Stage tuning 2008 SkiDoo XP800R

This stock XP800R with several hundered trail miles on it was brought for stage tuning by Richard Lavanant. Jim Cooper assisted with his SkiDoo computer to monitor engine operation including coolant temperature and detonation. Jim also can quickly advance/ retard engine timing (plus or minus about three degrees) to optimum.

Dyno testing requires constant coolant temperature to ensure repeatability. With Jim making sure all dyno tests were done with the same coolant temp, we were able to repeat every test within less than 1/2%. All multiple tests were averaged.

Airflow measurement with stock air system with cowl air inlet is impractical, so that data is not shown in the first phase of this test session.

We began the day with dyno room air temps in the low 50's F, and it tailed off to the high 40's by day's end. Testing carbureted sleds is done with a remote reservoir of gasoline routed through one of the dyno fuel flowmeters, then fed to the sled's fuel pump. We had four gallons of [supposedly] 93 octane gas left from a prior test session.

Beginning the dyno testing to create a baseline with stock 480 main jets, Jim Cooper noticed that his computer indicated that there were unusually high clicks of detonation during the first two dyno tests. So we went to a different gas station for four gallons of 93, and the detonation subsided. Surely that first batch of fuel was substandard, which unfortunately is to be expected 10% of the time we buy high test gas. I'm saving that fuel for my home standby power generator.

The stock airbox was left connected to the stock membrane-covered air inlet that delivers cold outside air to the engine.

Here is the baseline data of this XP800R, stock main jets:

EngSpd	STPTrq	STPPwr	BSFC B	Fuel B	AirTmp
RPM	Clb-ft	CHp	lb/hph	lb/hr	degF
6300	77.1	92.5	0.565	49.3	54
6400	79.4	96.7	0.654	59.6	54
6500	79.9	98.9	0.688	64.1	54
6600	82.2	103.3	0.682	66.4	54
6700	85.4	108.9	0.715	73.3	55
6800	89.1	115.3	0.715	77.8	54
6900	89.6	117.7	0.728	80.8	54
7000	91.8	122.4	0.723	83.4	54
7100	91.8	124.2	0.736	86.2	54
7200	93.0	127.5	0.725	87.2	54
7300	96.2	133.7	0.727	91.7	54
7400	97.6	137.5	0.723	93.7	54
7500	98.1	140.1	0.714	94.3	54
7600	100.6	145.6	0.703	96.5	54
7700	101.2	148.3	0.695	97.2	54
7800	101.1	150.1	0.697	98.7	53

7900	99.8	150.2	0.702	99.4	54
8000	97.5	148.5	0.707	99.1	53
8100	94.5	145.7	0.738	101.3	54
8200	90.5	141.3	0.780	103.7	54

