GET UP TO SPEED WITH BALLAST

Thinking of using water ballast to speed up your task? Tony Cronshaw asks coach Kevin Atkinson how to get started and the best strategies

ADVANCED pilots always seem to load water ballast and achieve very impressive task speeds. Tony Cronshaw talks to leading coach Kevin Atkinson, to find out how up-and-coming pilots can progress to using water ballast.

TONY: ***The logic that a heavier glider can achieve a faster cross-country speed seems slightly bizarre. What's the technical explanation for this?***

KEVIN: This is another of those interesting sweet spots in gliding. As we know, there is an optimum speed-to-fly between thermals (neither too fast nor too slow) for each glider type. Similarly there will be an optimum all-up-weight (neither too light, nor too heavy) to achieve the fastest task speed in given conditions. If the glider is flown too light, we are like a feather that climbs well in a thermal, but has poor penetration in the glide, especially into a headwind. If we are too heavy, we penetrate well, but it becomes difficult or impossible to climb in a thermal.

Fin ballast can correct the C of G (see glider manual) and alleviate unwanted up-elevator drag. It also improves manoeuvrability in turns (Kevin Atkinson)

TONY: ***Is the best strategy to start with full ballast and then dump part of it in the first thermal or two to find the sweet spot?***

KEVIN: That can work, but surprisingly competition pilots often complete their task without dumping any water.

TONY: ***How do they manage that? How can the sweet spot be a heavily ballasted glider?***

KEVIN: For very skilled pilots, a heavily ballasted glider may be the optimum as they employ numerous tactics to skew the sweet spot to the heavy end. These pilots know that ballast will help their final glide and are loathed to dump it even if conditions are momentarily poor. Better conditions ahead mean that survival and progressing slowly makes sense. Further tactics include setting off on task unduly heavy for the strength of initial thermals and routing along lines of energy. Advanced pilots are also very good at finding the best cores despite most thermals being mediocre.

TONY: ***What are the implications for the up-and-coming pilot?***

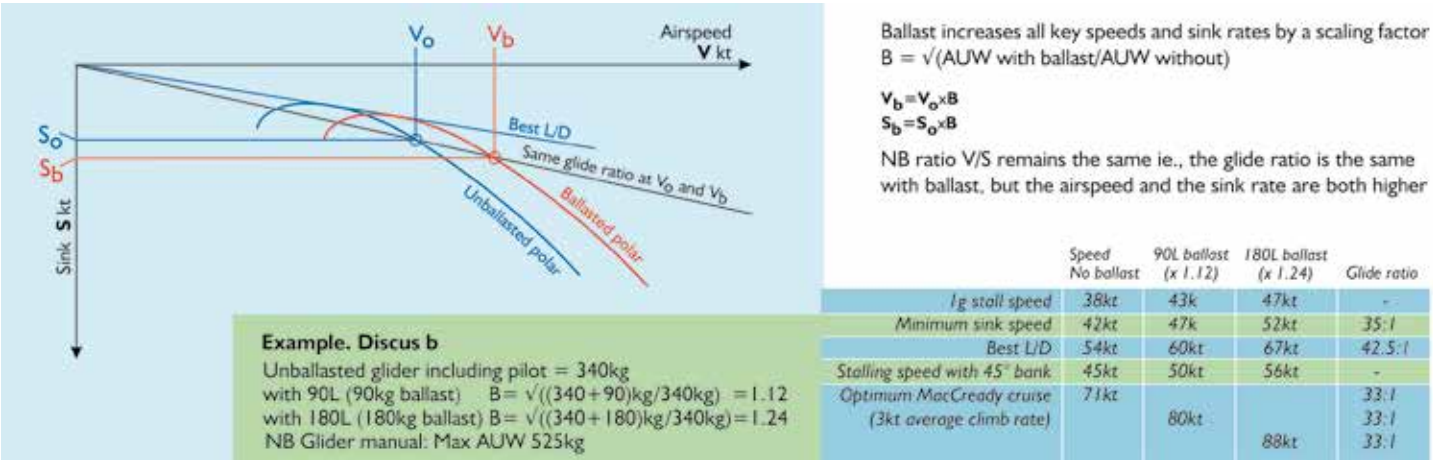
KEVIN: Quite simply, the sweet spot will be in a different place. Clearly, the pilot MUST be able to climb despite carrying water ballast, so it's partly a question of the pilot's skill to find decent thermals and knowing which thermals to ignore. Otherwise the first climb taken in a weak thermal will mean dumping all the ballast. It's also a question of the pilot's ability to centre the thermal efficiently. A pilot who can locate the core and stay in the core can afford to carry more ballast than the pilot who circles around the core, or is in and out of the core all the time.

