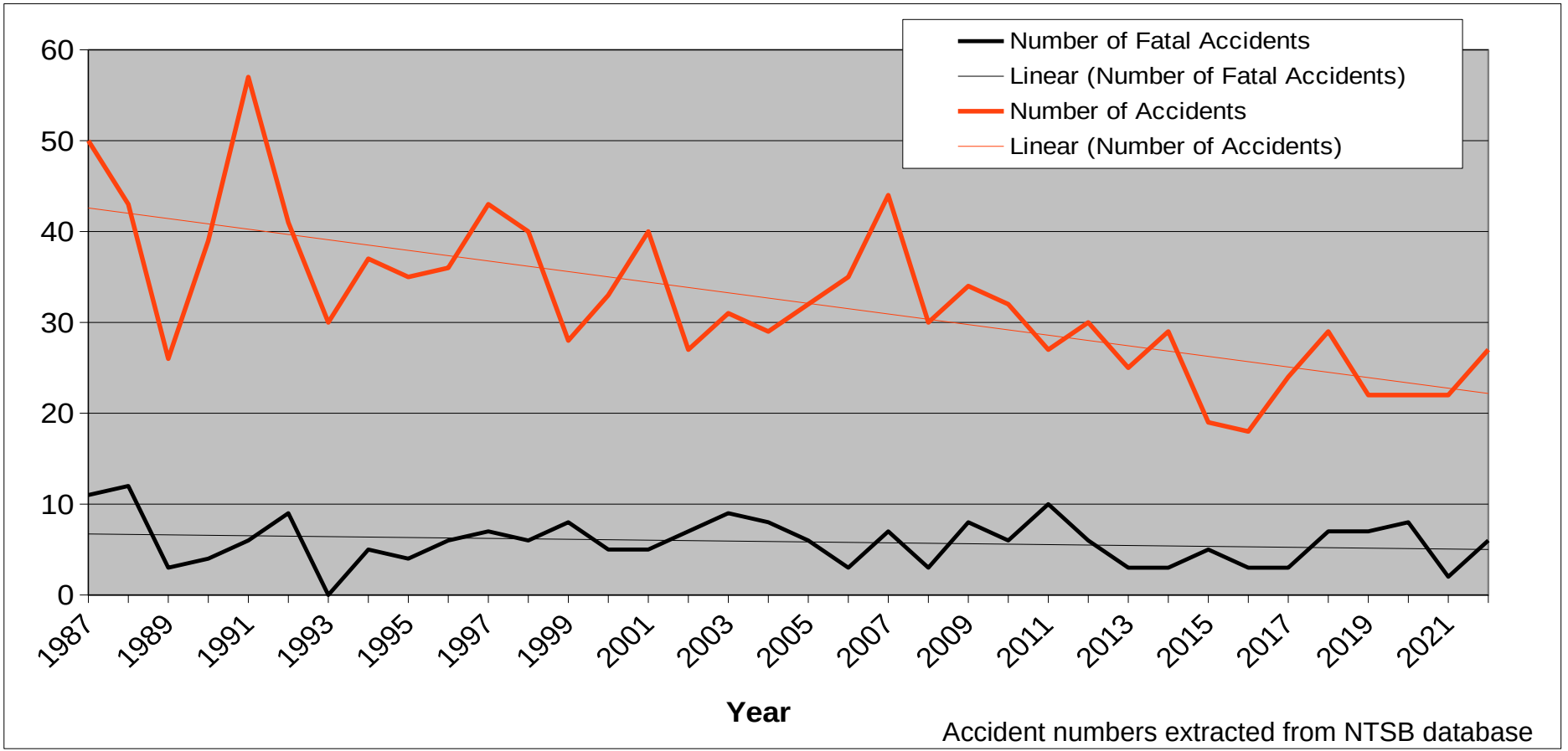
https://www.icao.int/APAC/Meetings/2012_APRAST/OccurrenceCategoryDefinitions.pdf

**Top 5 categories = 80% of accidents**
LOC-I: Loss of Control – Inflight
Unk: Unknown
SCF-PP: Structural failure- Power Plant
CFIT: Controlled Flight into Terrain
UIMC: Unintentional flight into IMC

