Ballasted Polar:

with the well known equation for lift:

$$mg = ½ \text{ rho } S V^2 C_a \quad (1)$$

and

$$o = m_b/m \quad (2)$$

o = ballast overload

$m_b$ = ballasted mass

m = unballasted mass as from reference polar

we solve eq. (1) for V

$$V = \text{sqrt}(m g / ½ \text{ rho } S Ca)$$

as we can consider everything except mass m as constant in the above expression we can conclude:

$$V_b / V = \text{sqrt}(m_b / m) = \text{sqrt}(o) \quad (2)$$

or

$$V = V_b / \text{sqrt}(o) \quad (3)$$

with the second order approximation for sink:

$$\text{Sink}(V) = a0 + a1 V + a2 V^2 \quad (4)$$

and (3) in (4), we get for the ballasted sink:

$$\text{Sink}_b(V_b/\text{sqrt}(o)) = a0 + a1 (V_b/\text{sqrt}(o)) + a2 (V_b/\text{sqrt}(o))^2$$

or

$$\text{Sink}_b(V_b) = \text{sqrt}(o) (a0 + (a1 / \text{sqrt}(o)) V_b + (a2 /o) V_b^2)$$

or, as now we have the same speed $V_b$ left and right of the equation.

$$\text{Sink}_b(V_b) = a0 \text{ sqrt}(o) + a1 V_b + (a2 / \text{sqrt}(o)) V_b^2$$

or more common as above formula works for any speed covered by the new polar:

$$\text{Sink}_b(V) = a0 \text{ sqrt}(o) + a1 V + (a2 / \text{sqrt}(o)) V^2$$

So finally we get the polar translated for the ballasted case and thats what we do today in XCS and also XCV when user increases ballast.