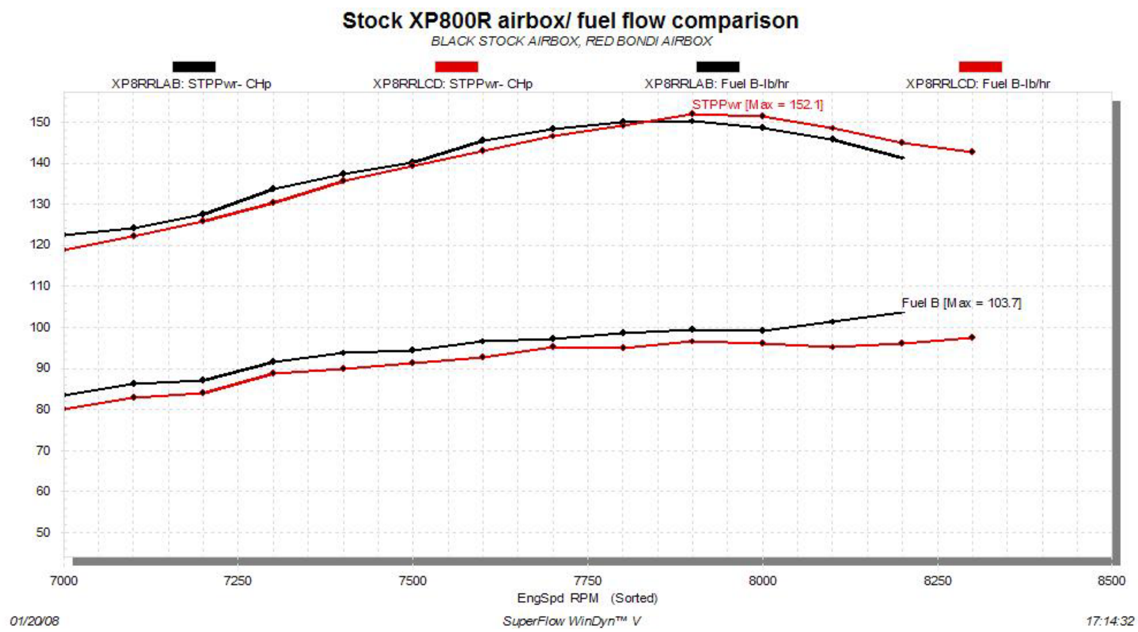
While we were doing the previous baseline testing we measured airbox internal pressure with a Boondocker water pressure measuring device. This is a graduated (in inches) glass beaker of water with a smaller glass tube glued inside--the smaller tube is connected by a hose to the pressure source. Negative pressure will pull water up the smaller tube; positive pressure will force water down the smaller tube. Interestingly, even at idle, there appears to be several inches of H2O *positive* air pressure inside the airbox. And some positive pressure appears to be maintained to the HP peak, all of this with the dyno blowers directed away from the stock air inlet. Since there was eight feet of 1/8th inch hose connecting the airbox chamber to the pressure meter taped to the dyno window, and the water column acts as a dampener, we couldn't see the pulses that surely occur inside the box as pistons rise and fall. But the average seems to be slightly positive. If my readings are accurate, this would indicate that the stock airbox creates absolutely zero restriction, all the way to peak revs even with the membrane cover on the hood opening. Could the venturi in the box inlet be helping create positive pressure pulses? So how can cutting holes in the airbox, or removing that venturi in the inlet reduce fuel flow (and add slight HP)? The DPM uses what appears to be the very slightly positive average pressure on the inlet of the carbs to *pressurize* the float bowls at idle, thus enrichening base fuel flow. So is it possible that removing that positive pressure might reduce fuel flow (and possibly compromise the operation of the DPM, which is supposed to compensate for altitude/ temp?). I don't pretend to understand all the operation of the DPM, but it would be good to assess airbox tuning sometime with a more accurate and quicker responding pressure transducer measuring pressure waves in the stock airbox, and inside the float bowls (Kevin Cameron has addressed this sort of planned airbox design phenomenon in the DTR archives on this website).

Until we obtain that real-time measuring equipment, we can only surmise. For now, here is the data of the Bondi airbox with larger, but venturi-less inlet. Note that fuel flow is reduced from nearly 100 lb/hr stock to 96 lb/hr. HP is increased by two at peak and beyond, but midrange HP is reduced probably because of the higher pipe center section temp. Since the stock jetting is rich, we may have matched the Bondi airbox HP by dropping main jet size 4% from 480 to 460 to reduce fuel flow 4%.

Bondi airbox installed with stock main jets:

EngSpd	STPTrq	STPPwr	BSFC B	Fuel B	AirTmp
RPM	Clb-ft	CHp	lb/hph	lb/hr	degF
6300	75.3	90.3	0.630	53.5	56
6400	75.8	92.4	0.727	63.2	56
6500	76.7	94.9	0.724	64.7	55
6600	77.8	97.7	0.703	64.7	55
6700	82.3	105.0	0.714	70.6	55
6800	86.0	111.4	0.720	75.5	55