LOC-I is the leading cause of Fatal and non-Fatal accidents in GA



# Number of Soaring Accidents




Accident numbers extracted from NTSB database

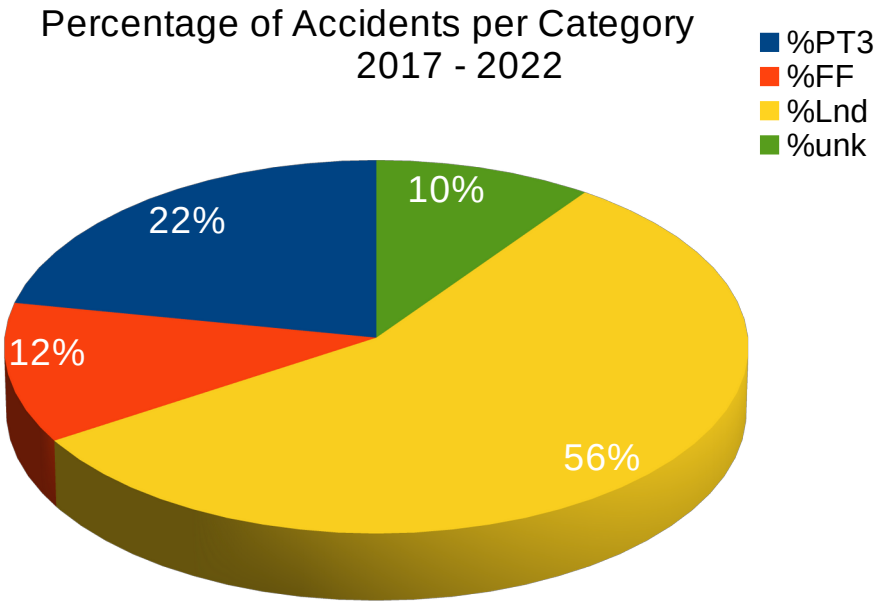
# Flight Safety

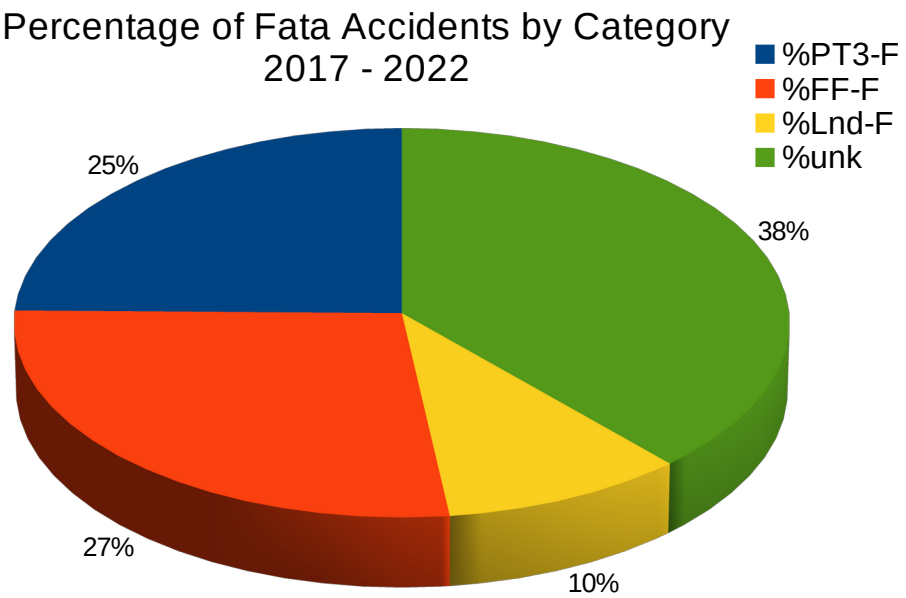
## Glider accidents (fatal and non-fatal) reported to the NTSB

| Year | PT3-NF | PT3-F | FF-NF | FF-F | Lnd-NF | Lnd-F | Unk-NF | Unk-F | Total |
|---|---|---|---|---|---|---|---|---|---|
| 2017 | 4 | 2 | 5 | 0 | 11 | 1 | 0 | 0 | **23** |
| 2018 | 3 | 1 | 1 | 4 | 17 | 1 | 0 | 1 | **29** |
| 2019 | 3 | 1 | 1 | 1 | 11 | 3 | 0 | 2 | **22** |
| 2020 | 3 | 4 | 1 | 1 | 9 | 1 | 1 | 2 | **22** |
| 2021 | 5 | 1 | 1 | 0 | 14 | 0 | 0 | 1 | **22** |
| 2022 | 3 | 1 | 2 | 0 | 7 | 4 | 6 | 1 | **27** |
| Total | **21** | **10** | **11** | **6** | **68** | **10** | **7** | **7** | **146** |

Fatal percentage: Launch – 25%, Cruise – 27%, Landing – 10%
Accident percentage: Launch – 22%, Cruise – 12%, Landing – 56%