TONY: ***What guidelines would you suggest to help getting started using water ballast?***

KEVIN: Let's consider a pilot who has a certain amount of cross-country experience, enough to achieve average climb rates over 2.5-3kts and task speeds over 65-75km/h (otherwise keep working at your climb rate and routing skills [1]). This suggests it's time to start trying water ballast on the stronger days. For the first few flights, I would recommend loading one to two barrels per wing (ie a total of 50-100L) because the feel and handling of the glider will change and it will take time to get used to that.

TONY: ***What about the practicalities of loading the water?***

KEVIN: Read the manual and talk to someone familiar with the water ballast system on your glider and the recommended loading method, eg a small pump into a gravity feed funnel, or a self-priming syphon. Pressurised water sources should not be used



	Speed No ballast	90L ballast (x 1.12)	180L ballast (x 1.24)	Glide ratio
1g stall speed	38kt	43k	47kt	-
Minimum sink speed	42kt	47k	52kt	35:1
Best L/D	54kt	60kt	67kt	42.5:1
Stalling speed with 45° bank	45kt	50kt	56kt	-
Optimum MacCready cruise (3kt average climb rate)	71kt	80kt	88kt	33:1 33:1 33:1

Figure 1 (Steve Longland)

in case the ballast tanks (or bags) are over-pressured and burst. Similarly, there will be procedures for the vents that let out the air while water is loading. Note that if a vent is taped over while waiting to launch, the tape must be removed before launching or the tank may not drain later in flight. For some glider types a vent tube will need hooking up at the wing root during rigging. If water is tending to leak out of ageing ports, try applying some Vaseline to the port/valves to stem the flow.

TONY: ***What sort of handling changes should the pilot be aware of?***
KEVIN: It's important to understand the theory and implications of water ballast. It's not all about performance, it's also about understanding safety implications. Look at the polar in the glider manual and see how it changes as the wing loading is increased. Note that ALL the familiar speeds – including all the stall speeds – will be higher for a given attitude. Note also that the increased cruise speed will be very helpful when combatting a headwind.

TONY: ***An example is shown in figure 1 (above) for a Discus b. With half ballast (90L), all speeds increase by 12 per cent whilst achieving the same glide angle, so this will be very helpful in the cruise and on final glide. Full ballast speeds would increase speeds by a huge 24 per cent, though thermals would need to be very strong [4] to warrant this. However, with ballast on board, will the climb rate suffer and possibly neutralise these advantages?***
KEVIN: The climb rate with ballast on board inevitably must suffer. It's very difficult to quantify by how much, but experienced pilots report that they can often climb successfully in the core and maybe don't lag that far behind lighter machines which have reached the top of the same bubble.

TONY: ***We also need to factor in how much of the flight is spent running lines of energy without circling, in which case the ballasted glider easily out-runs the lighter glider.***
KEVIN: I would add it's worth doing a bit of research to find out how different types of glider are suited to ballast [2], [4]. Note also that flapped gliders will have the edge over unflapped machines. Positive flap will help with slower, tighter thermalling. Neutral-to-negative flap will help with a faster cruise. This flexibility is exactly what is needed in strong conditions.

TONY: ***Since the stall speeds are higher, what are the implications, eg on aerotow?***
KEVIN: It's vital to stay well clear of stalling on aerotow. A stall on the early climb-out could be catastrophic, so the tug pilot MUST be informed that the glider has ballast on board so that sufficient towing speed is used, and avoid steep turns when low [3]. Remember on aerotow we need sufficient margins of airspeed to handle the effects of the tug's downwash (not the same as of the prop wash, which is below the downwash), which cause us to increase the glider's angle of attack on tow. We therefore operate a bit nearer the stall than you might think.