6900	87.9	115.5	0.707	76.8	56
7000	89.2	118.9	0.715	80.0	56
7100	90.4	122.1	0.722	83.0	56
7200	91.7	125.8	0.710	84.0	56
7300	93.8	130.3	0.725	88.9	56
7400	96.3	135.7	0.703	89.8	56
7500	97.6	139.3	0.696	91.3	55
7600	98.7	142.9	0.690	92.8	56
7700	99.9	146.5	0.691	95.2	56
7800	100.4	149.0	0.677	94.9	56
7900	101.1	152.1	0.674	96.5	55
8000	99.4	151.4	0.673	96.0	55
8100	96.3	148.5	0.681	95.1	55
8200	92.8	144.9	0.704	96.0	55
8300	90.3	142.7	0.727	97.5	55



We installed, dyno tested then afterwards removed an MPRP can muffler because it appeared to increase airflow (note the higher fuelflow), and the reduced restriction/ backpressure was not optimal for 15 seconds at WOT and HP dropped by one. Due to the new for 08 internal stinger in the stock single pipe, noise output was not as bad as with previous non-internal stinger pipes.

Bondi airbox, MBRP can muffler

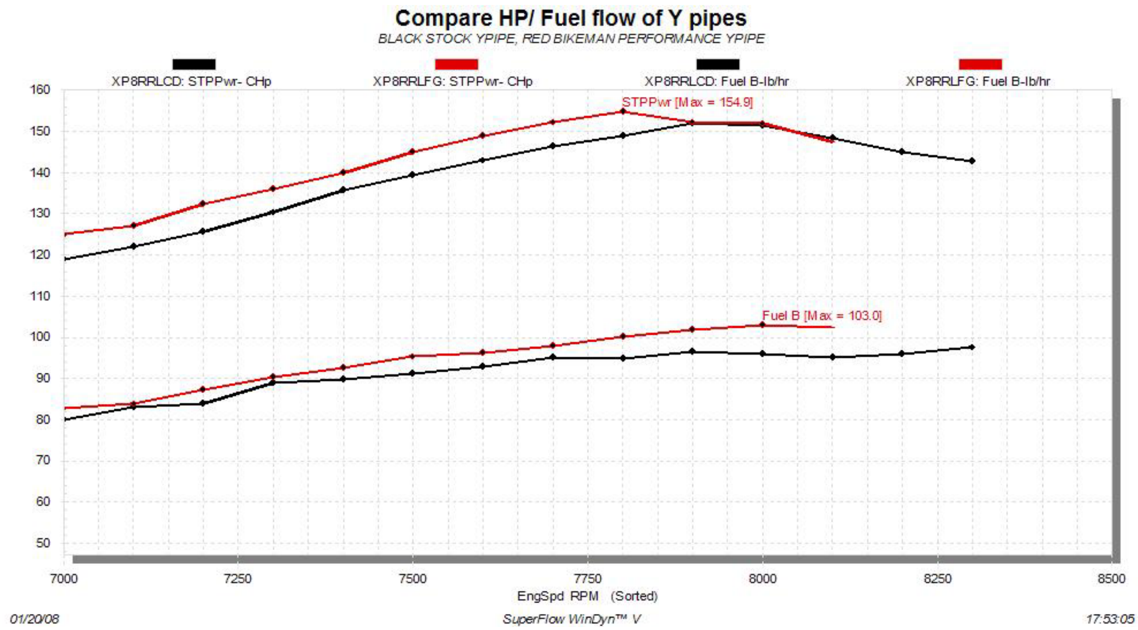
EngSpd	STPTrq	STPPwr	BSFC B	Fuel B	AirTmp
RPM	Clb-ft	CHp	lb/hph	lb/hr	degF
6300	75.9	91.0	0.815	70.0	53
6400	75.8	92.3	0.801	69.8	53
6500	76.5	94.7	0.771	69.0	52
6600	78.0	98.0	0.747	69.2	52
6700	84.8	108.1	0.720	73.8	49
6800	84.8	109.8	0.722	75.1	50