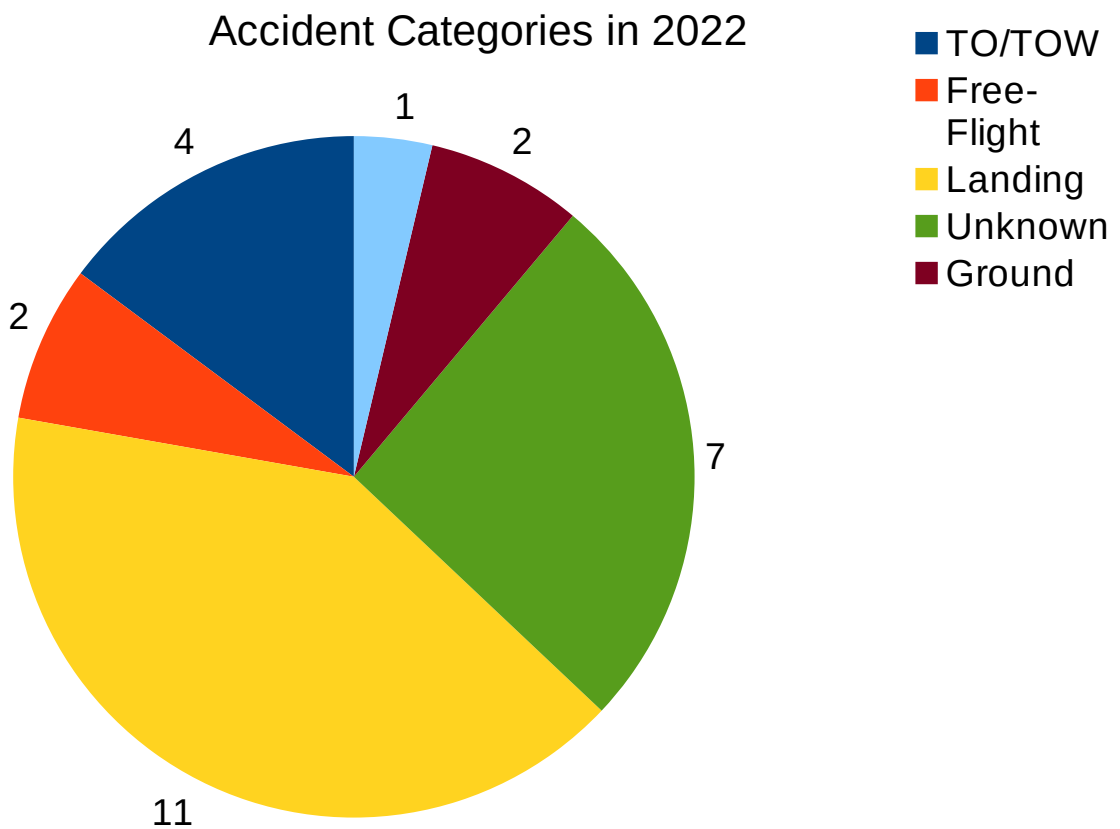
# Soaring Accidents by Category



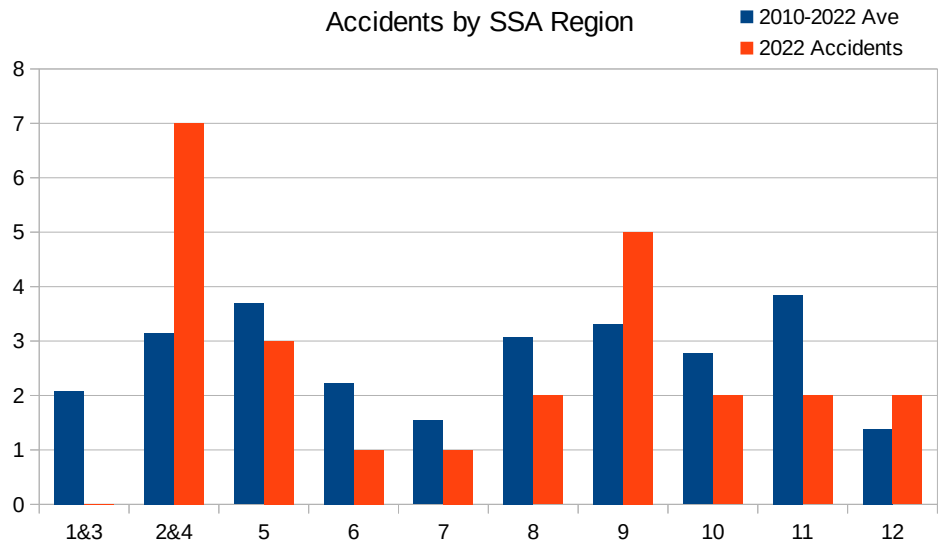



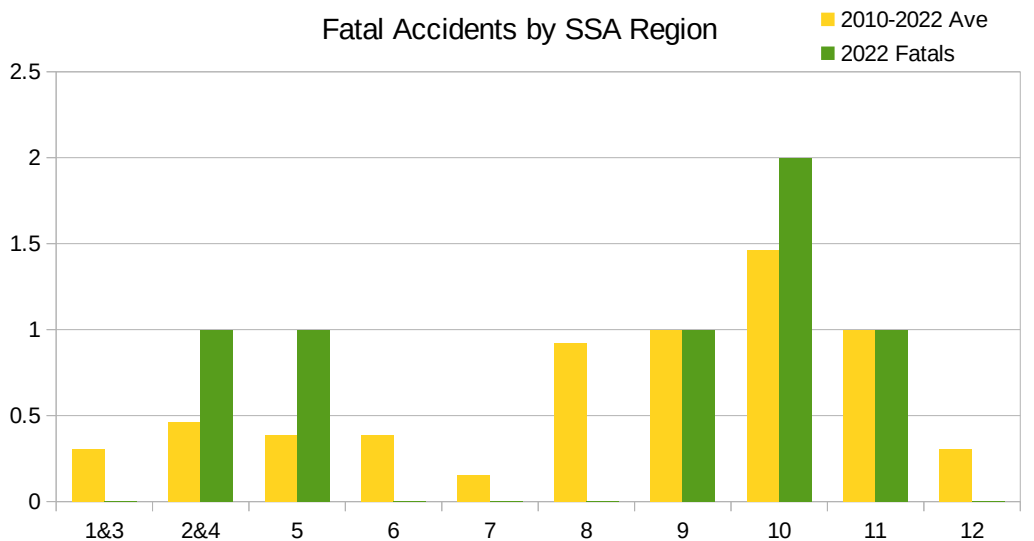

Low Altitude maneuvering (thermalling) seems to play a significant role in fatal glider accidents