TONY: ***What about preparing for the launch?***
KEVIN: Before the launch, ensure wings are held level for long enough for the water to come to rest in a balanced state: When parked with a wing down, all the water in one wing may have migrated towards the tip, in the other wing to the root. So ensure the wing runner is briefed or else a wing is likely to drop. NB: don't follow the example of some pilots, who continue to tow with a

THE PREVIOUSLY LEARNT INTUITIVE FEELING OF HOW TO CENTRE WILL NEED TO BE ADAPTED

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■ Kevin's book *Gliding in Lift and G-SINK* is available at *www.bgashop.co.uk* or direct from *kratkinson@yahoo.com*

Luke Dale dumping water on return to Lasham (Chris Sterritt)

[1] *Another two barrels please*, Ed Johnston, *S&G,* pp22-25, June/July 14
[2] *To water or not to water?* Tim Macfadyen, *S&G*, pp8-11, Feb/March 14
[3] *Water hazards*, Paul Fritche, *S&G*, pp18-19, April/May 14
[4] *Water: help or hindrance?* Bernard Eckey, *S&G*, pp34-37, Aug/Sept 14

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dropped wing – immediately release. The risk of a ground loop is not worth it.

TONY: ***What about the implications for speeds when thermalling?***
KEVIN: When circling we have to fly faster, so our circling diameter increases [4]. Staying in the core will be more difficult as a result. Moreover, since the ballast is carried in the wings, the glider is less responsive when rolling into a thermal, or when changing bank to re-centre. The previously learnt intuitive feeling of how to centre will need to be adapted.

TONY: ***Are there further safety related issues to be aware of?***
KEVIN: I don't recommend landing with water ballast. Although it may be permitted according to the glider manual, we don't want to get caught out by the approach speed needing to be higher, or the change of handling feel during the flare/float and a much longer ground run. Obviously, we should dump the ballast well before a field landing is threatening and try to soar away. I would also avoid the temptation to winch launch heavy.

TONY: ***What's the aim of tail ballast?***
KEVIN: Loading water ballast typically brings the C of G forward, so a fin tank is sometimes provided to allow a balancing amount of water to be loaded in the tail. This overcomes the issue of flying with a nose-heavy glider that needs a lot of back-trim and associated up-elevator losses (see photos on p12).

TONY: ***What are your recommendations on dumping water?***
KEVIN: Avoid dumping water when circling with others below you: It's very unfriendly if they are "washed out" of the thermal. Remember then to re-programme your flight computer for the revised loading. If you want to dump part of your ballast, you need to know the dump rate per minute. A simple test on the ground of dumping a full tank will give you an approximate dump rate per minute.

On final glide we need to open the dump valves in sufficient time – it could take several minutes to drain. Check if you can see it draining from both wings. If you see water is pouring out asymmetrically, prepare for a wing drop on landing, or stop dumping.

TONY: ***Are low temperatures a concern?***
KEVIN: Do not use water – or store water in the glider – when temperatures are approaching freezing. Ice could form on the valve/port preventing tanks from emptying. A frozen tank or fin tank could rupture.

TONY: ***Finally, could you recap the key reasons for using water ballast?***
KEVIN: To be worth the time and effort of loading water ballast, ask yourself the following questions:

- Will thermals be strong enough so that (with pilot's level of thermalling skill) the glider will climb well? This is a must.
- Will the task mean battling against significant headwinds (and routing along streets) where ballast could be a decisive factor?
- Will an incremental improvement on task time (or task speed or task distance) enable you to achieve a sought-after goal?
- Are you able to adapt your handling skills to fly and thermal accurately (perfectly enter the thermal, control the speed, change bank angle precisely), despite the glider operating at higher airspeeds, having far more momentum, and far less roll responsiveness?

This last point is crucial. It will unlock the advantages of carrying ballast, including: flying faster along lines of energy; better into-wind penetration; punching through bad air more quickly; reaching potential lift sooner; and faster final glides. In other words, enable the pilot to step up to a faster tempo of cross-country flying.

■ **In the next *Ask the Coach*, Tony talks to leading coach Kevin Atkinson about about why thermals are NOT all about hot air – and how physics can help us understand and exploit thermals more effectively.**