6900	86.1	113.2	0.716	76.7	51
7000	88.8	118.3	0.727	81.3	52
7100	89.4	120.8	0.720	82.2	52
7200	91.3	125.2	0.708	83.8	52
7300	94.9	131.9	0.711	88.7	52
7400	96.6	136.1	0.693	89.1	52
7500	97.2	138.8	0.694	91.0	53
7600	97.5	141.1	0.688	91.7	53
7700	100.9	147.9	0.676	94.5	53
7800	101.3	150.4	0.685	97.1	55
7900	100.3	150.9	0.694	98.8	54
8000	98.5	150.1	0.700	99.0	54
8100	95.4	147.1	0.731	101.4	54
8200	91.6	143.0	0.763	102.8	54
8300	89.2	141.0	0.790	104.9	54

With stock muffler reinstalled, we installed a Bikeman Performance Y pipe. The difference between this Y pipe and the stock pipe is the absence of bolt-access dents, and slightly longer length from ports to donut. The absence of dents appears to add airflow, and move the HP peak to lower RPM. Long ball end allen wrenches and patience are helpful in installing this new Ypipe.

Bondi airbox, BMP Ypipe, stock muffler reinstalled

EngSpd	STPTrq	STPPwr	BSFC B	Fuel B	AirTmp
RPM	Clb-ft	CHp	lb/hph	lb/hr	DegF
6300	77.2	92.6	0.602	52.4	56
6400	78.1	95.2	0.640	57.3	56
6500	78.7	97.4	0.631	57.8	56
6600	84.7	106.4	0.640	64.1	56
6700	87.1	111.1	0.664	69.5	56
6800	89.2	115.5	0.678	73.7	56
6900	90.6	119.0	0.689	77.2	56
7000	93.8	125.0	0.703	82.7	56
7100	94.0	127.0	0.700	83.8	56
7200	96.5	132.3	0.701	87.3	56
7300	97.9	136.1	0.705	90.4	55
7400	99.4	140.0	0.701	92.6	55
7500	101.5	144.9	0.697	95.3	55
7600	102.9	148.9	0.685	96.2	55
7700	103.8	152.1	0.683	97.9	55
7800	104.3	154.9	0.686	100.2	55
7900	101.2	152.2	0.710	101.8	55
8000	99.7	151.9	0.720	103.0	55
8100	95.7	147.5	0.737	102.4	55



Next Jim Cooper used his computer to first advance, then retard timing in small increments. In this case, the stock factory zero setting delivered the maximum HP.

Since we were eventually going to install Boyesen reeds, we next installed our dyno airbox which has a 5 inch hole carved in the left side to accommodate the SuperFlow airflow meter and normal topside inlet duct taped closed. Now we have airflow and A/F ratio readings, and like the Bondi box peak fuel flow was 103 lb/hr. Here is the dyno airbox [new baseline] average numbers with factory stock 480 main jets, same peak HP.

BMP Ypipe, dyno airbox/ airflowmeter

EngSpd	STPTrq	STPPwr	BSFC B	Fuel B	A/F B	AirTmp	Air 2
RPM	Clb-ft	CHp	lb/hph	lb/hr	Ratio	degF	scfm
7000	94.8	126.3	0.704	84.4	12.83	50	236
7100	96.2	130.1	0.702	86.5	12.79	51	242
7200	96.9	132.8	0.693	87.2	12.76	51	243
7300	99.2	137.9	0.697	91.2	12.49	50	249
7400	100.5	141.5	0.687	92.3	12.35	50	249
7500	103.3	147.5	0.687	96.2	11.89	50	250
7600	104.4	151.0	0.683	97.8	11.75	50	251
7700	104.2	152.7	0.679	98.3	11.71	50	251
7800	104.4	155.0	0.703	103.3	11.11	50	251
7900	101.7	152.9	0.712	103.3	11.18	50	252
8000	99.8	152.0	0.719	103.7	11.09	49	251
8100	96.2	148.4	0.737	103.6	11.00	50	249

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Since with all these adjustments so far air/fuel ratio was peaking in the low 11/1 range based upon our new airflow readings, we dropped main jet size 8% to 440, with a corresponding drop in fuel flow lb/hr. Now HP is up and A/F ratio is still-safe 12/1 at HP peak, with very light deto registering on Jim Cooper's laptop in the control room.