# Glider Accident Category

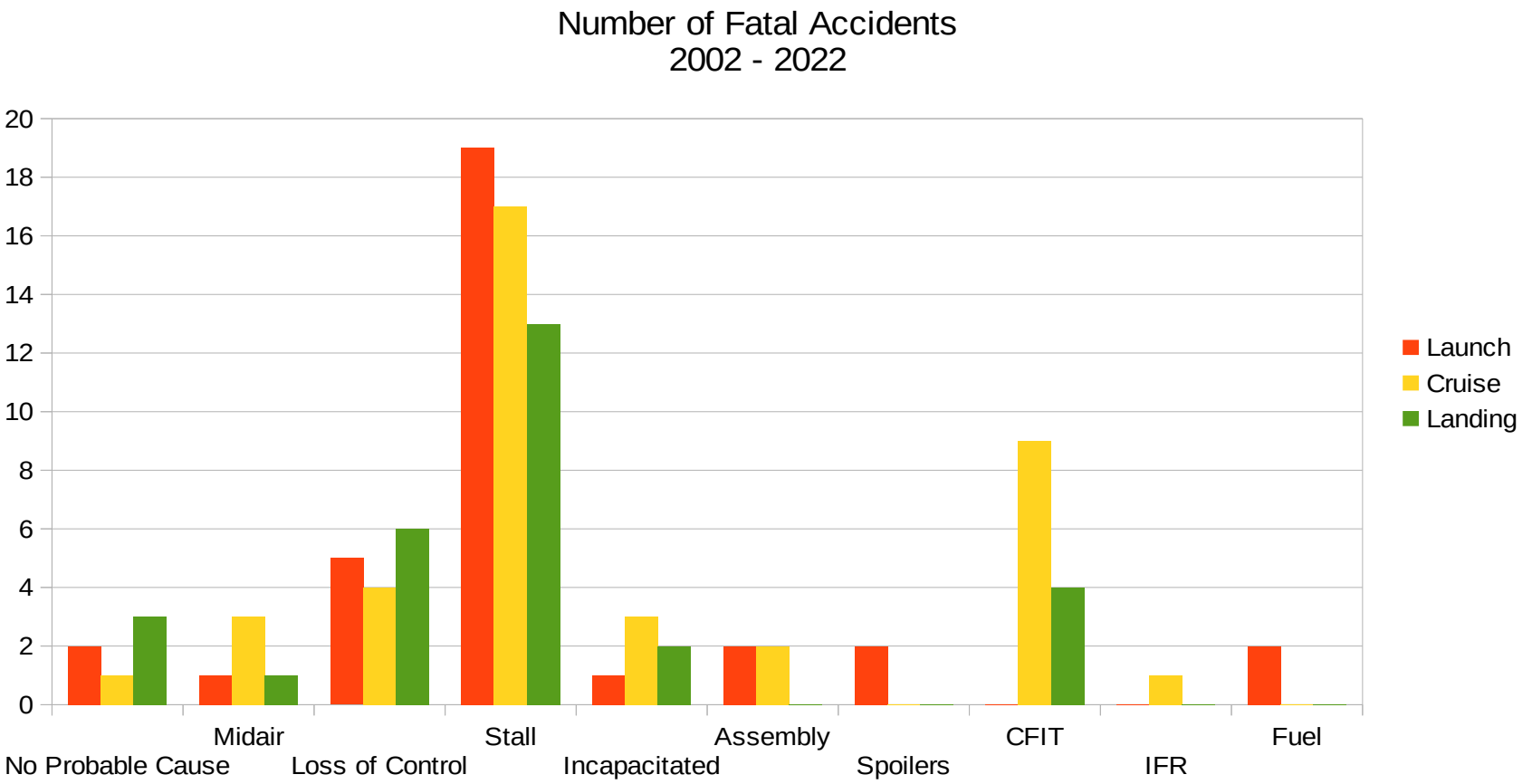


# Accidents by SSA Region

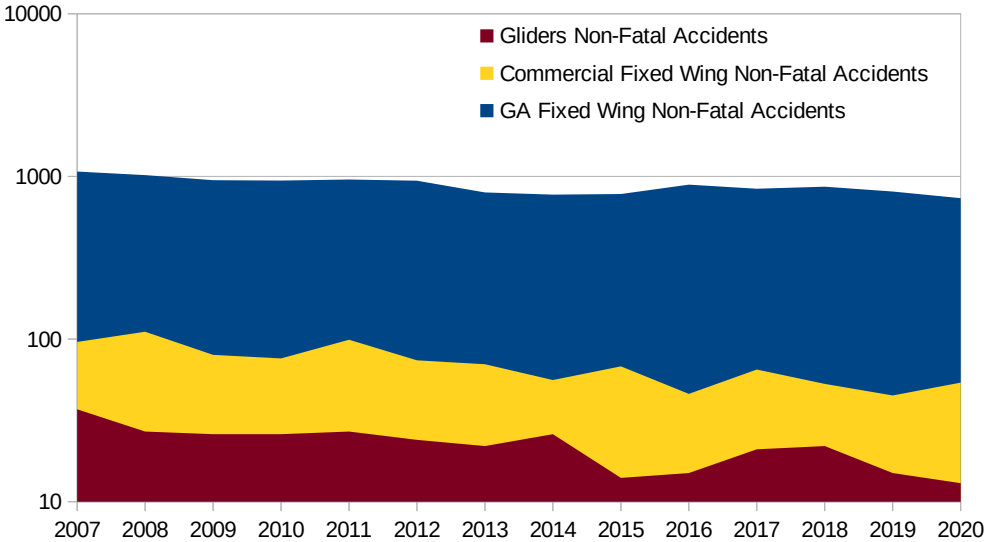


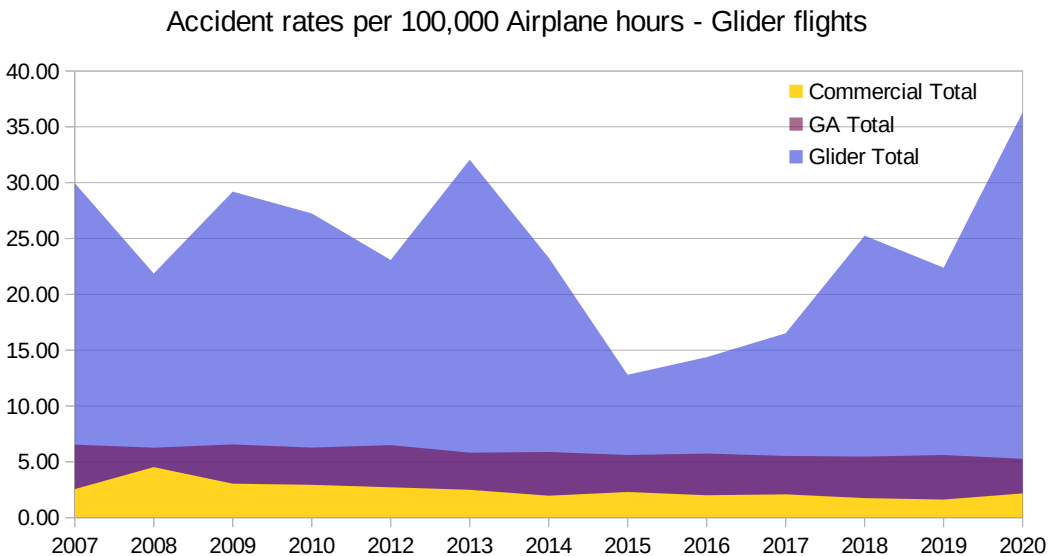
# Fatal Accidents Causal Factors



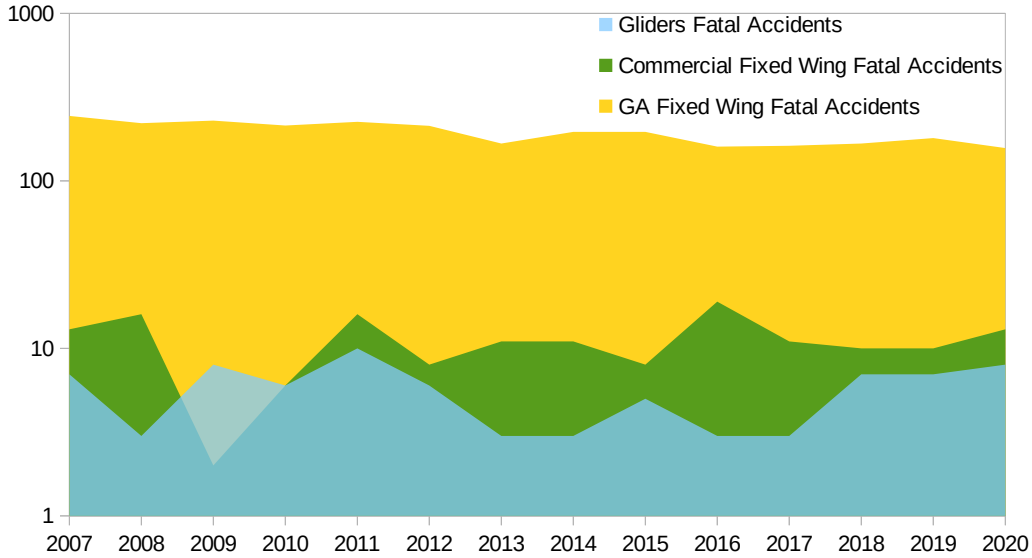
# GA/Glider Total Accident Comparison




Number of Airplane Flight Hours and Glider Flights extracted from FAA Survey Data