Reduce main jet size from stock 480 to 440.

EngSpd	STPTrq	STPPwr	BSFC B	Fuel B	A/F B	AirTmp	Air 2
RPM	Clb-ft	CHp	lb/hph	lb/hr	Ratio	degF	scfm
6200	73.5	86.8	0.892	73.4	11.27	49	181
6300	74.0	88.8	0.842	70.9	11.64	49	180
6400	75.0	91.4	0.810	70.2	11.79	49	181
6500	75.8	93.8	0.784	69.8	11.92	49	182
6600	77.4	97.2	0.720	66.3	13.30	50	193
6700	78.2	99.8	0.699	66.1	13.44	50	194
6800	79.7	103.2	0.676	66.1	13.59	50	196
6900	82.6	108.6	0.661	68.1	13.53	50	201
7000	92.0	122.6	0.670	78.1	13.70	48	234
7100	92.5	125.1	0.663	78.8	13.70	48	236
7200	96.3	132.0	0.684	85.8	13.06	48	245
7300	97.3	135.3	0.677	87.1	13.04	48	248
7400	98.8	139.2	0.664	87.9	13.11	48	252
7500	100.7	143.8	0.657	89.8	13.02	48	255
7600	104.0	150.4	0.652	93.2	12.47	48	254
7700	103.9	152.3	0.648	93.8	12.50	48	256
7800	104.8	155.7	0.650	96.1	12.19	49	256
7900	103.3	155.3	0.662	97.6	12.09	49	258
8000	101.7	154.9	0.671	98.6	11.85	49	255
8100	99.7	153.8	0.674	98.4	11.93	49	256
8200	96.1	150.0	0.700	99.7	11.75	48	256

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Next we installed a Bikeman Performance billet head with sea level "trail domes". The domes have about stock squish clearance (.055") but squish band is noticeably wider than stock. Chamber shape is more of a hemi-style compared with stock being more like a top-hat design.

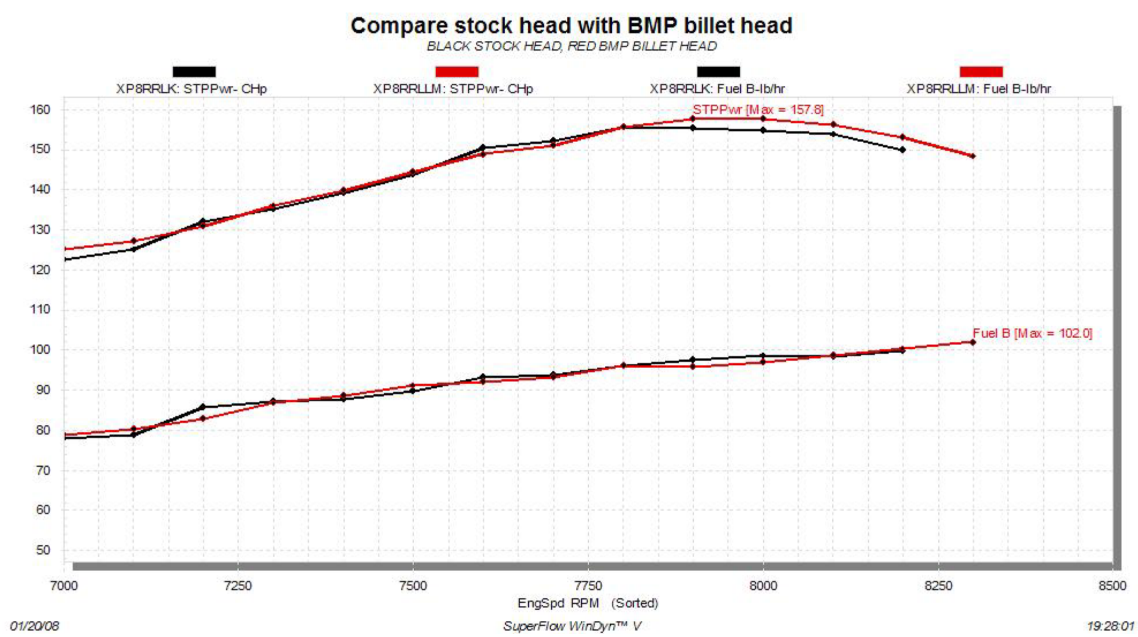
Cranking compression stock was about 160 psi on our gauge with the dyno electric start spinning the engine much faster than can be done with the pull rope. The BMP head registered a tad over 180 psi.

Here is the test data with BMP head. Interestingly the light deto we had been registering with the stock head now had disappeared. Either the BMP head is eliminating some hot-spot in the stock head, or the heavier mass of the billet head is dampening out the light detonation vibrations that were setting off the factory deto sensor.

Remove stock head install BMP billet head.

EngSpd	STPTrq	STPPwr	BSFC B	Fuel B	A/F B	AirTmp	Air 2
RPM	Clb-ft	CHp	lb/hph	lb/hr	Ratio	degF	scfm

7000	93.9	125.1	0.664	78.9	13.14	49	226
7100	94.2	127.3	0.665	80.4	13.02	49	229
7200	95.5	131.0	0.666	82.9	12.92	49	234
7300	97.9	136.0	0.671	86.8	12.67	48	240
7400	99.2	139.8	0.668	88.7	12.42	49	241
7500	101.2	144.5	0.662	91.1	12.35	48	246
7600	102.9	148.9	0.650	92.1	12.33	48	248
7700	103.0	151.0	0.649	93.2	12.17	49	248
7800	104.8	155.6	0.648	96.0	11.85	48	249
7900	104.9	157.8	0.638	95.8	12.02	48	252
8000	103.6	157.7	0.647	97.0	12.09	48	256
8100	101.4	156.3	0.665	98.8	11.83	48	255
8200	98.0	153.1	0.689	100.3	11.73	48	257
8300	93.9	148.4	0.724	102.0	11.56	48	257



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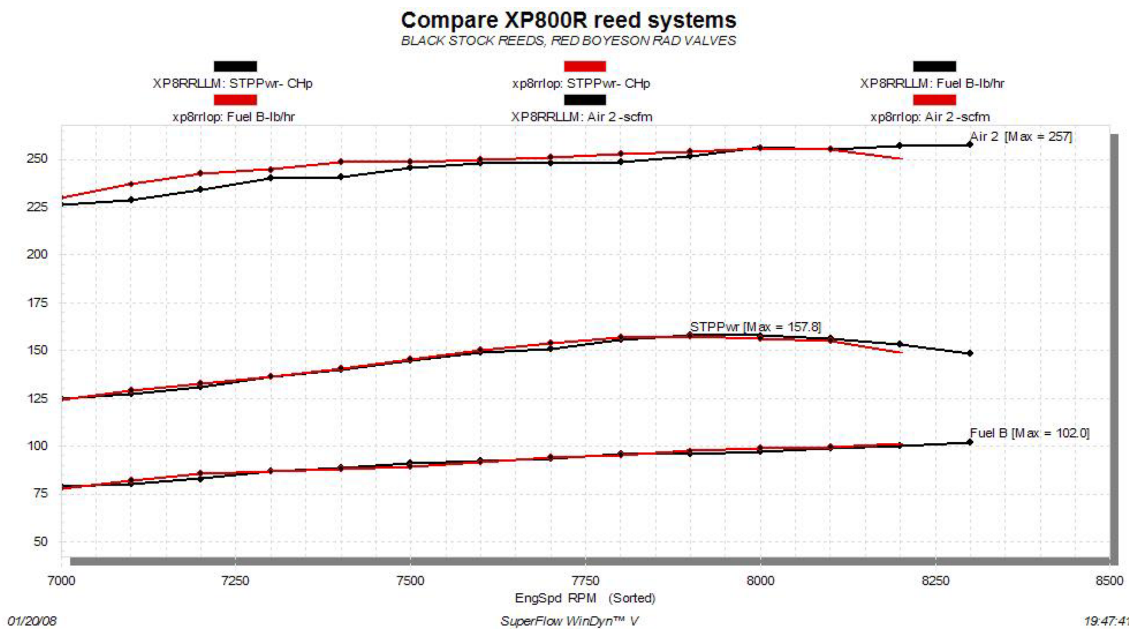
Next we installed Boyesen Rad Valve reed cages and the **X** shaped wing-like airfoils that clip into the inlets or the carbs. The Rad Valves are cast aluminum reed bodies that replace the stock Vforce-style plastic cages, and blend gradually into the inlet of the stock rubber carb boots. Our airflow meter indicated a slight increase in midrange airflow, but airflow at peak HP RPM was nearly identical to stock reeds. Beyond the HP peak stock reeds showed more airflow than the Rad Valves. But overall the HP was about identical between the two sets of reeds.