# GA/Glider Fatal Accident Comparison

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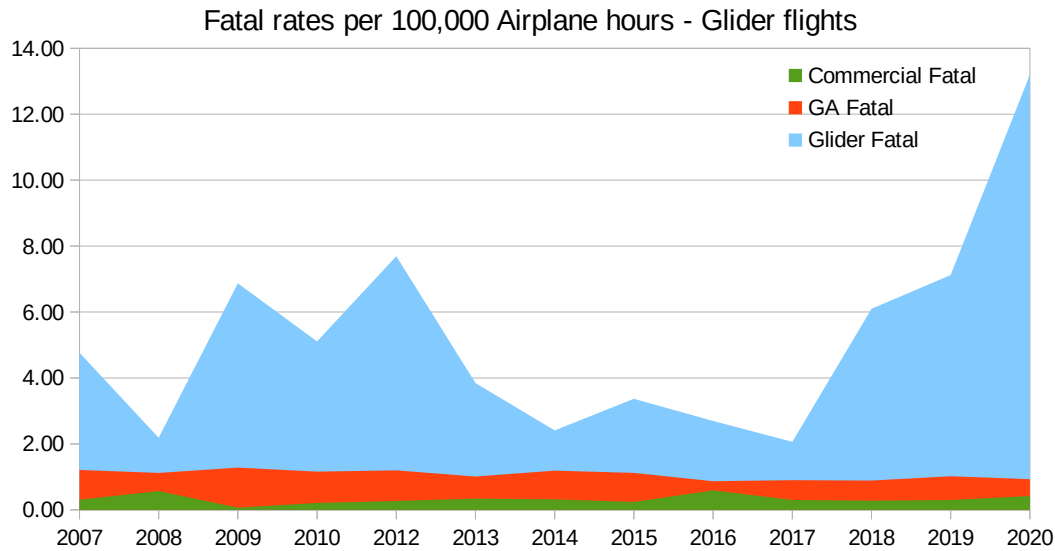
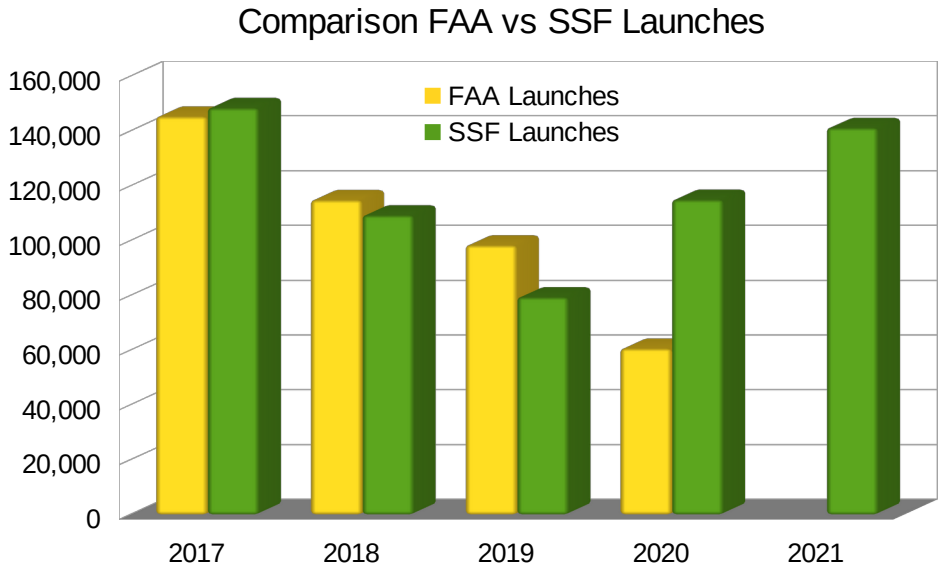
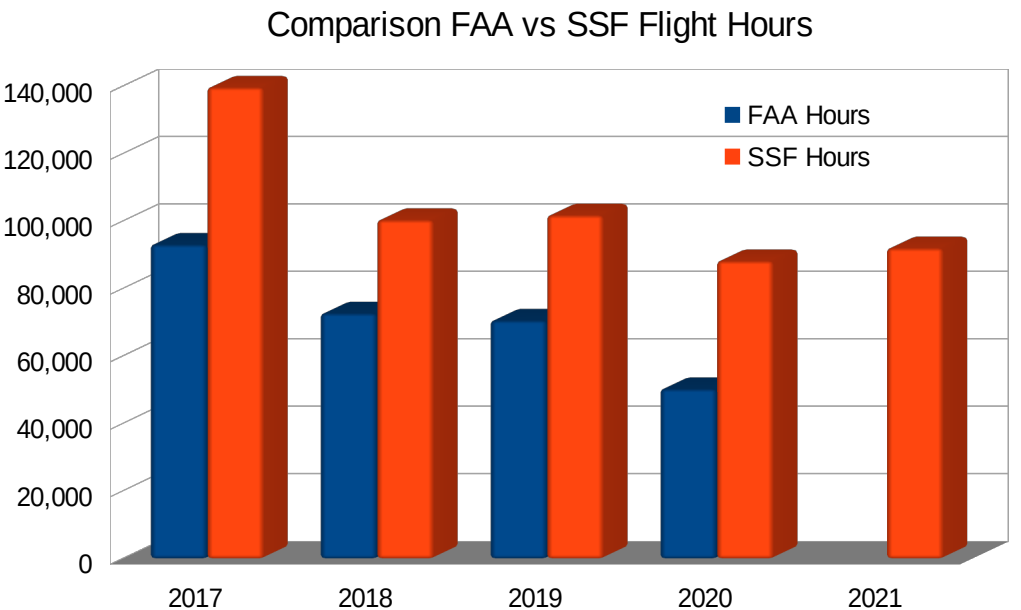
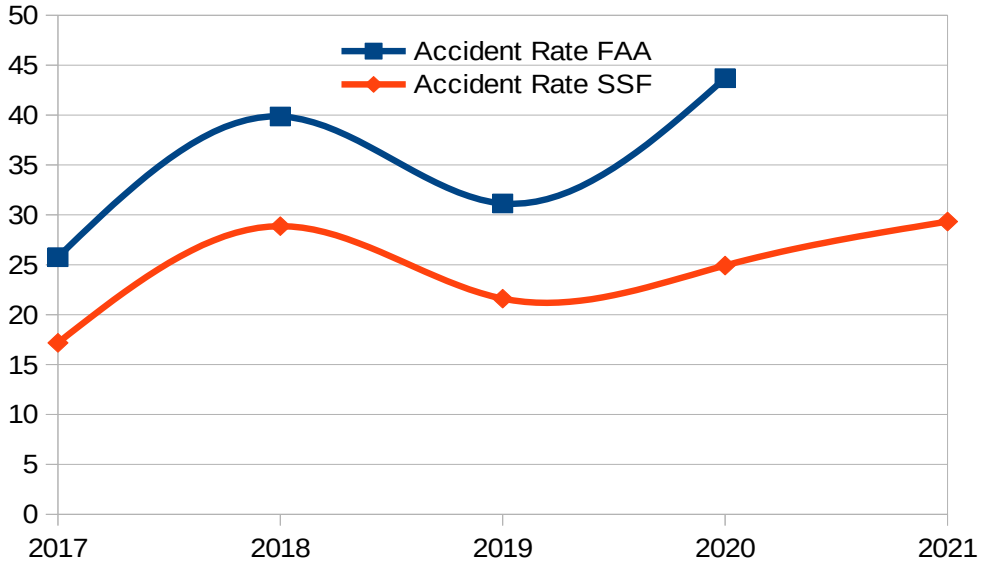