Remove stock reeds, install Boyesen Rad Valves and wings

EngSpd RPM	STPTrq Clb-ft	STPPwr CHp	BSFC B lb/hph	Fuel B lb/hr	A/F B Ratio	AirTmp degF	Air 2 scfm
7000	93.3	124.3	0.657	78.0	13.48	47	230
7100	95.6	129.2	0.665	82.1	13.20	47	237
7200	96.7	132.6	0.677	85.7	12.96	47	243
7300	98.0	136.2	0.666	86.6	12.93	47	245

7400	99.9	140.7	0.655	88.0	12.93	47	249
7500	101.8	145.3	0.644	89.4	12.74	47	249
7600	103.9	150.4	0.636	91.4	12.52	47	250
7700	104.9	153.8	0.640	94.0	12.22	47	251
7800	105.5	156.7	0.635	95.1	12.16	46	253
7900	104.8	157.6	0.646	97.4	11.94	46	254
8000	102.7	156.5	0.663	99.1	11.81	46	256
8100	100.4	154.9	0.673	99.6	11.74	46	255
8200	95.5	149.0	0.710	101.1	11.34	46	250



The sled owner was hoping for 160 HP after all of this, and since we were out of parts to try we reduced fuel flow from 97 to 94 lb/hr by dropping mains from 440 to 410.

Reduce main jet size from 440 to 410

7000	93.6	124.7	0.686	81.7	12.55	47	224
7100	94.4	127.7	0.676	82.4	12.93	47	233
7200	98.5	135.0	0.640	82.5	13.17	47	237
7300	98.7	137.2	0.654	85.7	12.89	47	241
7400	99.0	139.5	0.646	86.1	12.94	47	243
7500	100.4	143.3	0.635	86.9	12.91	47	245
7600	104.4	151.1	0.603	87.4	12.92	44	247
7700	106.5	156.1	0.610	91.1	12.47	46	248
7800	105.6	156.8	0.609	91.3	12.67	47	253
7900	105.8	159.2	0.619	94.1	12.40	47	255
8000	104.4	159.0	0.628	95.4	12.28	47	256
8100	102.8	158.6	0.624	94.5	12.31	47	254
8200	98.3	153.5	0.642	94.1	12.40	47	255
8300	93.5	147.7	0.683	96.2	12.31	48	259

We removed the Boyesen wing-like devices from the inlets of the carbs, and airflow increased at HP peak RPMs (but airflow dropped beyond HP peak RPM). Fuel flow dropped a few lb/hr, net result HP increased by a few tenths.