# FAA vs SSF Flight Numbers

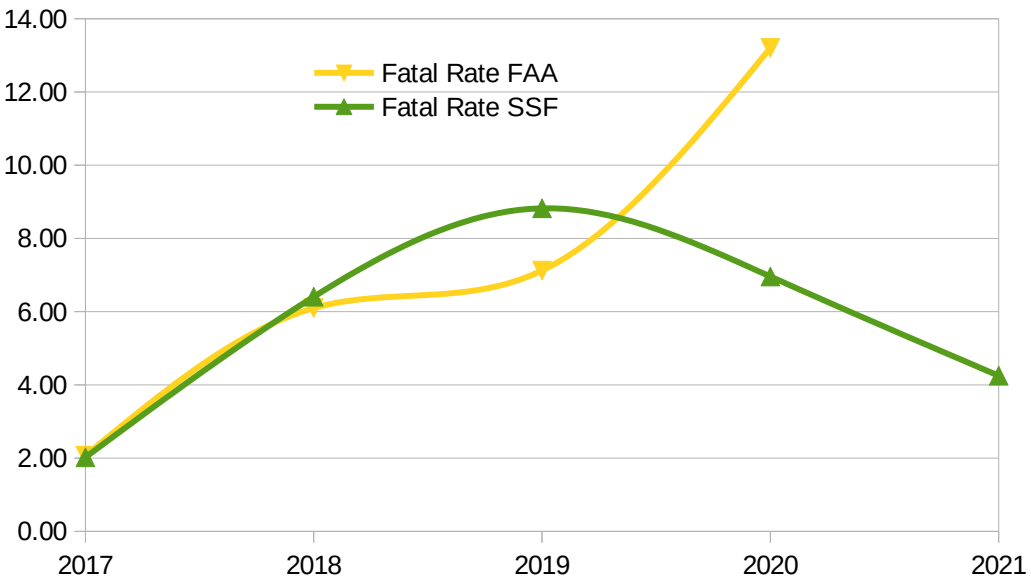


# FAA vs SSF Accident Rates




GA Accident rate is ~5.5 per 100,000 hours

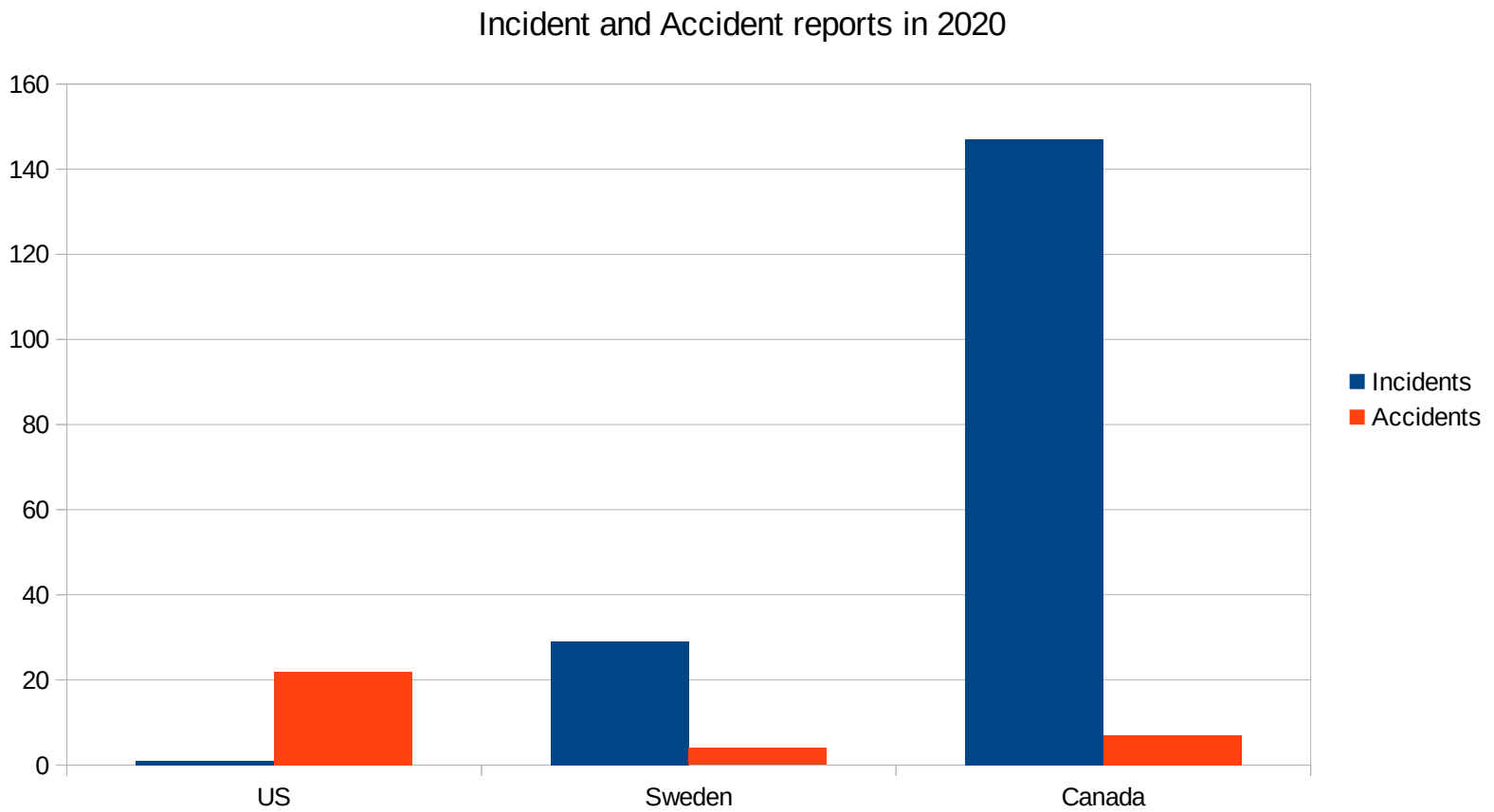



GA Fatal accident rate is ~1 per 100,000 hours

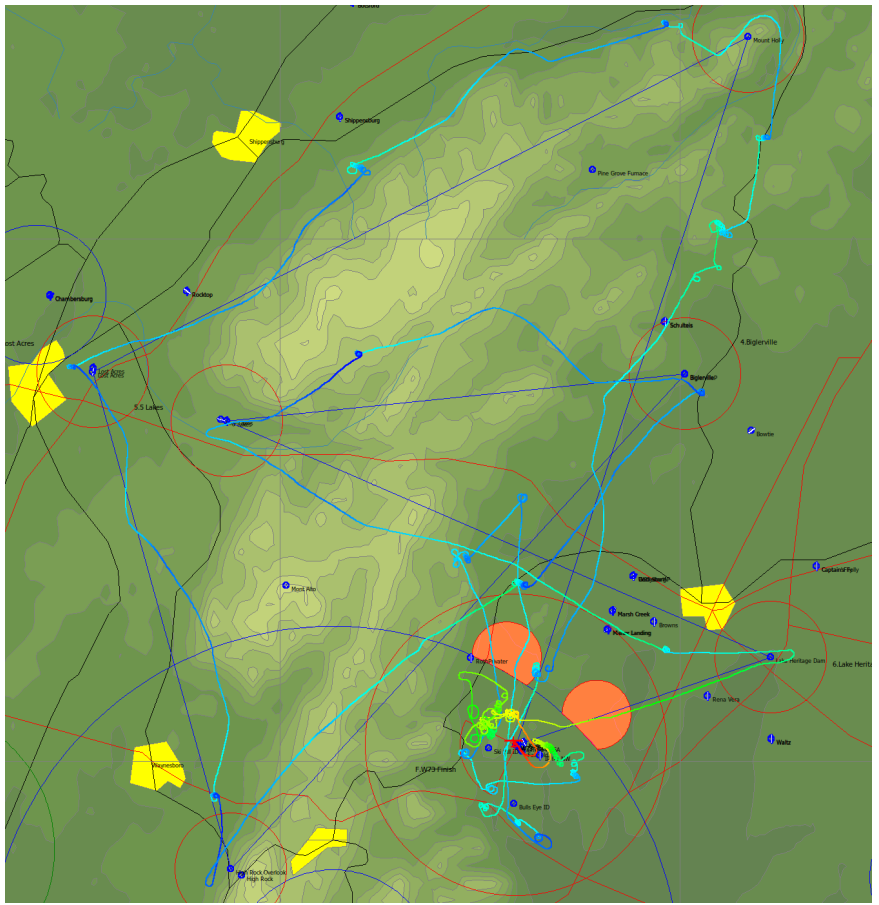
# What do we need going Forward

- More incident reports
- What can flight log data tell us
- Artificial Intelligence – Machine Learning analysis
- Modern Safety Management Systems - Leverage FlyTop

# Incident Reports



# Individual Flight Log Analysis




W73 Start - Mount Holly - Lost Acres - High Rock Overlook - Biglerville - 5 Lakes - Lake Heritage Dam - W73 Finish
Distance: 132.0ml
Start: 18:01:25 at 5410ft
Finish: 20:24:02 at 3076ft
Duration: 02:22:37
Speed: 55.54mph, XC Speed: 52.66mph

| Circling: | Time | Vario | Alt.Gain | Alt.Loss | Thermals |