Remove wings from carburetor bells

7000	90.5	120.6	0.627	72.4	14.04	46	222
7100	91.4	123.6	0.625	73.8	14.00	47	226
7200	96.1	131.8	0.646	81.3	13.50	48	240
7300	97.9	136.1	0.639	83.0	13.35	48	242
7400	99.6	140.3	0.628	84.2	13.29	48	244
7500	103.4	147.6	0.622	87.7	12.87	47	246
7600	103.2	149.4	0.618	88.3	13.02	46	251
7700	105.1	154.1	0.603	89.0	13.07	46	254
7800	105.1	156.1	0.613	91.6	12.84	46	254
7900	105.8	159.2	0.602	91.5	12.86	47	257
8000	105.0	159.9	0.609	93.1	12.49	47	257
8100	102.8	158.5	0.638	96.7	12.06	46	255
8200	99.2	154.8	0.645	95.3	12.15	47	253
8300	94.7	149.6	0.677	97.0	11.86	44	251
8400	90.6	144.9	0.706	98.0	11.65	44	249

Finally we reinstalled the stock airbox since that's what would be run in the field. Note that the addition of the stock airbox the fuel flow jumped 4 lb/hr to 97 lb/hr. BSFC is now a safer .65 lb/hphr but HP only dropped by 1.4.

Remove dyno airbox, install stock airbox

EngSpd	STPTrq	STPPwr	BSFC B	Fuel B	AirTmp
RPM	Clb-ft	CHp	lb/hph	Lb/hr	degF
6200	76.6	90.5	0.589	51.0	45
6300	75.8	91.0	0.606	52.8	45
6400	78.7	95.9	0.654	60.1	45
6500	79.4	98.2	0.639	60.0	46
6600	86.2	108.3	0.645	66.8	47
6700	88.1	112.4	0.664	71.3	47
6800	89.9	116.3	0.656	73.0	47
6900	90.5	118.9	0.656	74.6	47
7000	94.3	125.7	0.657	79.1	46
7100	95.9	129.7	0.679	84.3	46
7200	96.1	131.8	0.680	85.9	45
7300	96.2	133.8	0.665	85.3	44
7400	100.7	141.9	0.644	87.6	45
7500	102.7	146.7	0.653	91.6	47
7600	102.4	148.2	0.651	92.2	47
7700	103.4	151.5	0.635	92.0	47
7800	104.9	155.8	0.631	94.0	47
7900	104.7	157.5	0.642	96.7	47
8000	102.8	156.5	0.650	97.3	47
8100	100.8	155.4	0.660	98.1	46
8200	97.6	152.3	0.678	98.8	46
8300	92.3	145.8	0.726	101.3	45

Richard bought and installed over a thousand bucks worth of stuff on his XP800R that according to suppliers' claims should have added up to 30 HP over stock. We all know after following this for 20 years that that sort of adding-the-numbers increase is implausible. But the net effect of all of this, not counting added HP from leaning mixture is maybe six HP. But by doing the dyno research, Richard is able to keep the stuff that works and return the stuff that doesn't.

I'm suspecting that Richard will go for big bore cylinders to step up his HP (we've seen over 170 from consumers' pump gas big bore engines).

What about aftermarket single pipes? Bikeman Erich tells me that since the new stock XP800R single pipe has an internal stinger, and the pipe/ pipe mods that have helped the Doo 800s in the past only work on big bore or ported XP800R engines (I've seen that here). Rich Daly of DynoPort has been thrashing madly for a month on his dyno trying to find a pipe/ can combo that will provide meaningful repeatable increases and he's not there yet.

And finally with the deto protection on the new engine why enrichen mixture to .65 for riding at the expense of some HP? The deto protection of the new XP800R is good but if you experience hard deto the ECU will have to be reset by a dealer to eliminate the audio-visual warnings and limp-home performance. It seems likely that this feature might protect SkiDoo from warranty claims that might arise from poor tuning and/ or the use of substandard pump gas (according to Dateline NBC some 93 octane pump gas has been been measured at as low as 75 octane!). So it's wise to play it safe and not worry about 1.5 HP.

More to come.