|---|---|---|---|---|---|
| Total | 00:36:16 (25%) | 3.0kts | 11588ft | -712ft | 14 |
| Left | 00:18:32 (51%) | 2.9kts | 5689ft | -269ft | 6 |
| Right | 00:17:44 (49%) | 3.0kts | 5899ft | -443ft | 8 |
| Tries (<45s) | 00:01:56 (1%) | -1.7kts | 66ft | -404ft | 6 |

| Straight: | Time | Dis.Done | Alt.Gain | Alt.Loss | Avg.Speed | Glides | Avg.Glide | Mean L/D |
|---|---|---|---|---|---|---|---|---|
| Total | 01:46:20 (75%) | 145.2ml | 11781ft | -24990ft | 82mph | 14 | 10.4ml | 58.0 |
| Rising | 00:30:28 (29%) | 37.0ml | 3.8kts | | 73mph | | | -17 |
| Sinking | 01:15:52 (71%) | 108.2ml | | -3.3kts | 86mph | | | 23 |

Vario

| <1.5 | 2 | 3 | 4 | 5 | 6 | 6.5> | [kts] |
|---|---|---|---|---|---|---|---|
| 8.5 | 5.9 | 6.9 | 6.1 | 4.9 | 2.7 | 1.1 | [min] |
| -197 | 1207 | 2175 | 2503 | 2516 | 1709 | 961 | [ft] |

Altitude

| <2250 | 2500 | 3000 | 4500 | 5000 | 5500 | 6000 | 6250> | [ft] |
|---|---|---|---|---|---|---|---|---|
| 0.5 | 4.1 | 1.2 | 6.1 | 8.9 | 10.2 | 4.8 | 0.5 | [min] |
| 0.2 | 1.3 | 2.8 | 2.2 | 3.3 | 3.5 | 3.8 | 3.6 | [kts] |

Speed

| <65 | 70 | 80 | 90 | 95> | [mph] |
|---|---|---|---|---|---|
| 5.2 | 17.5 | 42.8 | 33.6 | 7.2 | [min] |
| 5.2 | 20.7 | 57.3 | 50.3 | 11.7 | [ml] |
| -102 | -420 | -3455 | -6572 | -2661 | [ft] |

W73 Start - Mount Holly
Distance: 24.6ml
Start: 18:01:25 at 5410ft
Finish: 18:27:26 at 5382ft
Duration: 00:26:01
Speed: 56.82mph, XC Speed: 56.49mph

| Circling: | Time | Vario | Alt.Gain | Alt.Loss | Thermals |
|---|---|---|---|---|---|
| Total | 00:10:28 (40%) | 1.8kts | 2320ft | -394ft | 4 |
| Left | 00:03:12 (31%) | 3.2kts | 1060ft | -26ft | 1 |
| Right | 00:07:16 (69%) | 1.2kts | 1260ft | -367ft | 3 |
| Tries (<45s) | 00:00:24 (2%) | -2.6kts | 0ft | -105ft | 1 |

| Straight: | Time | Dis.Done | Alt.Gain | Alt.Loss | Avg.Speed | Glides | Avg.Glide | Mean L/D |
|---|---|---|---|---|---|---|---|---|
| Total | 00:15:32 (60%) | 20.1ml | 1604ft | -3556ft | 78mph | 5 | 4.0ml | 54.3 |
| Rising | 00:04:20 (28%) | 5.0ml | 3.7kts | | 69mph | | | -16 |
| Sinking | 00:11:12 (72%) | 15.1ml | | -3.1kts | 81mph | | | 22 |

Vario

| <1.5 | 2 | 3 | 4 | 5 | 5.5> | [kts] |
|---|---|---|---|---|---|---|
| 4.0 | 2.7 | 2.4 | 0.8 | 0.5 | 0.1 | [min] |
| -138 | 600 | 778 | 328 | 266 | 92 | [ft] |

Altitude

| <4750 | 5000 | 5250> | [ft] |
|---|---|---|---|
| 4.4 | 4.0 | 2.1 | [min] |
| 1.2 | 2.3 | 2.1 | [kts] |

Speed

| <65 | 70 | 80 | 85> | [mph] |
|---|---|---|---|---|
| 1.6 | 3.5 | 8.1 | 2.3 | [min] |
| 1.7 | 4.2 | 10.9 | 3.3 | [ml] |
| -197 | -387 | -928 | -440 | [ft] |

# Safety Analysis of Flight Logs

## Data extraditable from Trace Files

1) Launch method (aerotow, ground, self)
2) Low altitude maneuvering
   - i: PT3 practice procedures
   - ii: Low saves
   - iii: Landouts with poor patterns
   - iv: Landing pattern
3) Engine operation
   - i: Self launch behavior
   - ii: Restart altitudes and results
4) Airspace infractions
   - i: Class B, C, D, SUA intrusions
   - ii: Class A operations (outside wave windows)
5) Trace correlation
   - i: Near misses
   - ii: Thermaling etiquette

## Possible Safety implications

1) Conformation with other sources
2) Loss of Control
   - i: Impulsive or planned response
   - ii: Low altitude maneuvering
   - iii: Poor decision skills
   - iv: Failure to account for conditions
3) Engine operation
   - i: Early turnout or shutdown
   - ii: Poor decision skills
4) Airspace infractions
   - i: Loss of Situational Awareness
   - ii: Poor decision skills
5) Trace correlation
   - i: Over-reliance on electronics
   - ii: Poor visual scanning techniques

# AI/ML Analysis

- What can Artificial Intelligence / Machine Learning do for us?
- Need to know what to look for (Probably Causes)
- General statistics not Individual accidents

# Flight Safety Evolution

- Rules and Regulations
- Accident and Incident investigations
- Human Factors and ADM/RM
- Modern Safety Management Systems using Pro-Active error recognition and remediation
- Identify trends and organizational directions, NOT individual pilot mistakes or actions

# Learning FLYTOP

- FLYTOP is a German program developed to promote a more pro-active safety culture
- Create multiple barriers to provide multiple opportunities to identify risks
- A training program focused on changing pilot and organizational behavior in order to prevent accidents
- Instead of waiting for an incident to happen, challenge your members to bring issues and concerns to light
- Then make sure some action is taken and document what happens

# Safety Implementations

## Reactive

- Identify critic errors once they occur and cause an incident
- Analyze the causal factors and associate blame
- Everyone knows as word of mouth spreads the story
- Develop rules and procedures to prevent a future occurrence

## Pro-Active

- Learn from errors instead of from accidents or incidents
- Document problem and solutions
- Inform everyone of the solution in a positive manner
- Tap into the knowledge and experience of your members
- Pilots are not alone, learn from unsafe acts, teach the organization

# Implementing FLYTOP

- Present this Pro-Active approach to your members and friends
- Challenge members to identify 1 potential safety or operational activity that needs to be examined every flying day
- Identify a lead member who can receive reports or answer questions
- Clearly show that reports lead to positive change not recriminations and finger pointing

# Implementing FLYTOP

- What are some examples of flight or ground operational issues that should be reported
  - Missed Checklist Items
  - Canopy left open and unattended
  - Tail dolly left on while glider is parked
  - Hanger rash
  - Runway incursions by members or non-members
  - No wing walker while using tow-out gear
  - Glider overrunning towing vehicle

# Conclusions

- Significant amounts of incident and accident data is missing
- Clubs and Commercial operators can provide anonymous data on an annual basis
- Flight Log data may provide insights
- Modern analysis algorithms (Artificial Intelligence - Machine Learning) may be useful
- Modern Safety Management Programs (FlyTop) will make a difference